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VOLUME LII

July 1 to December 31, 1920

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POWER

GENERAL INDEX TO VOLUME LII

July 1 to December 31, 1920

EXPLANATORY NOTE

Illustrated articles are marked with an asterisk (*), book notices with a dagger (†), inquiries with a double dagger (‡). The cross-references condense the material and assist the reader, but are not to be regarded as complete or conclusive. So, if there were a reference from "Boiler" to "Furnace" and if the searcher failed to find the required article under the latter word, he should look through the "Boiler" entries, or others that the topic might suggest, as he would have done had there been no cross-reference. Letters are indexed under title or subject, general articles under writer's name as well. Not all articles relating to a given topic necessarily appear under the same entries.

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POWER

Volume 52 New York, July 6, 1920 *Number* 1

The Federated American Engineering Societies Has Been Organized to Mobilize the Engineering Talent of America and Put the Engineer on the Map

ANY society, club or organization the chief object of which is the advancement of the knowledge and practice of engineering and the application of allied sciences, and which is not organized for commercial purposes, is eligible to membership.

All of the other professions appreciate the value of unity, and each has an integral national organization. The engineers are split up into clans and classes. An engineering society is organized for each new application of the engineering art. If the engineers are to become conscious and appreciative of engineers as a class, if the engineers are to become collectively articulate, they must have some instrument through which they can act, some medium through which they can speak with united effort and with one voice upon questions of public and professional concern.

Such an instrument, such a medium, The Federated American Engineering Societies seeks to be. And it *can* be if it has behind it the sympathetic, interested support of the engineers of America.

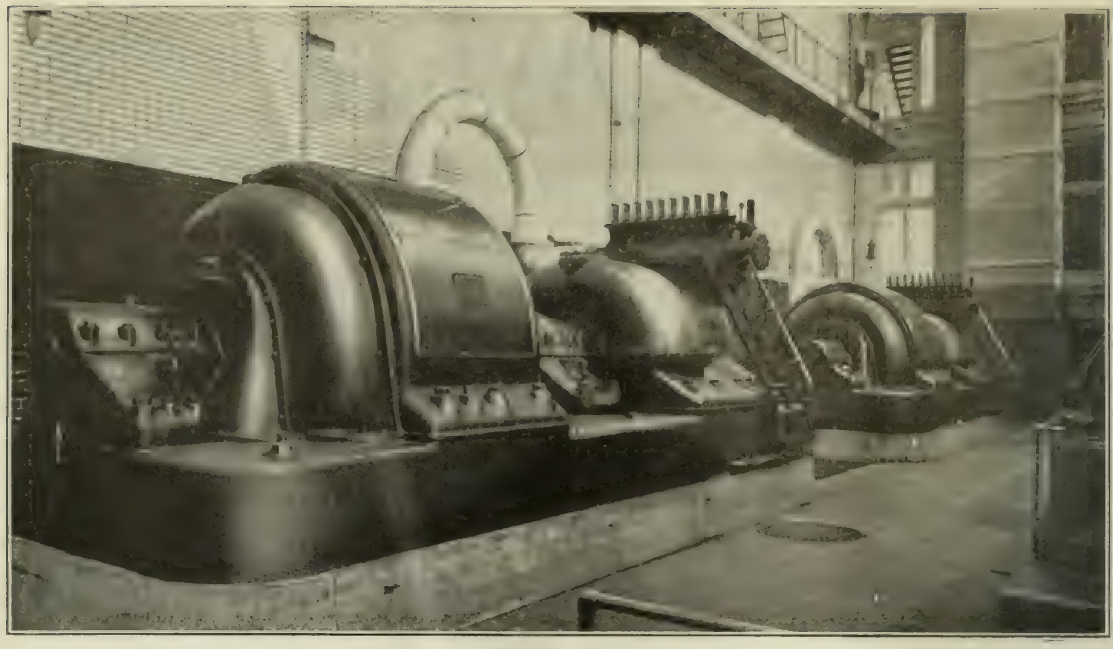
It cannot do this if the engineers who read this say, "It looks all right—let's see how it comes out," and then sit back and see if they can feel any effect.

Its success or failure is going to be spelled by the decision *now* of engineers all over the country whether they will join it or not and how actively they will participate in its activities.

Individual engineers can become connected with it only as members of its constituent societies, but if they feel that it is worth a dollar a year apiece to them to have an organization of this kind constantly working for them, through which they can give expression to their own ideas and effect to their own endeavors, they can urge the organizations to which they belong to join, apply for membership in an eligible society or unite with other engineers in the formation of local organizations which may become member societies of the federation.

The bona fides and high purposes of the movement are assured by the fact that it was inaugurated by, and is being developed under the auspices of, the four great professional engineering societies. The organizing conference has been already held, representatives of societies participating. Engineering Council, Alfred D. Flynn, Secretary, Engineering Societies Building, 29 West Thirty-ninth Street, New York City, is charged with the preparations for its first convention.

What are you going to do about it?



Operation and Adjustment of Turbine Machinery—I
What to Watch When Installing Turbines

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

TURBINE-driven sets in small sizes (below 75 or 100 kw.) are usually installed by the purchaser without the services of a trained erector. In most instances this work falls upon the shoulders of the purchaser's engineer. If not already familiar with turbines the engineer's source of information is usually a manufacturer's instruction book or a few words from an interested salesman; perhaps he may be forced to rely on his own judgment and investigation.

Turbine machinery, especially that which runs at five or ten times the speed of a reciprocating engine, requires different treatment from that given to engines. In general a turbine is relatively smaller and lighter, while the parts receiving the mechanical energy from the steam act at higher speeds and lighter thrusts and require stronger materials. When properly adjusted, a turbine requires less attention, runs longer between shutdowns, and for some classes of work costs less and is more economical than an engine of equivalent horsepower. With a smooth flow of power a flywheel is not so necessary as in reciprocating delivery, although the rotating parts often possess more flywheel effect than that found in an engine. On the other hand, a turbine requires more delicate adjustment and more careful handling of its parts, and is more easily put out of service from internal injury.

When an engine is out of adjustment, it expresses its displeasure by knocking or pounding, while a turbine vibrates or roars.

There are some conditions under which an engine set is to be preferred, and in the early days of turbine building there were many "battles" fought in commercial plants to make turbines operate satisfactorily, so that for several years actual comparisons were often unfavorable.

TURBINE NEEDS ACCURATE ADJUSTMENTS

Since the turbine has come into its own, however, the equipment found in modern power stations testifies to its advantages for such work. The turbine may now be regarded as an improved form of prime mover, which requires less time and attention from the engineer, but more accuracy and skill in adjusting, and which is more difficult to dismantle, repair and assemble, but which, if properly adjusted and cared for, will require it less frequently.

Small sets are usually of sturdy design, require little adjustment and are easy to repair, depending on their special conditions. In general they can be rolled on skids without special regard to deflecting the bedplate, or picked up by a crane with almost any convenient hitch without fear of undue buckling. So the work of placing them on the foundation is not difficult. Usually, no means are provided by the manufacturer for checking the alignment. So in most cases, locating and grouting can proceed without the refinements of checking the leveling or coupling.

These machines are usually shipped completely assembled, or practically so, and there remains little for the engineer to do except to clean thoroughly and connect up piping. It should be borne in mind that cinders and dust, sand, etc., are likely to be carried into the machine in transit, therefore all loosely covered bearings, etc., should be carefully inspected. Before the steam and exhaust connections are made, the steam passages should be inspected with a drop-light to make sure that no bolts, tools, pieces of coal or other foreign objects are lodged in them. Oil can now be supplied and the machine made ready for final inspection and starting.

Bedplate Deflected by Weight of Parts

Medium-sized turbine sets, from 150 to 2,000 kw., are more delicate than smaller sets, and erecting men from the manufacturers usually erect and start them. These are as a rule shipped assembled with the possible exception of small parts.

Bedplates are easily deflected by the weights of the parts carried and should be given uniform support in rolling and handling. In hitching to a crane hook, the heavy elements should be supported individually instead of carrying their weight on an unsupported part of the bedplate.

After placing the machine on the foundation, the alignment should be checked and adjusted. The method most frequently used by manufacturers is that of leveling the bedplate. Small surfaces are placed at convenient points along the bedplate upon which a level may be laid. These surfaces are machined so finely that a very sensitive level will show the same inclination when placed in several positions that are parallel. To bring the surface close to a true plane surface it is usually necessary to grind or scrape it. The various portions of the bedplate are lowered or raised by means of wedges until all surfaces show level lengthwise and crosswise. The level should be so sensitive that when placed one-thousandth of an inch out of level in one yard, the bubble will deflect $\frac{1}{32}$ in.

Other Means of Leveling Turbines

Instead of leveling surfaces, spots are often machined on the bedplate upon which a straight-edge should be rested, upon which the level is placed. Wedges under the bedplate are then adjusted as before until the straight-edge may be placed across any two spots, both lengthwise and crosswise, and indicate a true level.

There is still another method of leveling in frequent use where the bedplate is not suitable for either of the aforementioned arrangements. In this case uprights are bolted and doweled to various parts of the set and so machined that their upper ends can be leveled by means of straight-edge and level as in the spot method.

Another well-known means of checking alignment in commercial use is to dispense with leveling entirely and to arrange for the checking to be done on the coupling. The wedges are manipulated until the coupling flanges are parallel, as measured by inserting shim gages or feelers between the flanges, and also central, which condition is measured by placing a small steel straight-edge across the outside surfaces of the flanges. When parallel the shim gages should show the same space between the flanges at all points within one-thousandth of an inch. When central the straight-edge will touch evenly at all points throughout its length on both flanges.

After the set has been correctly checked and properly located, it is ready for grouting, cleaning and completion of assembly.

In erecting large turbo-generator sets the manufacturer supplies a specially trained man unless there is some other special arrangement. In instances where a second-hand machine is purchased or where a set is transferred from one locality to another, the engineer of the plant may be called upon to undertake this work.

Handling the Heavy Pieces

While there are adjustments to be accurately made, steamtight joints, pressed fits, etc., that are far from easy, it often happens that the most trying work is handling the heavy pieces without injury to delicate blades, bearing surfaces, etc. It is most important to plan the job as completely as possible so that all work may progress smoothly and the erecting man may give his entire attention to the work in hand without fear of getting "hung up" and wasting time or labor.

When the machine is received on freight cars, the various parts must be identified and arrangements made for unloading. It is necessary to consider which parts are first needed, which are to be stored until later, where and how they are to be stored and how transported to the foundation when needed. In most plants the cars are brought within reach of the power-house crane; often it is necessary to roll or drag them to the crane; sometimes the plant may be in the process of building with no crane in operation, and may be a considerable distance from the point of unloading, so that the rigging work is the largest problem.

As the unloading proceeds, the shipping lists can be checked. Meanwhile, a shack can be erected close to the job for tools, storing delicate parts, blueprints, and for the convenience of the men. Wedges and blocks for the grouting and special tools can be ordered for the work, to be ready when needed.

First to be placed on the foundation is, of course, the bedplate. If this comes in sections, they should be bolted together securely either by heating the bolts or by driving the wrench with a sledge. To make sure of a good job, this should be checked in all ways before grouting.

Temporary Assembly of Casing

The center lines of the foundation laid down by the designer of the plant should be used in locating the bedplate, and then openings made in the foundation for pipe connections, generator air ducts, drains, etc., should be checked to see if they correspond with the turbine requirements. If the steam and exhaust pipes are already in place, the final connection is up to the erecting man. Sometimes it is better to check these by temporarily assembling parts of the turbine casing, etc., to match exactly with the piping, instead of trusting to blueprints and figuring from the bedplate to the point of connection. A little forethought will often obviate the necessity of moving a 100-ton condenser, or of chipping out a concrete opening at the last minute, or of straining pipe flanges to make pipe connections and causing a bad joint, or other trouble.

The bedplate can now be carefully leveled. As a special precaution the alignment may be checked with a tight line, but this is advisable only in special cases where alignment trouble is suspected or where new parts are to be aligned and doweled.

The best results can be obtained by using a steel wire of 0.008 to 0.010 in. in diameter, such as a piano wire. This should be new and without kinks and should be used as it comes directly off the coil. A piece should be tested for breaking strain by using it to pick up various weights with a crane. The tension should be produced by suspending a weight of about three-quarters breaking strain.

Aligning Bearing Pedestals

The bearing pedestals, turbine casings, generator and other parts to be aligned should be placed on the bedplate. The bearing pedestals or other parts from which the line is to be located should be carefully bolted and doweled in permanent position. The bearings at each end are used if possible.

The line is now stretched between two rigid supports, such as heavy timbers or convenient columns or pieces of machinery, with the tension as noted before. The line is now moved up or down or crosswise at each end until it is exactly central with the bored surfaces of the end-bearing pedestals or other parts used as a permanent guide. Wedges to suit the rigging are convenient in making small changes in position of the wire. The distance from the wire to the bored surface can be roughly measured with an inside caliper and with final accuracy by an inside micrometer or pin gage. The pin gage is generally the machinist's choice and is made by selecting a piece of wood ¼ to ¾ in. in diameter, and ⅜ in. shorter than the average measurement. A pin or needle is driven in at each end so that measuring is done between the two pinheads or needles. The distance is changed by driving the pins in or pulling them out. The position of the wire must be adjusted so that the radical distance to the bored surface is the same at each side as well as above and below. It is not difficult to obtain an accuracy of 0.0005 inch.

After the tight line has been set, the other bearing pedestals, turbine casings, generator, gear housing, etc., can be adjusted so as to be central with the line. They should then be doweled, by drilling and reaming and accurately fitting dowels.

The middle bearing will be lower than the outside bearings by an amount equal to the sag in the wire. This would ordinarily be negligible up to 15 ft. span of wire. It can be checked by assembling the rotary element and opening up the coupling. The middle bearing should be shimmed until the distance between the flanges of the coupling is the same above as it is below, or perhaps 0.002 to 0.006 in. more on top.

Turbine Casing Is Usually Set Low

The turbine casing is usually set low to allow for expansion. It is best, if any question arises in this connection, to get the manufacturer's information on this point. It can readily be settled, however, by making the adjustment that seems best, and then checking the alignment with shaft again, when the machine has been put in service, and correcting to be central under working conditions of temperature. If the shaft is sprung, the spring must be measured, and this should be taken into consideration when centralizing with the shaft.

After the foregoing questions of checking location, alignment, pipe connections, etc., have been settled, the grouting can be poured. While this is hardening, the parts next to be assembled should be cleaned and made ready.

The importance of cleaning is seldom realized by the inexperienced. The practical man knows that grit or sand in a bearing running at high speed can cause considerable damage in a few minutes. A scraped joint, where no gasket is used, is difficult or impossible to make steam-tight when dirt is present. Dirt causes alignment troubles when shims and contact surfaces are not properly cleaned. Cleaning is something of an art. An appreciable skill is required in preparing, with a sharp machinist's scraper, a scraped surface which has been warped by bolt pressure and expansion, and which is covered with sticky dope. Some judgment is required in getting this work done by unskilled and unreliable labor. When large pieces are cleaned, it is a good plan to provide putty knives or old files ground to a dull edge. The work can then be inspected by an experienced man, and filing or scraping done as required.

Delicate parts which are being assembled should be covered with a tarpaulin or other shield each night to prevent dust settling from the air, and solid particles, such as bolts or nuts, finding their way in. The steam passages must be continually guarded and inspected.

The most difficult part of the assembling is usually the turbine rotor and casing. It is most important to have reliable men to watch different parts as the lowering is done.

The remaining parts to be assembled, which include generator, packing casings, steam chest, valve gear piping, etc., often require much painstaking work and represent a large part of the job.

Chapters to follow will deal with steps that the engineer may be called upon to make to produce a so-called "perfectly" running machine. Perfection is usually too expensive for commercial practice, but from a practical point of view there is a state that is called perfection which is the only goal worth while for turbine-machinery erectors and which can usually be reached by a little forethought and thoroughness rather than by laborious and expensive means.

Don'ts for the Diesel Engineer

Don't regulate the compressor discharge pressure by using a relief valve. Put a throttle valve on the compressor suction line.

Don't grind the fuel-pump valves too often. Filtering the oil will reduce valve cutting.

Don't fail to recheck the valve timing after grinding a valve.

Don't think you are getting correct ignition. Use an indicator and know.

Don't overlook jumping the piston at each shutdown to note the play in the rod bearings.

Don't carry the cooling water below 120 deg., nor higher than 150 deg.

Don't feel that the indicator is the steam engineer's toy. The Diesel operator needs it fully as much.

Don't let the pipe trenches fill with dirt simply because it will be out of sight.

Don't carry an excessive air pressure—cylinder knocking is frequently due to this.

Don't start redesigning the engine as soon as it is installed.

Don't be satisfied with less than two circulating-water pumps and an auxiliary air compressor.

Don't flood the cylinders with lubricating oil; an excessive amount will carbonize on the cylinder walls.

Don't be satisfied if the engine exhaust is dark. Anything other than a clear exhaust proves that the engine is not properly tuned up.

The British Thermal Unit and the Mechanical Equivalent of Heat

By F. R. Low

THE British thermal unit, or B.t.u. as it is commonly abbreviated, is the English unit by which quantities of heat are measured. Heat quantity is quite a different thing from temperature. If a cupful of water is dipped out of a barrelful, they will both have the same temperature, but there is a good deal more heat in the barrelful than there is in the cupful. There is more heat in a pint of water at 32 degrees Fahrenheit than there is in a teaspoonful at 212 degrees.

The British thermal unit is that amount of heat which is required to increase the temperature of one pound of water one degree Fahrenheit.

This definition, commonly given, is well enough as far as it goes, and tells as much as anyone needs to know about the B.t.u. in order to use it intelligently and to the degree of accuracy required in ordinary engineering calculations; but it is not precise.

What Is a Pound?

The pound is the English unit of weight. Masses or quantities of matter are weighed by comparing the attraction which exists between them and the earth with the attraction between the earth and standard weights, as in a scale balance or upon a spring scale that has been calibrated with standard weights. Our early weights and measures were brought over from England, and there got to be such a diversity among those in use at the different custom houses and elsewhere that the necessity of a standard became apparent. The Treasury Department, therefore, between 1830 and 1835 adopted an avoirdupois pound based upon the standard Troy pound brought over from England a number of years before and deposited in the Mint at Philadelphia for the express purpose of serving as a standard for American coinage.

In 1866 Congress made the metric system lawful in the United States and fixed the values of the new system in terms of the system in general use.

In 1875 a Metric Convention was signed at Paris establishing an International Bureau of Weights and Measures to be supported by the countries that signed the convention. These included all the principal countries of the world, one of which was the United States. France set apart, in the park of St. Cloud, near Paris, a plot of ground which was declared neutral territory and dedicated to the use of the new bureau. The bureau undertook to prepare accurate copies of the standard meter and kilogram in the French archives. These were completed and distributed in 1889. Those falling by lot to the United States were Meters Nos. 21 and 27 and Kilograms Nos. 4 and 20. On April 5, 1893, the Superintendent of Weights and Measures, with the approval of the Secretary of the Treasury, decided that the international meter and kilogram would in the future be regarded as the fundamental standards of length and mass in the United States both for metric and for customary weights and measures.

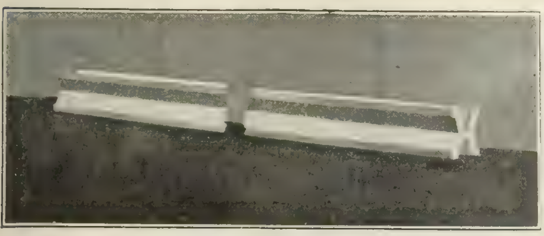


FIG. 1. PROTOTYPE METER. STANDARD MEASURE OF LENGTH IN THE UNITED STATES

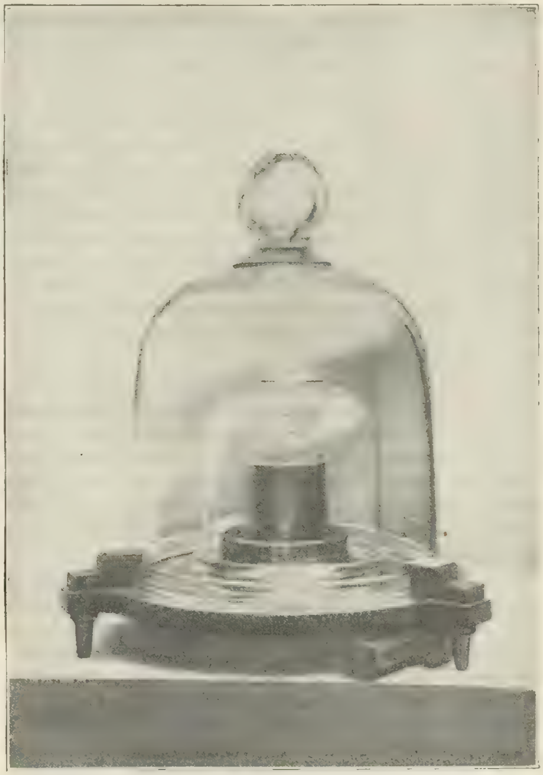


FIG. 2. PROTOTYPE KILOGRAM NO. 20 STANDARD FOR MEASURES OF WEIGHT IN THE UNITED STATES

The United States prototype meter and kilogram now in the possession of the Bureau of Standards, into the keeping of which all the property of the Office of Weights and Measures passed with the establishment of the Bureau in 1901, are shown in Figs. 1 and 2 respectively. The relation between the standard meter and the Imperial yard which had been set by the act of 1866 was by chance the exact relation within the error of observation. The act fixed the kilogram as equal to 2.2046 pounds avoirdupois. The more exact value since determined and now used is 2.204622.

The pound, then, is equal to $\frac{1}{2.204622}$ of the standard kilogram preserved at the International Bureau of Weights and Measures at St. Cloud, itself as close a copy as it was possible to make of the original meter in the archives of France, and reproduced with the utmost attainable exactness in the two copies preserved by our own Bureau of Standards.

WEIGHING A POUND

We have now a definite, positive value for the pound of mass, but it is not so simple a matter as it seems to weigh out a quantity of another substance that will have *precisely* the same mass as the standard weight.

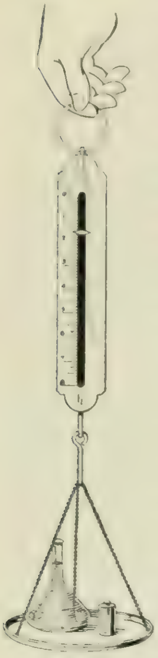


Fig. 3

Suppose we suspend a flask upon a spring scale with a standard pound weight beside it, as in Fig. 3. Note the position of the pointer, remove the pound weight and pour water into the flask until the pointer returns to the same point. You now have a pound of water in the flask. Mark the water line at the neck.

Suppose you had done this at the Bureau of Standards in Washington and later you tried to weigh out a pound of water at the International Bureau of Weights and Measures near Paris. You set the same flask on the same spring scale, and fill it with water up to the mark which you made at Washington, but the pointer on the scale comes down lower than it did before as indicating the combined weight of the pan, flask and pound weight. What is the matter? Is Paris water heavier than Washington water?

You empty and dry out the flask and hang it with the standard pound weight on the scale and find that the pound weight, as well as the pound of water, weighs more at Paris than it did at Washington.

The attraction between the earth and a body outside it varies inversely as the square of the distance apart of their centers of gravity. It is less, therefore, on top of a high mountain, in a flying balloon or airplane than at the sea level. It is more at the poles than at the equator, for the earth is flattened at the poles and the surface there is some thirteen miles nearer to the center than it is at the equator.

The attraction between a body and the earth is partly counterbalanced by centrifugal force. At the equator a body on the earth's surface is whirling around the earth's axis with a velocity of some 1,500 feet per second which, even with a radius of nearly 4,000 miles, produces a considerable tendency to throw the body off. Further, a body on the top of a mountain at the equator is going faster and has a greater centrifugal force than a body at the level of the sea. Here is another reason why altitude may affect the attraction. At the poles there is no angular velocity and no centrifugal force, and so a body at a pole would be attracted toward the earth's center more strongly both by reason of the lesser distance between its center of gravity and that of the earth and of the absence of centrifugal force. And so the nearer we get to the poles and the lower we get upon the earth's surface, the more a body would weigh on a spring scale.

But the mass as determined by comparison with standard weights on a pan balance would be the same at all altitudes and at all degrees of latitude, for although the attraction between the earth and the body to be weighed would be greater at higher latitudes and at lower altitudes, the effect upon the standard weights would be the same and the body would balance the same standard mass wherever the weighing process took place.

This so far as altitude and latitude are concerned. It is not strictly true on account of another consideration.

Imagine a weight to be suspended upon a spring scale, as in Fig. 4. Note the position of the pointer. If the weight were immersed in water, as in Fig. 5, the pointer would rise, showing that the weight was not pulling so hard upon the spring.

The weight is buoyed upward by the water. The flotation force is equal to the weight of the volume of water displaced by the immersed body, and the scale will read lighter by an amount equivalent to the weight of that amount of water. The effect would be the same if the entire scale were immersed, as in Fig. 6.

How about the pan balance? Suppose a pound of wood were weighed upon it and then the whole thing were immersed in water. The wood would float off and apparently weigh nothing. Suppose we weigh something that weighs more than an equal volume of water but less than an equal volume of the metal from which the weights are made, like a piece of coal, for instance, the weights being of brass. If we put enough coal into one pan to just balance the weight in the other when the scales are in the air, as in Fig. 7, the pan holding the coal will rise and the pan with the brass weight in it will sink when they are immersed in water, as in Fig. 8. The lifting effect on the coal pan will be equal to the weight of a volume of water equal to the volume of the coal. The lifting effect upon the weight pan will be equal to the weight of a volume of water equal to the volume of the weight. The volume of the coal is greater than that of the brass weight, the lifting effect upon it is greater, and the scale is thrown out of balance.

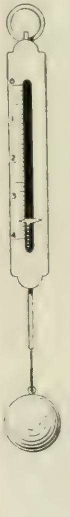


Fig. 4

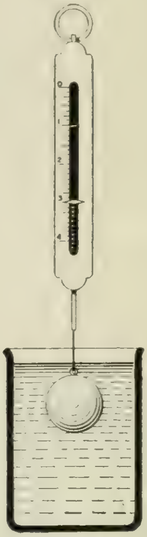


Fig. 5

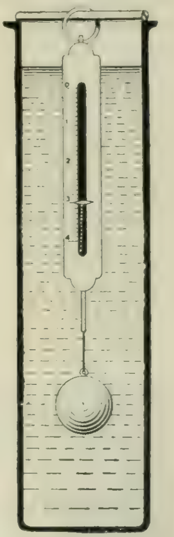


Fig. 6

The effect would be the same in kind, though not in degree, if the scales were immersed in a tank of some heavy gas like CO_2 instead of in water; and, although it would take a very delicate balance to show it, there would be a difference in the mass required to balance a standard weight in dense air or in rarefied air, in air at the sea level or at the top of a mountain, in air when it is dry and dense and the barometer is high or when it is charged with the vapor of water and the barometer is low. If the last degree of refinement were necessary, the weighing would have to take place in, or be referred to, a vacuum or to a given medium, as air, at a given pressure and at a standard temperature, for the volumes of the standard weights and the substance weighed would not be likely to change in the same proportion with change of temperature. Worcester's dictionary says that the standard pound of the United States is equivalent to the weight of 27.7015 cu.in. of distilled water at 62 degrees F. the barometer being 30 inches and the water weighed in air with brass weights. The foregoing explains why all these conditions are necessary.

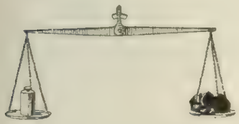


Fig. 7

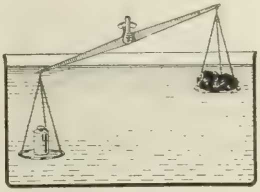


Fig. 8

Weight and Mass

The terms weight and mass are used carelessly and interchangeably for the quantity of matter that is in a given body (which is the same regardless of altitude or latitude or temperature or environment) and for the attraction that exists between the body and the earth. If we use the verb "to weigh" to mean to weight down, to pull, we can rightly say that a body will weigh more at the pole than at the equator even in the pan balance, for the standard "weights" with which it is measured would weigh more there too, but only just as much more as the body does, so they would continue to balance each other although each *weighed* more.

We cannot, then, measure the mass of a body, the amount of matter that there is in it, by its weight, using the word weight in this sense, without taking a lot of other things into consideration. But a pound of mass means a mass equal to that in the standard pound weight. This is the same everywhere and always, and when a definition like this says "a pound of water," it means a very precise and definite quantity. In the light of all these considerations the old saying, "A pound's a pound the world around," takes on a new significance.

What Is a Degree Fahrenheit?

You may be told that the difference between the boiling and freezing points of water is divided, on the Fahrenheit scale, into 180 equal parts and each of these is a degree Fahrenheit.

Water may freeze at 32 degrees Fahrenheit and it may not. It probably would if you gave it time enough, but you can hold a vessel of water for a considerable time at 32 degrees or even below without freezing it. But put ice, enough of it, into a vessel of water in which it will melt, and the temperature of the water will go down to a certain point and stay there as long as enough ice is kept melting in it to keep it there. It doesn't matter how much ice you put in, you cannot get it any cooler, and it doesn't matter how much heat you apply to it, if you keep ice melting in it fast enough to take up that heat it will not get any hotter. Ice melts at a certain fixed temperature, and that temperature is the zero of the centigrade scale and the 32-degree point of the Fahrenheit scale.

What Is the Boiling Point of Water?

The boiling point of water depends upon the pressure under which it is heated. If heat is applied to a vessel of water, the temperature will rise to a certain point and then it will become stationary and remain so until the water boils away. It does not matter how much heat you apply, you cannot get it any hotter. But this point depends upon the pressure under which the process is conducted. In a vacuum of 26 inches the water will not get above 125 degrees Fahrenheit. In a boiler under 150 pounds pressure, absolute, it will get up to 358.5. The boiling point, 212 deg. at atmospheric pressure, is what is meant.

What Is the Atmospheric Pressure?

But what is the atmospheric pressure? It is greater at sea level than on a mountain top; it is greater at the same place when the air is dry than when it is full of water vapor, as is shown by the variation in the height of the barometer from time to time in the same location. So we have to have a standard atmospheric pressure, and it has been fixed at that pressure which will support a column of pure mercury 760 millimeters in height, the temperature of the mercury being that of melting ice, zero degrees centigrade, or 32 degrees Fahrenheit.

So we have as a precise definition of the Fahrenheit degree $\frac{1}{180}$ of the difference between the temperature of melting ice and the highest temperature to which pure water can be heated under a pressure that will support a column of mercury 760 millimeters in height, the mercury being at the temperature of melting ice and the water boiling. The temperature of melting ice is called 32 degrees and that of the boiling water under 760 millimeters pressure $32 + 180 = 212$ degrees.

And it is said that the B.t.u. is the amount of heat required to raise the temperature of one of those standard pounds of water through one of these degrees.

Heat Required Different for Different Degrees

But which degree? It may not—in fact, it does not—take as much heat to raise the temperature of a pound of water one degree in one part of the scale as in some other part.

The amount of heat required to raise a pound of water one degree is called its specific heat. The diagram, Fig. 9, shows how Professor Marks and Doctor Davis assumed this specific heat to vary in computing their tables of the thermal properties of steam. You see we should get a different value for the B.t.u. if we made it the amount of heat required to raise a pound of water from 39 to 40 degrees, the point of its maximum density, as was the practice of some physicists, or at 62 degrees, as was the practice of others, or at

15 Centigrade as was European practice, or at some other point. This is one of the things that makes the difference between the steam tables of various authors. The most advanced practice is to use the average specific heat between 32 and 212 degrees. Defined in this way, then, the British thermal unit is $\frac{1}{180}$ of the amount of heat required to raise a standard pound of water from the temperature of melting ice to the temperature at which it will continue to boil under a pressure of 760 millimeters of mercury—if we want to be very precise, the mercury to be at 32 degrees and to have a specific gravity of 13.59593.

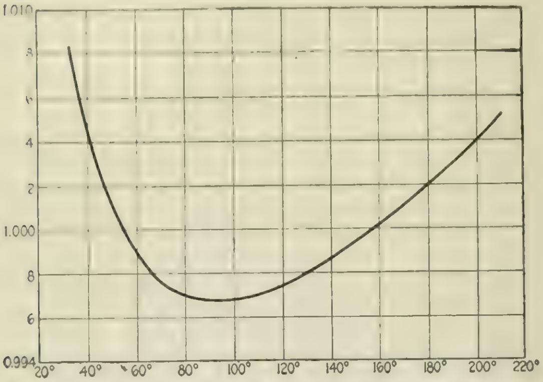


FIG. 9. THE SPECIFIC HEAT OF WATER BETWEEN THE MELTING POINT OF ICE AND THE BOILING POINT OF WATER AT ATMOSPHERIC PRESSURE. THE AVERAGE VALUE BETWEEN 32 AND 212 DEG. EQUALS UNITY

THE MECHANICAL EQUIVALENT OF HEAT

Heat and work are interconvertible. The steam engine, for example, converts heat into work and the work is reconverted into heat in the friction of bearings, the cutting of metals by tools, the overcoming of electrical resistance, etc.

The "mechanical equivalent of heat" is the amount of work that would be done or the amount of energy that would be generated by the conversion of a certain amount of heat.

The mechanical equivalent of the B.t.u. is the amount of work or energy corresponding to one British thermal unit. Joule in 1843-50 gave for this value 772 foot-pounds. Professor Rowland in 1880, with more refined methods of experiment, found it to be higher and 778 was generally adopted. The latest determination indicates that it is between 777.5 and 777.6 foot-pounds.

BUT WHAT IS A FOOT-POUND?

The foot-pound, you are likely to be told, is the amount of energy required to lift a pound weight through a vertical distance of one foot; but, as we have seen, this would be more difficult at sea level than at an elevation, and at a high latitude than at the equator. The foot is definitely fixed as one-third of a standard yard, but it is still necessary to have a specific definition for the unit of force.

The generally accepted definition is that it is the pressure exerted by a standard pound in vacuo at a place where gravity has an acceleration of 980.665 centimeters per second per second, this value of gravity being that adopted by the International Committee of Weights and Measures. The "poundal" is the force which, acting upon a mass of one pound for one second, will produce a velocity of one foot per second.

The metric unit of force is the dyne. It is defined as that force which, acting on a mass of one gram for one second, produces a velocity of one centimeter per second.

The metric unit of energy is the erg and equals the energy developed by a force of one dyne acting through one centimeter.

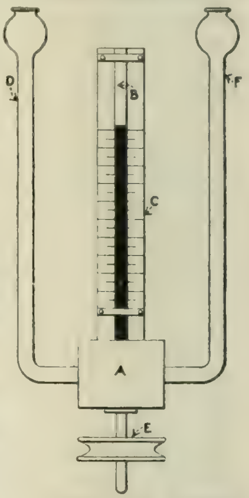
The metric unit of heat is the calorie and equals the amount of heat necessary to raise the temperature of one kilogram of water one centigrade degree (in which case it is called the "large calorie") or one gram of water one centigrade degree, in which case it is called the "small calorie." The part of the scale generally used is 15 to 16 or 16 to 17 degrees, but present practice favors the "mean calorie," which is $\frac{1}{100}$ of the heat required to raise one gram (or one kilogram according to whether the small or large calorie is meant) of water from 0 to 100 centigrade.

Simple Speed Indicator

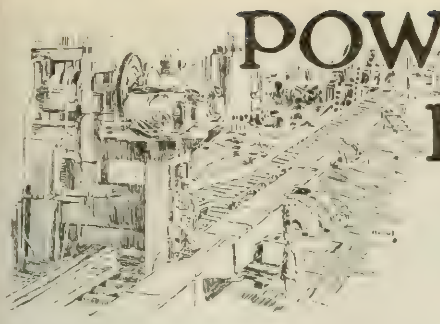
By H. WILLIAMSON

In a large steel works in Canada, there is in use an ingenious speed indicator designed as shown by the accompanying illustration, in which *A* is a brass box; *B* is a glass tube, open at the top and communicating with the box *A* at the bottom end; *C* is a graduated scale, the figures denoting revolutions per minute; *D* and *F* are two brass tubes open at the top or bulbed end and also communicating with the box *A*; *E* is a pulley by which the instrument is driven, the vertical shaft being mounted in a suitable bearing.

The operation is as follows: Mercury is poured into the instrument through either tube, *B*, *D* or *F*, until it rises to the top or zero end of the scale. If the instrument is now rotated by means of a belt on the pulley *E* to the shaft whose speed it is desired to know, the centrifugal force drives the mercury from the box *A* up the brass tubes *D* and *F*, causing a corresponding lowering of the column in the glass tube *B*. This depression varies with the speed. The instrument is used only for moderate speeds and is a permanent fixture on the engine frame. It is remarkably sensitive.



On merchant ships built during the past few years, a refrigerating plant of ample capacity is always found. On cargo ships this is about two tons per 24 hours. Ammonia compression, ethyl chloride, CO_2 and SO_2, systems are the rule, with preference for SO_2 in the Shipping Board vessels. Steam drive is being displaced by motor drive. The dense air system has until recently held the field in the Navy. CO_2 systems are now installed on practically all new ships except destroyers, where ethyl chloride and SO_2 systems are found, with a few of the CO_2 type.



POWER DRIVES FOR ROLLING MILLS

By

W. O. Rogers

Several types of shears are described and illustrated. Some are simple in design, and others are massive and somewhat complicated. Plate and jobbing mills, structural, sheet and tin-plate mills, also wire-rod mills are briefly described.

AMONG the important machines used in rolling mills are the shears that shear the metal into proper lengths. Perhaps the simplest is the belt-driven lever shear used for shearing cold metal. It consists of a heavy bed on which an oscillating jaw is pivoted. One end carries the cutting plate, and the other end carries a crankpin, the crank of which connects with a pin carried by a large gear. This gear meshes with a pinion on a flywheel shaft, the latter being driven by a belt in the old machine and by motors in the more modern type (see Fig. 1). When a motor is used, it is gear-connected to the flywheel shaft. Some of these lever shears have compound drives; that is, the motor is geared to a flywheel shaft, which is geared to a second-motion shaft, the latter carrying a pinion meshing with a geared shaft that gives motion to the shear. Another design of lever shear is made with compounded shaft, but is equipped with a friction-clutch drive. Many of these lever shears are covered with metal casings to prevent accidents. The average size shear is driven by about a 25-hp. motor of the induction type and is capable of cutting cold steel sections up to 7 x 7 in. square.

In tin-plate and sheet mills a different type of shear is used for squaring up the sheets. They are of various sizes up to 180 in. in width, and in later designs are motor-driven. They are designed for cutting thin sheets or stacks of tin plate $\frac{3}{16}$ in. or less in thickness. The shear is actuated by crankrods, that receive motion from two or more eccentrics carried on a shaft.

The shears used in conection with slab and billet mills are of a different character and because of the heavy service are of extremely rigid construction. Fig. 3 shows a 3,600-ton capacity steam-hydraulic shear used for shearing slab from a slabbing mill. The thick slab of steel comes from the rolls of the right thickness, but it is in long sections. While hot the piece is run on rollers to the shear, and the slab is there cut into smaller ones. These are afterward reheated and rolled into plates, etc.

The hydraulic shear is perhaps the simplest piece of hydraulic apparatus in the steel mill. It consists of a heavy frame carrying at one end, in a suitable housing, a knife blade, and at the other end a cylinder. A piston rod carries another knife blade, and the piston works this blade up and down, producing shearing action between the blades. Steam acts on top of an intensifier piston and forces the piston rod into a hydraulic cylinder, thereby producing the pressure required for shearing. With this arrangement there are two hydraulic systems used. One is a closed system between the cutting cylinder and the intensifier, and the other, the regular mill system, is connected through suitable valves to the cylinder for the return stroke. By using the steam intensifier, the expansive power of the steam is utilized, and it is possible to get a working pressure of 6,000 lb. per sq.in. The capacity of this type of shear ranges from 300 tons up to 3,600 tons. The larger sizes are equipped with multiple cylinders for various pressures for cutting different sizes of slabs. Hydraulic bloom shears are made either up-cut or down-cut.

Another type of shear is shown in Fig. 5. It is motor-driven, and the huge gearing indicates its cutting strength. As the bloom comes from the mill, it is cut up into smaller pieces and shoved to the right by the manipulator shown on top of the roll train. The pieces

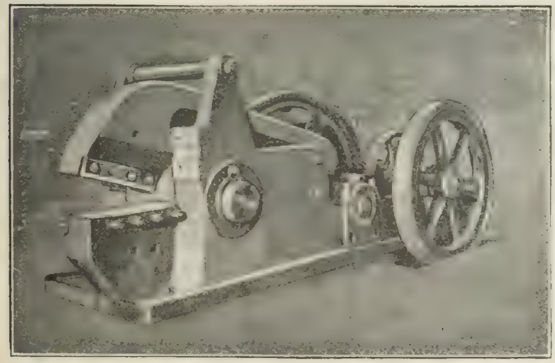


FIG. 1. ONE TYPE OF LEVER SHEAR

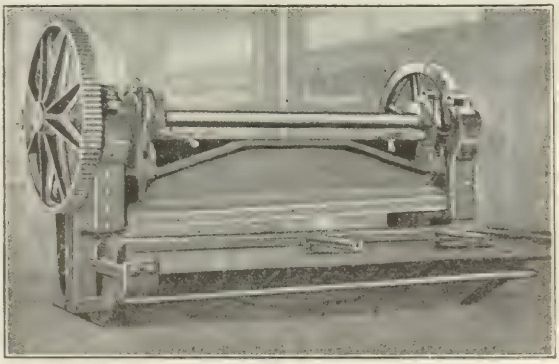
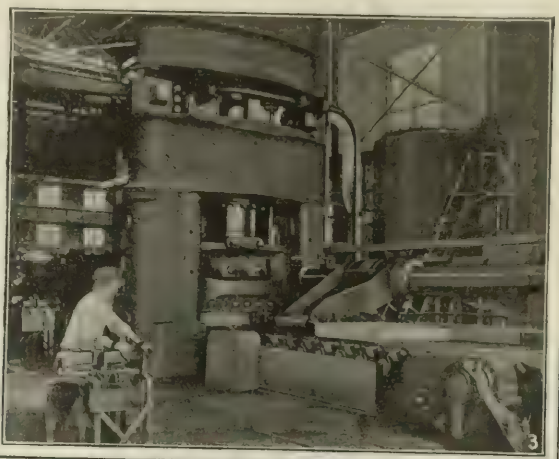
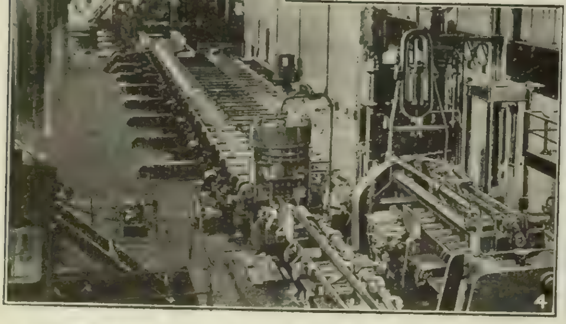


FIG. 2. MOTOR-DRIVEN SQUARING SHEAR

are then removed to be reheated and rolled into the desired product. Bloom shears are built for shearing any size of bloom. They are generally motor-driven for shearing blooms up to 14 in. square, but when larger blooms are to be sheared, hydraulic shears are best.

In Fig. 4 is shown a 44-in. reversing blooming mill with a slab shear and billet shear in the foreground. These are hydraulically operated. To use a popular expression, these shears cut through the hot metal as easily as a knife cuts through a piece of cheese. After passing the shears, the steel pieces are reheated and rolled into rods, plates, sheets, and a hundred-and-one products. The mills used in working up these metals are much smaller than the blooming, billet and plate mills, and are arranged with roughing and finishing stands, each consisting of two or three rolls. One of the largest, if not the largest, shear in the world is at the Lukens Steel Car Plant, Coatsville, Pa. It is of the hydraulic type, and the knife is 215 in. long and has a shearing capacity of 2 in. thickness. It is used with a 204-in. plate mill, the largest in the world. One of the simplest mills is that used in rolling tinplate sheets or bars. It is generally made with two stands, two smooth rolls in one stand, although three-high stands are also used. Fig. 8 shows a structural mill of the former type, and Fig. 9 shows a bar mill of the latter. In the two-high mills the top roll is carried in bearing blocks that are moved up and down for roll adjustment by means of a double-pitch screw that is turned by means of gears and an adjusting wheel or adjusting levers which are used to turn the screw either up or down.





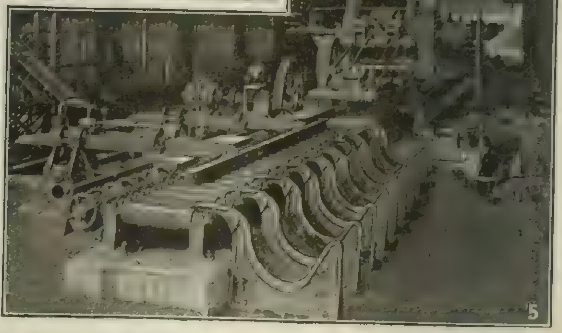


FIG. 3. A 3,600-TON CAPACITY STEAM-HYDRAULIC SHEAR.

FIG. 4. A 44-IN. REVERSING MILL WITH SLAB SHEAR AND BILLET SHEAR IN FOREGROUND.

FIG. 5. MOTOR-DRIVEN BLOOM SHEAR

In operating the two-high mills, the steel is put through the rolls in one direction only, the return being over the top of the upper roll. After each passage the rolls are adjusted closer and the sheets are passed through them until the desired thickness is obtained. With a three-high stand the metal is rolled in both directions in its passage through the stand. On the forward pass the piece passes between the bottom and the center roll, and on the return pass the piece passes between the center and the top roll.

The view shown in Fig. 7 is of a complete sheet mill at the main plant of the Youngstown Sheet and Tube Co. The engine is a twin tandem-compound Corliss with a 34 and 60 x 60-in. cylinder and is rated at 2,000 hp. at 30 r.p.m. In this instance the engine shaft is coupled to the mill stand, there being no reduction of speed between the engine and the rolls, as is generally the case. The engine is placed in the center of the mill and drives a train from each end of the crankshaft. The method of roll adjustment is shown on the nearest stand. As the sheet comes to the rolls from the far side, it slides out on the rest piece and the bar at the back of the stand assists the operator to pass the sheet back over the top of the roll. The heating furnaces are shown at the extreme left, and the squaring shears at the extreme right together with several sets of rolls. The pile of sheet next to the engine partition indicates the kind of work produced. A front view of a complete plate mill is shown in Fig. 6. The arrangement is similar to that shown in Fig. 7, excepting that the stands are placed farther apart. In the foreground is a lever type of shear, the gearing of which is inclosed, and the location of the engine driving the stands is shown by the flywheel and its position between the stands. The heating furnaces are at the extreme right, the weighted door-lifting levers being shown.

When the rolls are to be changed on this type of mill, a traveling crane is moved in place and a tackle is attached to the two lugs that are formed at each side of the stand casting. It is then lifted out of the way sidewise, the rolls lifted out by the same crane, and the new ones are put in position when the stand is replaced.

If one wishes to see metal pass through a mill at extremely high rate of speed the continuous wire mill is the place to see it. A wire is produced from a heated

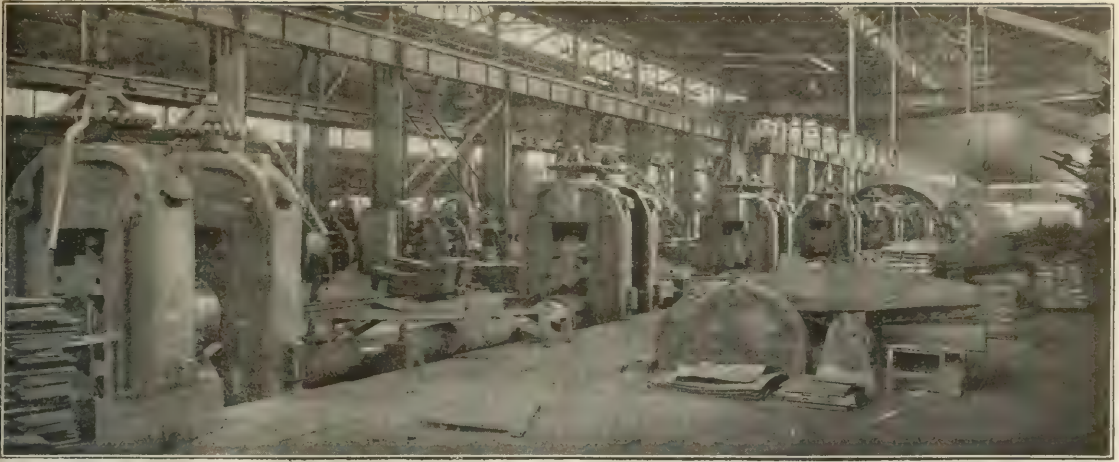


FIG. 6 A COMPLETE PLATE MILL. IT IS SIMILAR TO A SHEET MILL INSTALLATION

billet. In this mill the billet is sent from the heating furnace into the roughing mill rolls and passes automatically through the mill until it is wound on reels ready for tying up for delivery. The speed of the wire at the reel is about 30 miles per hour. The furnace in which the billets are heated is gas-fired. It is built sloping and the billets are sent down in a single layer as fast as one is pushed out to the roughing mill. This is done by a pusher machine, which in some mills grabs the end of the billet and after forcing it out of the oven turns it one-quarter turn just as it enters the rolls, so as to knock off the scale. The billet comes out of the furnace through a small door and enters the first stand of rolls, which is placed quite close to the furnace.

The billets are about 25 or 30 ft. in length and about 1¾ in. square. After passing through a number of stands, the wire is reduced to the desired size. Owing to the elongation of the billet each succeeding stand of rolls revolves at an increased speed so as to allow no slack betwen the stands. It requires about one minute from the time the billet enters the roughing roll until it is rolled up. By the time the last end of the billet has left the furnace, more than 50 per cent of the rod is wound up into a coil containing 2,000 or 3,000 ft. of wire, all depending on the size.

On leaving the roughing rolls the leading end of the billet passes through a pair of flying shears, which cut off a piece a few inches in length, the object being to get a clean end in order to permit of the correct entry of the work between the rolls of the succeeding intermediate trains. The flying shears are an interesting mechanical device consisting of a pair of blades which, during the act of closing, are free to travel with the moving wire until it is severed. After leaving the intermediate train, the work passes into the rolls of the finishing train, which may be driven separately from the roughing and intermediate trains, so that the rod will not be overfed between the intermediate and

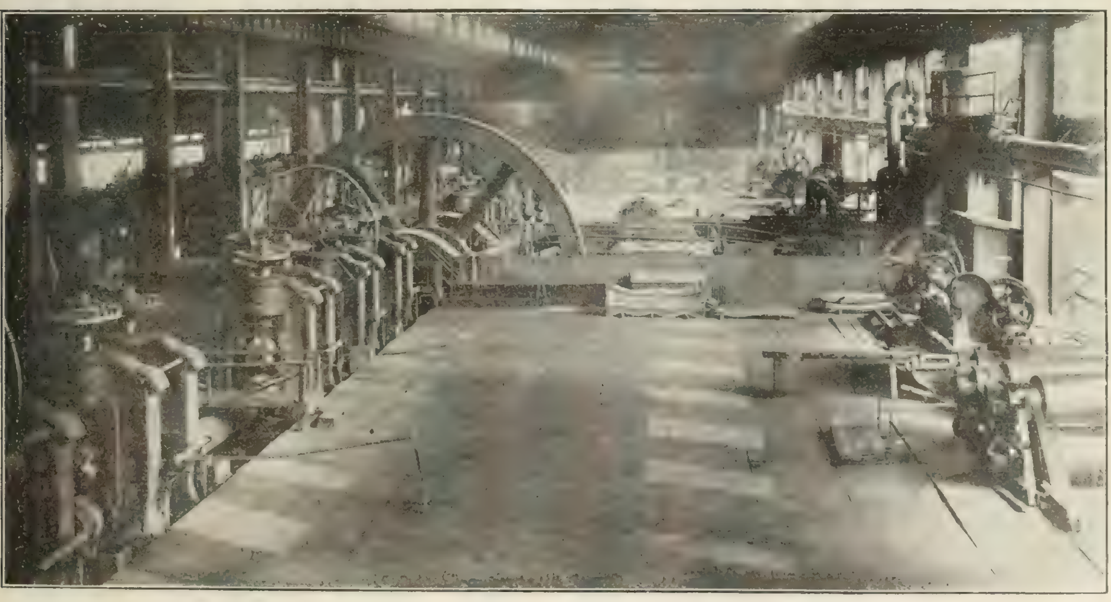


FIG. 7. A COMPLETE SHEET MILL. ENGINE PLACED CENTRAL BETWEEN STANDS

finishing rolls, which can occur, due to uneven wear in the roll grooves or because of a lack of synchronization of the engines. On the other hand, a difference in engine speed would be just as likely to develop a tension in the bar as to create a sag.

Uneven wear may be expected to occur, because the rolls of the intermediate train run at a considerably faster speed than the rolls of the roughing train. At the finishing train the wear in the grooves is more rapid than in the rolls of the roughing train, and in order to reduce labor and delays involved in frequent replacing of the rolls, the rolls are cut with a number of grooves, all grooves being of the same section. Some mills, however, are made so that with any alternation in the size of the wire, the rolls would have to be changed.

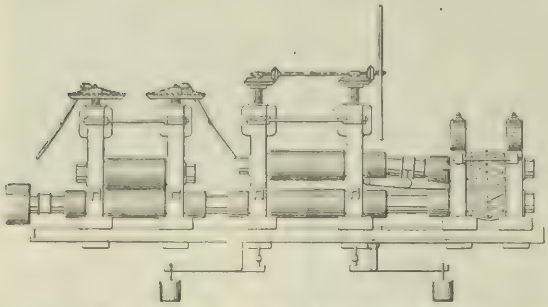


FIG. 8. TWO-HIGH PLATE AND JOBBING MILL

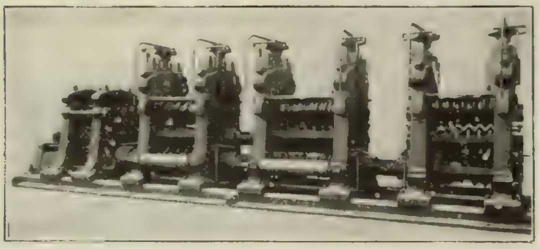


FIG. 9. THREE-HIGH BAR MILL

(The next article will be devoted to electrical driving apparatus.)

Supporting Conduit Risers

By Roy J. Turner

The method shown in the accompanying illustrations has proved to be satisfactory and economical for holding the wires in a vertical conduit run so as to satisfy the National Electrical Code requirements. To apply this method, the back of the junction box must be of steel sufficiently heavy to "take" safely a machine-screw thread *M*, Fig. 1. Then the conductors can be gripped in porcelain cleats *A*, *B*, *C* and *D*. A piece of flat strap iron with a hole in each end is placed between the outer cleat and the machine-screw head. This distributes the strain and thereby prevents cracking of the porcelain. To support the conduits themselves, their ends should be threaded for some distance, as shown at *L* (Fig. 1) and a locknut run down on them. In fact, in some cities the inspection bureau requires two locknuts on every conduit that enters a steel box. In such cities a bushing and a locknut on the conduit *N*, Fig 1, are deemed insufficient. To economize space within the anchor box it is often desirable to stagger the cleats, as exhibited at *C* and *D*. A heavy angle *S* should be provided to support the vertical weight of the box and the conductors in conduit which it supports. Angle S_T is also usually located at the top of the box, and the box is bolted to it. The arrangement given in Fig. 2 has also been applied successfully and is quite satisfactory for the smaller conductors. With this a cleat is bolted tightly around the conductor. This cleat rests on the bushing in the bottom of the box. Thus it prevents the conductor from moving vertically downward.

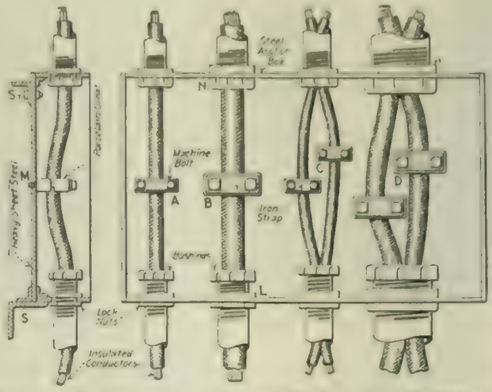


FIG. 1. SUPPORTS FOR CONDUCTORS IN VERTICAL CONDUIT RUNS

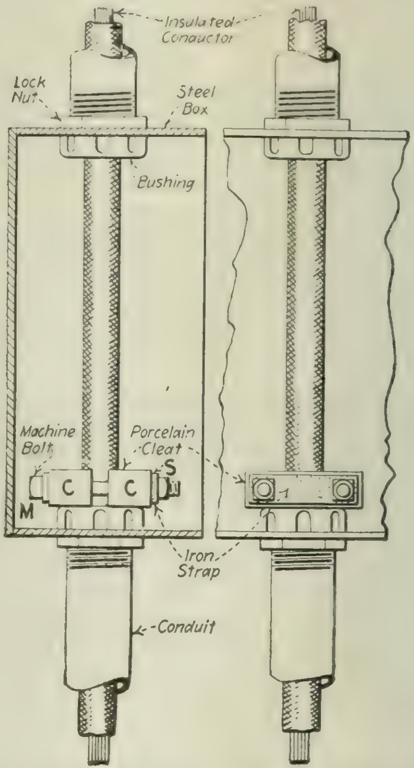


FIG. 2. CONDUCTORS IN A VERTICAL CONDUIT RUN SUPPORTED WITH A PORCELAIN CLEAT CLAMP

How To Calculate a New Winding for an Induction-Motor Stator Core

By A. M. Dudley
Designing Engineer, Westinghouse Electric and Manufacturing Company

The six factors that require consideration in figuring a new winding for an induction motor to operate under new conditions of speed, horsepower, voltage, phase or frequency are enumerated, then a problem is worked out to show how each is determined. No attempt is made to consider all the items that would be investigated by the designing engineer in working up a new design, but only those points that may be considered fundamental are treated of. However, the treatment is such as will give a winding that will be satisfactorily operative in a high percentage of cases.

THERE have appeared in *Power* at intervals for the last three years articles on "Reconnecting the Windings of Induction Motors" so that they might be operated under conditions differing from those for which they were originally designed. The author feels that this series is not quite complete until he has given some idea of how a winding may be figured for a given core without reference to any winding that might previously have been on the core. Obviously, in an article with the limited space assigned to this one, there cannot be attempted a complete treatise on the design of induction motors with detailed methods of calculation which will make him who reads a finished designer. In this discussion no reference will be made to all the points considered by the designing engineer, but only those factors will be covered in detail which it is felt are the most vital, and these will be handled in as elementary a manner as possible.

Performance of an Induction Motor

The performance of an induction motor is made up of a number of different factors. It must be able to start its load without drawing from the supply circuit an abnormal current, with a reasonable temperature rise and power factor. It must have a good efficiency and have as much mechanical clearance as possible between the stationary and rotating members so as to increase the life of the bearings. It must have a momentary overload capacity of from one and one-half to two times normal full-load torque without "pulling out" or stalling. Some of these characteristics may be favored at the expense of others; for example, it is possible to get a high power factor at the expense of having a very small clearance between stator and rotor, or it is possible to have a high efficiency at a cost of low starting torque and high starting current.

It is understood that all these characteristics are affected in various ways by the different features of the design, that is to say by the axial length of the iron core as compared to the rotor diameter, or by the number of slots or the kind and thickness of the laminated steel used and matters of this kind; but the thing that has the greatest effect and can most easily be modified is the number of turns in the stator or primary winding. In figuring this detail, which is of prime importance, it is therefore good practice to have at all times a mental picture of what happens to each characteristic when the cross-section of the conductors or the number of turns in the primary winding is changed. In order to summarize this quickly, the various characteristics are listed in order and considered separately. The main considerations in the operation of any induction motor are: Starting torque, starting current, air gap or clearance, power factor, efficiency, heating, maximum torque, or pull out, noise, and mechanical vibration.

If there were two motors that were exact duplicates in material and all mechanical dimensions excepting that one motor had more turns in the winding than the other, when comparing the characteristics just named, the motor having the most turns would have a lower starting torque and a lower starting current. It would probably have a higher power factor. It might have a higher or a lower efficiency for the reason that the copper loss would be higher and the iron loss lower, and whichever one preponderated would determine whether the efficiency was higher or lower; in other words, whether the copper loss increased faster than the iron loss decreased, and vice versa. Similarly, the heating would be more or less, depending on the sum of the losses. In general this motor would be a little quieter and have less tendency toward mechanical vibration.

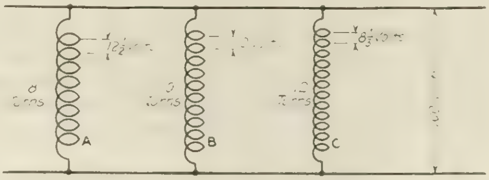


FIG. 1. THREE CIRCUITS IN PARALLEL

On the other hand, considering the motor with the fewer number of turns, it will have relatively, a higher starting torque and a higher starting current. It will have a higher or lower efficiency depending on the proportion of iron to copper loss, as explained in the preceding paragraph; similarly, the heating will vary with the amount of total losses. This motor would have a tendency to be noiser and have more mechanical vibration.

It will be noticed that these changes are the same as would occur if the voltage were raised or lowered on any motor. Increasing the number of turns in a winding has the same effect as lowering the voltage, and decreasing the number of turns has the same effect as raising the voltage on the winding. This can be seen from Fig. 1, where three windings are shown in parallel across 100 volts. Winding *A* has 8 turns in series, and there are 12½ volts effective on each turn. Winding *B* has 10 turns, and there are 10 volts effective on each turn; similarly, winding *C* has 12 turns, and the effective voltage on each turn is 8⅓ volts. Since the performance of the motor as regards torque and other characteristics is proportional to the voltage per turn in the winding, if we consider winding *B* as the normal winding for 100 volts, the *A* winding on 100 volts would operate and give the same result as the *B* winding if there were 125 volts applied to *B*. Similarly, the *C* winding on 100 volts would operate and give the same result as would the *B* winding if *B* had 83⅓ volts applied to it. Another vital consideration is the cross-section of the conductors used in the winding, necessary to carry the amperes required to develop the desired horsepower. There are in all 19 points that have to be considered by the designing engineer in making the complete design of an induction motor.

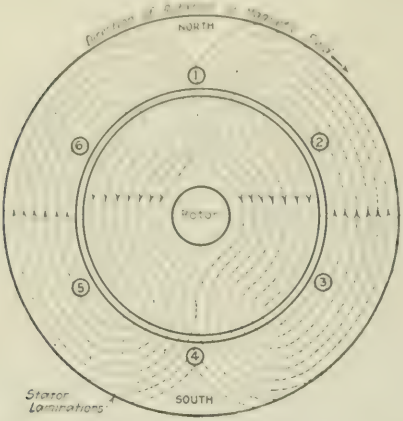


FIG. 2. FLUX DISTRIBUTION IN A TWO-POLE INDUCTION MOTOR

Since the consideration for the moment assumes an old core that already exists, many of these factors are already determined and some can be assumed. The facts that require checking in determining a new winding for new conditions of speed or horsepower or voltage or phase or frequency, and which may be considered as fundamental are:

1. Is the core large enough to wind for the horsepower and speed that are desired?
2. Is there cross-section of iron enough below the slots to carry the magnetic field that is needed in the air gap to do the work desired?
3. How many turns are required in the stator winding?
4. What should be the cross-section or size of the wire or conductor used in the stator winding?
5. What should be the cross-section of the bars in the rotor, and what should be the cross-section of the resistance rings at the ends of the rotor bars, assuming a squirrel-cage rotor winding?
6. Will the rotor diameter permit operating at the proposed r.p.m.?

These are a comparatively few questions that can be readily answered and broad general limits laid down against which the individual case can be checked. This will assume some points, but in general if the winding falls within these limits the motor will be sufficiently operative to fill the immediate requirement.

Proceeding at once to the determination of these quantities, (1) is answered by checking the so-called "output coefficient," that is to say, the horsepower of which a given core is capable at a given r.p.m. This may be expressed by the formula,

$$Hp. = K \times D^2 \times L \times r.p.m.$$

where K is the so-called "output coefficient," which varies somewhat with the size and speed of the motor and the operating voltage; D the diameter of the stator bore in inches; L the axial length of the laminated iron core in inches measured parallel to the shaft; and *r.p.m.* the revolutions per minute.

Suitable values for the output coefficient may be found in several textbooks, but the table given in Sec. 7, par. 246, of the fourth edition of the "Standard Handbook for Electrical Engineers," is reproduced herewith.

Pole Pitch in Inches	Values of Output Coefficient *K* When Output Is Expressed in Horsepower, Linear Dimensions in Inches and Speed in Revolutions per Min. 4 Poles	8 Poles	12 Poles	16 Poles	20 Poles	24 Poles
5		0.000025	0.0000265	0.0000263	0.0000254	0.0000246
7	0.0000222	0.0000329	0.0000331	0.0000331	0.0000331	0.0000331
10	0.0000336	0.000039	0.0000394	0.0000394	0.0000394	0.0000394
12	0.0000392	0.0000436	0.0000438	0.0000440	0.0000443	0.0000443
16	0.0000434	0.0000482	0.0000484	0.0000486		
20	0.0000454	0.0000505				

The following example is given to illustrate the use of this table. A stator core having a bore of 17 in. and an axial length of 6 in. was brought into a repair shop and a request made to put in a winding for 50 hp. to operate at about 730 r.p.m. on 25 cycles. To determine whether this was physically possible, the following calculation was made. The number of poles necessary to give the required speed is found by the expression,

$$Poles = \frac{Cycles \times 120}{r.p.m.}, \text{in this case} = \frac{25 \times 120}{730} = 4$$

$$Pole\ pitch\ in\ inches = \frac{diameter \times 3.14}{number\ of\ poles} = \frac{17 \times 3.14}{4} = 13.4$$

The nearest figure to this in the table is 12 in. and opposite 12 in. under 4 poles is the figure 0.0000392. Then the horsepower that this core will develop at 730 r.p.m. is 0.0000392 × 17^2 × 6 × 730 = 49.6. Hence, the conclusion is reached that this core would wind satisfactorily for 50 hp. at 730 r.p.m., since the output

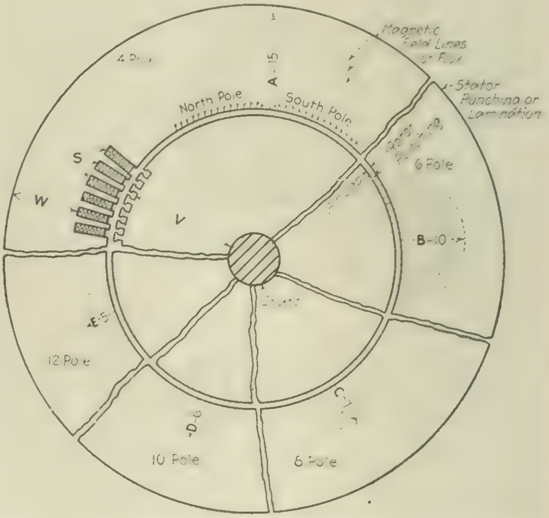


FIG. 3. CORE SECTION SHOWING EFFECT ON MAGNETIC FIELD BY CHANGING NUMBER OF POLES

coefficient for 13.4 in. would be a little greater than for 12 in. in the table which was used in the trial calculation.

The second question, as to whether there is sufficient cross-section of iron in the core between the bottom of the slots and the outside periphery, can be determined by figuring the actual amount of magnetic flux per pole that must be set up to do the required work. This can be readily understood by a reference to Figs. 2 and 3, which illustrate the manner in which the magnetic flux is divided into as many groups or circuits as the motor has poles. In passing from the stator to the rotor through the teeth, then behind the rotor slots and back to the stator and again behind the stator slots to the starting point, it will be noted that there must be enough iron behind the slots to carry the flux or the motor will overheat. Referring to Fig. 3, it is evident that the more poles the motor has, the less iron it requires in the core behind the slots of both stator and rotor. Therefore, the correct way to determine this point is to figure the amount of magnetic flux per pole and figure the cross-section of the core behind the slots and see that there are not more than 80,000 to 100,000 magnetic lines per square inch and if so, and other conditions are proper, the core should be satisfactory for the assumed conditions of the winding.

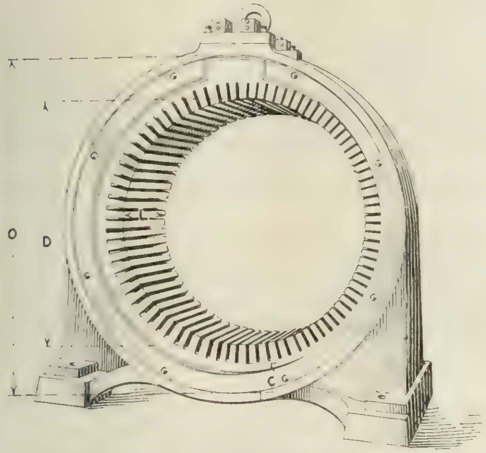


FIG 4 STATOR CORE IN FRAME

PECULIAR DESIGN PROBLEM

Here we are confronted with a peculiar problem which often faces the designer, which is, that he must know part of his answer before he can solve the problem and find the rest of it. In other words, the amount of magnetic flux in the core will depend on the number of turns of wire in the coils, and the problem which he is trying to solve is how many turns should be put in the coils. So it is apparent that he must guess the number of turns required and find out if the amount of magnetic flux is reasonable, or else he must figure how much flux can be carried in the core he is using and from that figure check back and see how many turns are required in the winding to give this magnetic result. When the number of turns is settled and the cross-section of the copper is figured for the desired horsepower and voltage, there is at once a question whether the slots will accommodate that many conductors of that cross-section after taking room enough to allow for the insulation required on the coil at that particular voltage. If the result is unfavorable and the copper so figured will not go in the slot at all, it means that the motor is not good for that much horsepower and the desired rating will have to be reduced. The number of turns cannot readily be reduced as that would mean more magnetic flux, and the core back of the slots is already figured for 80,000 to 100,000 lines per square inch, which is all it will stand. The reason why the number of conductors and the magnetic flux are tied in together in this way is because the conductors which are in series, when cut by the rotating magnetic field, must generate or produce practically line voltage. This fact has been referred to many times in previous articles.

The formula for the field flux per pole or per magnetic circuit is

$$\textit{Flux per pole} = \frac{45{,}000{,}000 \times \textit{Volts per phase}}{\textit{cycles} \times \textit{conductors per phase} \times K_1 \times K_2}$$

where

Volts per phase = Line volts in the case of a two-phase winding or a delta-connected three-phase winding, and
= Line volts ÷ 1.732 in the case of a star-connected three-phase winding;

Conductors per phase = Number of wires per slot which are in series × number of slots ÷ number of phases;

K_1 = A so-called "distribution factor" and is 0.905 for two-phase and 0.955 for three-phase;

K_2 = The so-called "chord factor" and depends on the pitch or throw of the coil. Its technical value is the sine of one-half of the electrical angle spanned by the coil.

A practical method of getting this factor, which is close enough for general purposes, is to use the expression

$$\textit{Chord factor} = K_2 = \sqrt{\frac{(\textit{No. slots per pole})^2 - 2(\textit{No. slots dropped})^2}{(\textit{No slots per pole})^2}}$$

or taking a concrete example, suppose there is a 72-slot motor wound for six poles and having a coil throw of 1 and 8, what is the chord factor, or K_2, which is under discussion? Since there are 72 slots and six poles there are 12 slots per pole and full pitch would be slots 1 and 13. Winding 1 and 8, drops 5 slots and thus our formula becomes

$$\sqrt{\frac{12^2 - 2(5)^2}{12^2}} = \sqrt{\frac{144 - 50}{144}} = \sqrt{\frac{94}{144}} = 0.80$$

To illustrate how this flux formula is applied, assume a core having dimensions as shown in Fig. 4. which it is desired to wind for 50 hp. 25 cycles three-phase four poles, 440 volts and 730 r.p.m. full-load speed. The outside diameter O of the stator lamination equals 25½ in., inside bore D of the stator lamination equals 17 in. The axial length of the core L equals 6¾ in., but it contains two ventilating ducts each ⅜ in. wide, so that the net iron core length equals 6 in. The primary slots are 1.7 in. deep, so that the dimension C, or the radial depth of the laminations below the slots, equals $(25\frac{1}{2} - 17) \div 2 - 1.7 = 2.55$ in., and the actual cross-section of the core below slots through which all of the flux per pole must pass is equal to $C \times L$, or in this case $2.55 \times 6 = 15.3$ sq.in. A reference to Fig. 2 of this article indicates that when the flux per pole passes from the rotor into the stator, it divides and half goes one way and half the other way. Hence, in the present case the total available cross-section of iron to carry the flux per pole is not 15.3 sq.in., but twice that, or 30.6 sq.in. As previously stated, 80,000 lines per square inch is a permissible density, so that a total flux per pole of $30.6 \times 80{,}000$ can be used, or 2,448,000 lines. The only other factor missing from the flux per pole formula which is necessary to give at once the total number of conductors per phase is the chord factor. This depends upon the slots in which the two sides of any coil are placed. In the core that is under consideration there are 48 slots, and since a 4-pole winding is under calculation, the full pitch for the winding would be slots 1 and 13. Full pitch is too long mechanically, and some space endwise can be saved and some copper as well by chording it a few slots, so for illustration it is assumed that the coils lie in slots 1 and 10. Using the approximate formula given for chord factor above, this factor becomes

$$\sqrt{\frac{12^2 - 2(3)^2}{12^2}} = \sqrt{\frac{144 - 18}{144}} = \sqrt{0.875} = 0.93$$

Expressing the flux per pole formula in terms of conductors per phase, this expression follows:

$$\textit{Conductors per phase} = \frac{45{,}000{,}000 \times \textit{volts per phase}}{\textit{cycles} \times \textit{flux per pole} \times K_1 \times K_2}$$

Remembering that the distribution factor for three-phase equals 0.955 and substituting the values calculated, and assuming a delta-connected winding,

$$\textit{Conductors per phase} = \frac{45{,}000{,}000 \times 440}{25 \times 2{,}448{,}000 \times 0.955 \times 0.93} = 362$$

Since there are three phases, there will be required a total number of conductors $3 \times 362 = 1{,}086$; and since there are 48 slots, there will be $1{,}086 \div 48 = 22.6$ conductors per slot. What a designer would do in this case would be either to wind 22 conductors per slot and throw the coil 1 and 11 instead of 1 and 10 or else to wind it 24 per slot and throw the coil 1 and 9, either of which would be a good winding without a great deal of difference between the two.

There are two coils per slot and hence with 22 wires per slot there would be 11 wires in each coil. As the wires are arranged in two or three layers, 11 would not be exactly divisible by either 2 or 3, hence, in the case of a two-layer coil there would be one layer of 5 wires and one layer of 6 wires side by side, or in the case of a three-layer coil there would be two layers of 4 wires each and one layer of 3 wires. Either of these arrangements would be wasteful of space, and hence it would be preferable to have 12 wires per coil, which is evenly divisible by either 2 or 3. If the coil is wound in slots 1 and 11, the chord factor is 0.97, and if it is wound in 1 and 9 the chord factor is 0.866. Hence, the real, effective number of wires in one case is $22 \times 0.97 = 21.3$ and in the other case is $24 \times 0.866 = 20.78$, which would give very close to the same result so far as torques are concerned.

In this calculation it was noted that the figure 440 was used for the voltage. This assumed a series-delta connection. If, for example, it had been desired to connect the winding in two parallel delta for the same voltage, there would have been required twice as many conductors per phase and each conductor would have had one-half the cross-section, since there would be two paths in parallel for the current instead of one in series. Similarly, if the winding was to have been connected in series star instead of series delta, the voltage used in the equation would have been $440 \div 1.73 = 254$ instead of 440. Hence, in the result the conductors required per phase would have been $\frac{362}{1.73} = 209$ instead of 362. It is well to remember the fact that with a star connection only about one-half as many turns are required in series as with a delta connection. It sometimes makes an easier coil to wind and a coil that is mechanically stiffer and stronger, if less turns of a larger-sized wire can be used. This is one of the principal reasons why a star connection is used much more frequently than a delta connection.

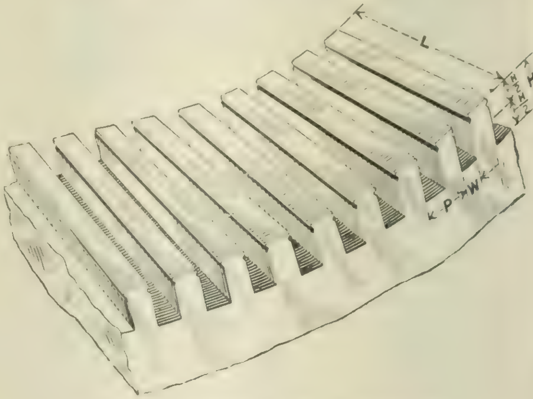


FIG. 5. SECTION OF STATOR CORE

The foregoing calculation concerned itself only with the density of the magnetic flux in the stator core behind the slots and was checked first to make sure the required field had room to get through the core. However, before accepting this figure the teeth should be checked also to see how hard they are working. The diameter of the stator bore of the core under calculation is 17 in. The depth of the slots is 1.7 in., therefore the diameter to the middle of the slot is 18.7 in. and the slot pitch at this point or the dimension P from Fig. 5, equals $\frac{18.7 \times 3.14}{48} = 1.22$ in. The slot width $W = 0.65$ in., hence the tooth width $P - W = 1.22 - 0.65 = 0.57$ in., and since the net core length $L = 6$ in., the cross-section of one tooth at its mid-section is $6 \times 0.57 = 3.42$ sq.in. There are 48 teeth total and 4 poles, hence there are 12 teeth per pole through which the magnetic flux of one pole may pass. Therefore, the total iron cross-section of 12 teeth $= 12 \times 3.42 = 41.04$ sq.in. It was calculated in the foregoing that there were 2,448,000 magnetic lines per pole and it would seem that all that was necessary to check the tooth density would be to divide this figure by 41.04. This is not the case as in the core, for the reason that all the teeth do not carry the flux equally, but those in the center of a pole at a given section carry a maximum and those halfway between poles carry nothing, so that in order to take care of the maximum, the foregoing result is divided by 0.636. Hence, in the problem in hand, the maximum density in the teeth is $\frac{2,448,000}{41.04 \times 0.636} = 94,000$ lines per square inch. As a matter of fact it is actually about 96,000 lines, since the 2,448,000 was figured with 362 conductors per phase and a throw of one and ten, whereas there are now $24 \times 48 \div 3 = 384$ conductors per phase, but the throw is only one and nine, and substituting back in the original flux equation,

Flux per pole =

$$\frac{45,000,000 \times 440}{25 \times 384 \times 0.955 \times 0.866} = 2,480,000 \text{ lines.}$$

This value (96,000 for density in the teeth) is perfectly permissible. It should not be allowed to exceed say 130,000 for 25-cycle machines, nor about 110,000 for 60-cycle machines.

CROSS-SECTION OF CONDUCTORS

Having determined the number of conductors required in the slot—that is, 24—the next step is to figure the necessary size of the conductor or cross-section and see if the coils will go in the slot after being properly insulated. In order to figure this, it is necessary to know what the full-load current of the motor will be. The formula for finding the full-load current of a two-phase motor is,

Full load current per lead =

$$\frac{\textit{Horsepower} \times 746}{2 \times \textit{volts per phase} \times \textit{efficiency} \times \textit{power factor}}$$

where the efficiency and the power factor are the full-load values and are expressed in hundredths, that is with a decimal point in front of each. For example, 90 per cent efficiency is written 0.90 and 85 per cent power factor is written 0.85, etc. For a three-phase motor the formula changes to,

Full load current per lead =

$$\frac{\textit{Horsepower} \times 746}{1.73 \times \textit{volts per phase} \times \textit{efficiency} \times \textit{power factor}}$$

which it will be noted is similar to the two-phase formula except 1.73 is used in the denominator instead of 2. One thing must be especially noted about the three-phase motor, and that is, the full-load current so found is the current in the outside motor lead or the current drawn from the line. If the motor is star connected inside, this same current flows in the motor winding itself and hence in the conductors in the slots, unless the winding is in two or more parallels, in which case, of course, the lead or line current splits up into as many parts as there are parallel paths. On the other hand, if the windings inside the motor are delta connected, as they are in the case we are considering, the current in the windings will be less than the current coming in the lead as figured in the foregoing and it is necessary to divide by 1.73 a second time to find what current must be provided for in the coils themselves.

Preparing to apply the foregoing formula, at once the problem arises, What is the full-load efficiency and the full-load power factor of the motor for which this winding is being figured? Of course there is a wide variation in these figures between small and large motors, and between high and low speeds, and between 25 and 60 cycles. The handiest approximation the author has ever used and one that has given good results is to assume that a three-phase 550-volt motor draws from the line in each lead just about one ampere per horsepower. This is very closely true in most lines of commercial motors over a wide range of sizes and speeds. Then if the motor in question is not three-phase or if it is not 550 volts, the current can readily be changed to other voltages. For example, assume a 40-hp. motor. Then at 550 volts three-phase it follows that its full-load current per lead is 40 amperes, at 440 volts its full-load current would be $\frac{550}{440} \times 40 = 50$ amperes, at 220 volts it would be $\frac{550}{220} \times 40 = 100$ amperes, at 110 volts it would be $\frac{550}{110} \times 40 = 200$ amperes, and so on. Similarly, to convert to two-phase, multiply these values by $\frac{1.73}{2.00} = 0.86$, because the current per terminal of any two-phase motor is always 0.86 times that of a corresponding three-phase.

Referring again to the formula for the full-load current of a three-phase motor, to give one ampere per horsepower at 550 volts would mean that the product of the efficiency and power factor would be 0.785. This might be assumed to be 89 per cent efficiency and 88 per cent power factor or any other combination whose product gave 0.785. At all events this is an average value and sufficiently near correct for the present purpose.

Since the present calculation assumes a 50-hp. three-phase 440-volt rating, it may be assumed that the full-load current per lead is $\frac{50 \times 550}{440} = 62.5$ amperes. Since the winding is to be delta connected, the current in the coils themselves will be $\frac{62.5}{1.73} = 36.1$ amperes.

CIRCULAR MILS PER AMPERE

There is no fixed rule that can be followed for the cross-section of copper required in the coil per ampere. It may be as low as 400 circ.mils in some cases and may have to be as high as 1,000 circ.mils in others. Slow-speed motors and higher voltages (where there is more insulation to pass the heat through) require larger copper than do higher speeds and lower voltages. In the present case and in most average cases a figure of 750 circ.mils can be used. For the present case, then, the circ.mils required would be $36.1 \times 750 = 27,075$. Looking in a wire table, the nearest size to this is No. 6 B. & S. round wire, which shows 26,250 circ.mils, which is near enough. The problem now is, Will 24 No. 6 wires go in a slot 0.65 in. wide by 1.70 in. deep and allow for the retaining wedge at the top and the proper insulation for 440 volts? To answer this it is necessary to know something about insulation requirements. As there are commonly only two voltage classes met with, it can be stated that voltages up to and including 550 volts will require a space in the width of the slot of about 0.1 in. and in the depth of the slot of about 0.15 in. and voltages above 550 up to and including 2,200 will require about 0.16 in. in width and 0.26 in. in depth. These figures in depth do not include any retaining wedges, but must be allowed in addition to the wires between the bottom of the wedge and the bottom of the slot. In the case just being figured, the wires will evidently go in better 3 x 8 than any other way. The diameter of No. 6 round wire over double cotton covering is 0.178 in. Three wires in width would be $3 \times 0.178 = 0.534$ in.; adding 0.1 in. for insulation gives $0.534 + 0.1 = 0.634$ in., which goes very well in the width of the slot, which is 0.65 in. In depth 8 wires would require $8 \times 0.178 = 1.424$ in. The allowance for insulation is 0.15 in., and the usual coil retaining wedge requires 0.125 in., so that the total required depth will be $1.424 + 0.150 + 0.125 = 1.699$ in., which just exactly fills the available depth. It should be understood that the 24 wires are not 3 x 8 in one coil but 3 x 4 in each coil and two coils in the slot according to the usual practice.

If the wires had not fitted in the slot as shown it would have been necessary to choose a wire small enough to go in the space and then by trial after the winding was complete find out how many horsepower the winding would carry without overheating. If it were not possible to get 50 hp., it would probably develop 45 hp. without trouble if the output coefficient checked to 50 as shown in the beginning of this article.

CALCULATIONS FOR ROTOR WINDING

With regard to the rotor winding, if it is of the wound-rotor type the number of wires per slot can be made any number that is convenient provided the total weight of copper in the rotor winding is made approximately 80 per cent to 85 per cent of that in the complete stator winding.

If a phase-wound, the coils must of course be connected for the same number of poles as the stator. If there should be an old winding on the rotor for a different number of poles, it may be possible to reconnect it for the number desired; but as rotor windings are nearly always of the "wave" type or something of the same order, it is usually impossible to reconnect for any other number of poles.

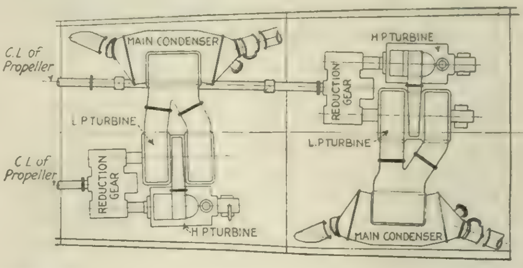
If the rotor winding is squirrel cage, the number of bars and their cross-section are probably fixed. The cross-section of the end rings, if of rolled or drawn copper, should be so chosen that the weight of bars plus rings is perhaps 75 per cent to 80 per cent of the total weight of the stator coils. If the rings are cast copper or cast brass, it should be remembered that a larger cross-section will be required, since the conductivity of the best cast copper is only 80 per cent to 85 per cent of the conductivity of rolled copper, and cast brass is as low as 18 per cent to 25 per cent of the conductivity of drawn or rolled copper. This would mean that a ring of cast brass would have to be 4 to 5 times the cross-section of the corresponding rolled copper ring to carry the same current. It should also be remembered that a two-pole motor would have proportionately the heaviest ring on the squirrel cage, a four-pole next, then a six and so on, and that when ten poles or twelve poles are reached the ring would probably be no larger in cross-section than would be required for mechanical strength and construction.

Such in its briefest form is the simplest calculation that can be made which it is safe to make in the hope of getting the desired results. It will be noticed that no attention has been paid to calculating the leakage reactance, the no-load current, the starting and maximum torques, the circle diagram nor any of the refinements that the designing engineer commonly employs; and yet if care is used in employing the checks that are made, the experimenter should be rewarded with reasonable results.

To sum up, the available core is first checked by the output coefficient to see if it will develop the horsepower at the desired speed. Next a check is made to see how much magnetic field can be handled in the core and teeth. Then the proper number of conductors is chosen to generate the line voltage when acted upon by the permissible magnetic field. These conductors are then made of the proper size to carry the working current and insulated for the working voltage and fitted in the slots. This is all that is attempted, and it is assumed that if these conditions are met, all the other conditions of operation will fall reasonably in line or can be adjusted after trial without too much change to meet the desired requirements. Naturally, such broad assumptions may not result in a design of finished nicety, but they may sometimes give quick results where results must be had quickly or not at all.

Swiftest Vessel in United States Navy

In her recent official trials the United States "Satterlee" broke all American speed records by steaming at a rate of 38.257 knots. The best previous record made by an American war vessel is 37.04 knots. The "Satterlee" is driven by two 14,000-hp. Westinghouse compound turbines which developed 31,223 hp. and broke all power records for this class of vessel. The diagram shows the layout of the engine room and the location of the two turbines and condensers.



THE DESTROYER SATTERLEE

Refrigeration Study Course—XIII. Ammonia and Ammonia Piping

By H. J. Macintire

IN THE steam engine or turbine plant the quality of steam delivered to the engine is uniformly constant, as a rule. For instance, it may be wet, dry and saturated, or superheated. It may have a trace of air present, but this is almost negligible. In the boiler room, however, conditions are different. The feed water may be heavily acid or impregnated with carbonates, sulphates or other solids in solution. If exhaust steam is returned to the boiler from the hotwell or open heater, there may be considerable oil contamination, all of which tends to cause scale or corrosion of the tubes or plates.

Refrigerating systems have troubles somewhat of the order of these boiler difficulties, but in a different manner. The system may accumulate air, on account of repair work, or with the low side operating under a vacuum or by carelessness in the initial charge of the system. Then moisture may get into the expansion piping when blowing out the coils with steam to remove oil, or by being carried into the system by condensing on the piston rod. The oil, of course, gets into the coils by being carried out of the cylinder with the discharge gas. Let us see how these impurities affect operation and the production of refrigeration.

The Effect of Air

The effect of air in a steam condenser is to increase the back pressure, which decreases the economy of operation. Air or other inert gas in the ammonia system collects in the condenser, where it increases the head pressure over and above that which should exist due simply to its own vapor tension. The head pressure may be 10, 20, 50 or more pounds greater than it should be, and the horsepower required to produce a ton of refrigeration will be correspondingly increased.

In addition the air collects in the condenser, first forming an insulation film about the condenser pipes, Fig. 1, and then, as it accumulates, fills the condenser. It is a mistake to suppose that air or inert gas collects in any particular part of the condenser. All gases tend to diffuse and become uniformly mixed. The only way to separate the ammonia from the gas is to condense it. This is done partly in the process of purging when the cooling water is showered over the pipes while the compressor is not pumping on that particular stand; then the gas in the upper part of the condenser is allowed to bleed out, it being less rich in ammonia in the process.

The Effect of Water

Air in the system is thereby seen to affect the head pressure and therefore to increase the horsepower per ton, but the accumulation of water in the ammonia system has a worse effect: It may prevent obtaining the required temperature in the refrigerating coils. Moisture *will* get into the system in one way or another. If it gets in via the condenser, it mixes with the anhydrous ammonia in the receiver and finally passes through the expansion valve into the refrigerating coils. As the boiling pressure of the ammonia (the back pressure) is relatively high, there is an almost negligible tendency for the water in the coils to evaporate. It remains in the low side and forms first a strong aqua ammonia, and then (as the water increases) a less strong aqua.

Aqua causes the cooling coils to behave *dead*. The boiling action is decreased, or the temperature required cannot be obtained. To get the results desired, a lower suction pressure must be carried than would be required if the ammonia were free of water. The result of a lower suction pressure for ammonia compressors has already been given considerable emphasis, increasing, as it does, the horsepower per ton of refrigeration and decreasing the capacity of the compressor. The effect may be noted in the table, which shows the boiling temperatures of aqua ammonia under various pressures.

BOILING POINTS OF AMMONIA

Suction Pressure, Lb Gage	Boiling Temperature Saturated Ammonia, Deg. F.	Boiling Temperature Ammonia 5 per Cent Moisture, Deg. F.	Boiling Temperature Ammonia 10 per Cent Moisture, Deg. F.	Boiling Temperature Ammonia 15 per Cent Moisture, Deg. F.
30	17.4	22	27	32
25	12.2	17	22	27
20	6.5	12	16	22
15	0.1	5	10	14
10	—7.2	—3	2	7
5	-15.9	—12	—7	-2

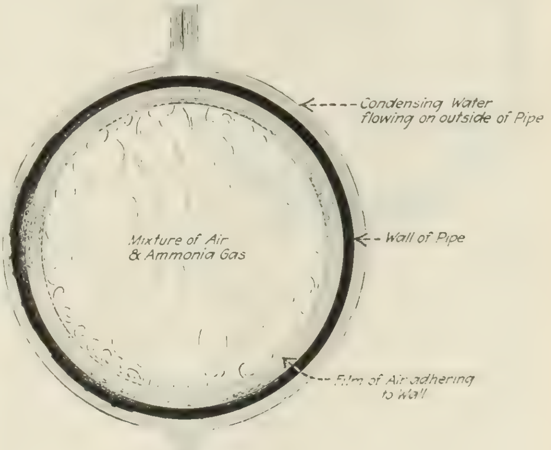

Condensing Water flowing on outside of Pipe
Wall of Pipe
Mixture of Air & Ammonia Gas
Film of Air adhering to Wall

FIG. 1 SECTION OF CONDENSER COIL WHEN FUNCTIONING

For example, at 20 lb. gage pressure anhydrous ammonia will boil at 6.5 deg. F., but if 10 per cent water is present the temperature of boiling of the solution (at 20 lb.) will be 16 deg. F. Therefore (see table) it will require a suction pressure of 10 lb. with 15 per cent moisture to give the same boiling temperature as can be obtained at 20 lb. with anhydrous ammonia.

The Effect of Oil

No refrigerating system can be kept entirely free of oil. The vertical inclosed-type compressors are splash lubricated, and the horizontal high-speed machines must have copious amounts of oil or trouble will occur. Even the old style, slow-speed compressors carry over considerable oil, which is supposed to be caught by the oil separator. However, we all know that no separator can remove all the oil from the discharge gas. Some is volatilized and condensed with the ammonia in the condenser, and some is not caught by the separator. In fact, it is safe to assume that from 2 to 5 per cent of the oil will get into the condenser and ultimately collect in the low spots of the direct expansion piping. It may mix with impurities or dirt and form a thick mud, or it may solidify at the temperature carried in the system.

The net result of oil in the expansion piping is for reduced efficiency of coil surface. The oil or grease will form an insulating covering. As everyone knows, the refrigerating coils are the means only of heat exchange. The ammonia is evaporated by being in an *atmosphere* which is hotter than the boiling temperature of the ammonia at the *pressure* being maintained in the coils. Therefore, heat passes into the coils, and the ammonia is boiled away to make room for more liquid passing into the coils through the expansion (pressure-reducing) valve. In consequence of heat being used to boil the ammonia, the atmosphere or brine is cooled. We naturally desire to get as many heat units past the walls for every square foot of pipe surface as is possible under the circumstances, but an oil film $\frac{1}{100}$ in. thick is as bad as a boiler scale $\frac{1}{10}$, or a steel plate 10 in. thick.

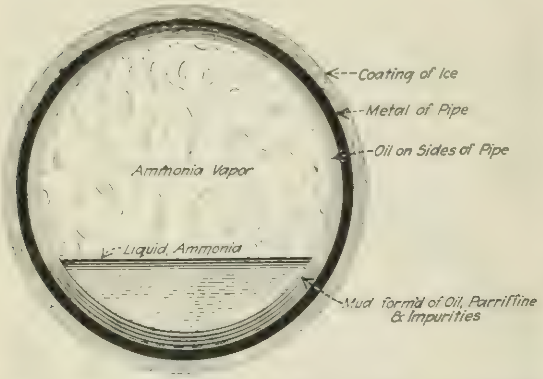


FIG. 2. SECTION OF COOLING COIL WHEN FUNCTIONING

Unlike steam surface condensers, which are usually of brass and some 0.05 in. thick, refrigerating piping is usually $1\frac{1}{4}$ or 2 in. normal diameter and the walls are usually extra heavy. The outside surface is frequently heavily coated with ice; the net result is a great reduction in the unit heat transference (see Fig. 2). If a pipe will not allow sufficient heat to transfer, then more surface will be required or a greater temperature difference will have to be carried. Either of these alternatives is commercially unbearable, and so the piping must be kept in as clean a condition as possible, just as in boiler and steam condenser practice.

The best possible arrangement of piping to keep the low side free of oil or water is to arrange all piping so that it will drain, and contain no pockets. At each low point install a trap which may be opened to the atmosphere or to a regenerator apparatus. Although semi-solid oil will still remain on the sides of the expansion piping, yet ease in cleaning is obtained and liquid impurities may be drained readily.

DIRECT-EXPANSION PIPING

More trouble is encountered with the low side, perhaps, than with any other part of the system. The cause is mainly due to the fact that it is not generally clearly understood. And yet it certainly is not more difficult to understand than the steam boiler, the steam surface condenser, the closed feed-water heater or the economizer. Each of these devices is a heat-exchange apparatus, and the heat transfer is made possible by having *metal* contact with the two substances. But to transfer heat there must be a temperature *difference* on the two sides of the metal—a temperature difference in the two substances, the ammonia and brine or ammonia and atmosphere in the room to be cooled.

As has been pointed out before, the ammonia in the refrigerating coils must be maintained at the proper pressure for satisfactory service. Why does not a drum of ammonia provide refrigeration and become frosted with a thick layer of frost? Why does not the liquid receiver normally become frosted and tend to refrigerate the compressor room, also the liquid lines leading up to the expansion valves? Because the pressure in these pipes or drums is too great, and therefore the temperature corresponding (due to its saturation laws) is greater than or equal to the temperature of the air in the engine room or the atmosphere. To have an evaporation of the ammonia, its boiling temperature must be below that of the substance on the other side of its container. The heat must flow into the expansion coils from the outside. The point in question is brought out by every-day operation of the plant. If a sharp freezer and a cooler are on the same system and a pressure of 15 lb. gage is carried, the ammonia will become "lost" and the receiver will become empty. Investigation will show that the sharp freezer coils are flooded because the room was too cold to evaporate the ammonia and it accumulated in the coils. The remedy would be in reducing the back pressure to 10 lb. or 5 lb. gage, in which case the boiling temperature of the ammonia would drop to —7.2 deg. F. or —15.9 deg. F. and, as the sharp freezer is supposed to be kept at zero degrees, boiling action would be stimulated and refrigeration would be maintained. This whole process is expressed by the formula:

Refrigeration in B.t.u. = *area of pipe in sq.ft. times coefficient of heat transmission times temperature difference on the two sides of the pipe.*

which shows that no matter what area in square feet is available (it could be 10,000 sq.ft.) unless there is a temperature difference on the two sides of the pipe so that heat may flow from the air to the ammonia, there will be no refrigeration.

From the formula it would seem that to secure refrigeration in moderate amounts it is necessary to have either extensive piping or a large temperature difference. For example, a ton of refrigeration may be obtained by the following:

Sq.Ft.
A.... 400 × 2 × 15 = 12,000 B.t.u. per hour
B.... 200 × 2 × 30 = 12,000 B.t.u. per hour

where in each case the coefficient of heat transmission is taken as being equal to 2.0. In B only half the piping is needed as compared with A, but the temperature difference is twice as great, thereby requiring about 10 lb. suction as compared with a case using 20 lb. as A. Likewise, if 800 sq.ft. were used only $7\frac{1}{2}$ deg. F. temperature difference would be required, and a higher suction pressure. The higher the suction pressure the greater the number of pounds of ammonia handled, and therefore the greater the efficiency of operation with respect to the power input.

Steam-Engine Operation and Maintenance—Loose Flywheels

BY H. HAMKENS
Consulting Engineer, Newton, New Jersey

IT IS not a rare occurrence that a flywheel gets loose on the shaft. If the wheel is split, the hub bolts may have come loose, and in that case the nuts may be tightened or the bolts can be taken out, heated and shrunk in. It is, of course, understood that there must be sufficient space between the two halves of the hub for a good clamp fit, the space to be from ½ to ¾ in. according to the size of the wheel. A flywheel of the built-up kind getting loose on the shaft is an indication of carelessness in putting it on. The majority of built-up wheels are provided with two hub centers between which the arms are clamped, as shown in Fig. 1. As a rule two feathers are used, both fastened in the shaft. There are, however, instances where each half-center has two separate keys driven in. The center marked X is forced on the shaft very tight, while center Y is drawn up by means of bolts. Centers and shaft are bored and turned to four different diameters; A represents the nominal diameter of the shaft, B is bored 0.010 in., C 0.020, and D 0.030 in. larger than A. For D and C a press fit allowance of 0.001 in. per inch of diameter is made; the allowance for A and B cannot be more than one-half that amount. The bolts and holes should have a taper of ⅛ in. per foot. The bolts should have a large fillet under the heads and be driven in tight.

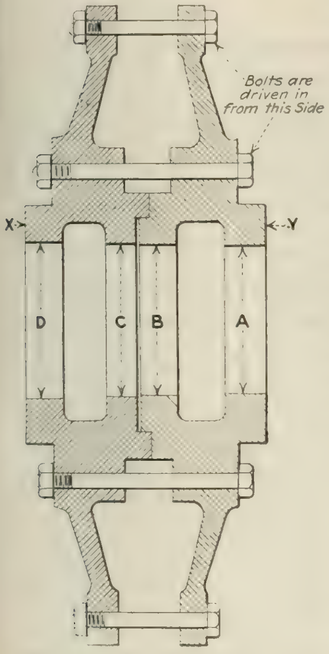


FIG. 1. HUB CENTERS FOR BUILT-UP FLYWHEEL

From the description it is evident that unless the work is carefully done in all its stages, there are some chances of the bolts and the male center working loose. The bolts, or those which get loose, can easily be renewed, but if a center gets loose it is serious. The only remedy will probably be to drill off the loose half and replace it with a new one which is made in two pieces and bolted together as shown in Fig. 2.

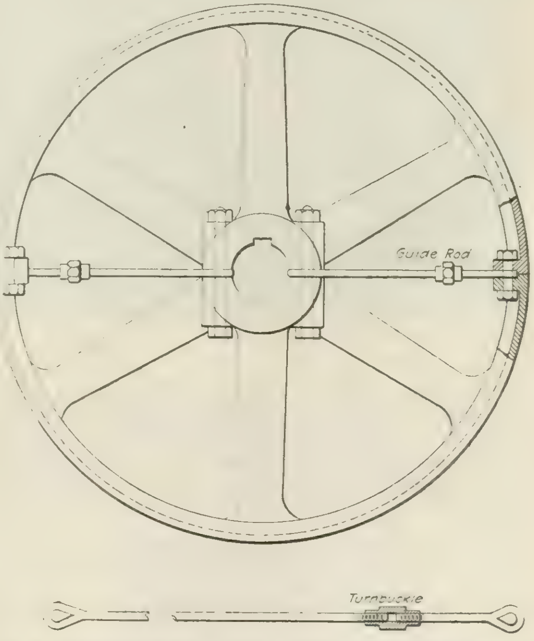


FIG. 3. SPLIT FLYWHEEL STRENGTHENED BY A TIE ROD

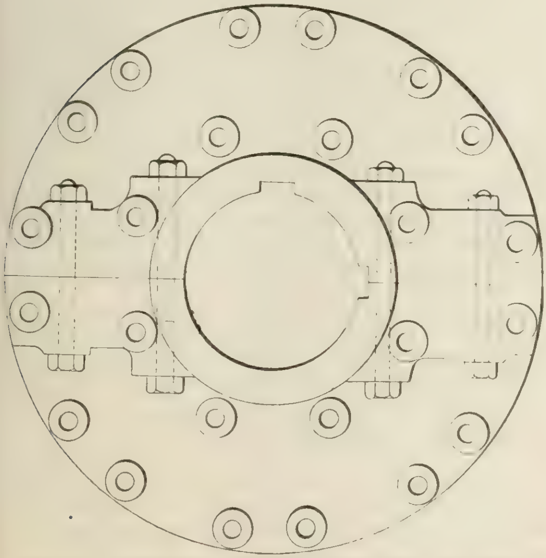


FIG. 2. FLYWHEEL CENTER IN HALVES, BOLTED

Fatigue of the metal due to continuously varying strains in the arms and rims of flywheels is responsible for cracks and failures. The tension in the rim of a flywheel varies as the square of the velocity; it is approximately expressed by the formula $T = \frac{V^2}{10}$, in which V represents the velocity per second. Taking a wheel 16 ft. in diameter with a variation in speed of from 90 to 100 r.p.m., the stresses per square inch in the rim will be 562 and 688 lb. respectively, a change of over 20 per cent. While this is considered to be well within the limit of safety, it may in the course of time become a source of danger in addition to other strains.

Besides tensile strain there is considerable bending stress in the rim between each pair of arms; this is especially the case in that part where the joint is located between the arms if the wheel is constructed as shown in Fig. 3. For rim velocities of a mile a minute or over the design is dangerous and should not be tolerated. As a safeguard guide rods are often put in between the hub and rim bolts with a turnbuckle for tightening the rod, as shown in the sketch. The rational way to construct a split wheel is shown in Fig. 4, in which the parting is through two arms. This design eliminates excessive bending strains at the joints.

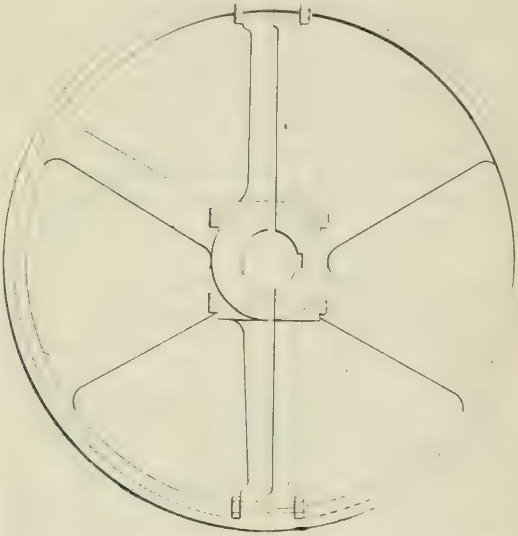
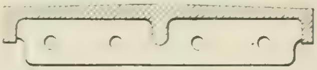
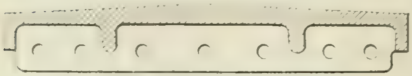


FIG. 4. SPLIT FLYWHEEL WITH PARTING THROUGH THE ARMS

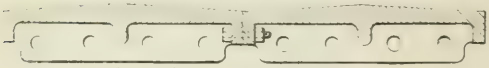
Bandwheels should have deep ribs at the edges and in the center, as shown in Fig. 5; *A* shows the design for one set of arms, *B* for a double set, and *C* for very wide faced wheels for two belts in which two separate rims are bolted together through the rim flanges.



A, *Rim with one Center Rib*



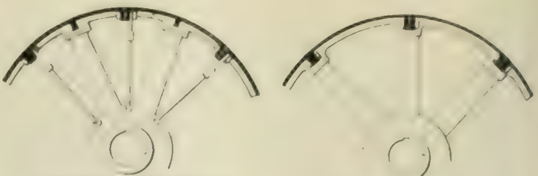
B, *Rim with 2 Center Ribs for 2 Sets of Arms*



C, *2 Rims bolted together*

FIG. 5. RIM SECTIONS OF FLYWHEELS

For large built-up bandwheels there are several designs extant. In Fig. 6 *A* is perhaps the least desirable as the joints are located between the arms, introducing heavy bending strains; to make these wheels safe guide rods are put between rim bolts and hubs, similar to those on the split wheel. On the wheel shown in Fig. 6 *B*, the joints are located over the arms, which is the correct place for them. In this design the bending stresses are reduced to a minimum; it is much safer than wheels of the other construction.



A, *Undesirable Construction* **B**, *Correct Design*

FIG. 6. BUILT-UP FLYWHEELS

Prof. C. A. F. Benedicks, Ph. D. of Stockholm University, has developed a new theory of metallic conduction of electricity which explains certain phenomena not made clear by the former electron theory. As a consequence of this new theory one has to conclude that even in a single homogeneous metal thermo-electric current can be produced. Heretofore such currents were believed to be produced only when two dissimilar metals were present. In liquid mercury it has been possible to definitely prove the existence of thermo-electric currents. During a lecture before the Institute of Metals, London, England, the professor demonstrated a new rotating thermo-electric apparatus made entirely of copper and revolved in a magnetic field, the driving force being obtained solely from unequal heating of strips of copper by means of small gas jets.

It is proposed to divert water from the high-level rivers in Southern Germany to the low-level system of the Main, says the *Electrical Review*, of London. The fall of the River Lech, for instance, which now flows south and joins the Danube, would be increased from 300 ft. to 1,080 ft., resulting in a total of 500,000 hp. if arranged with open canals and falls at three points. The first fall would be at Nuremberg, where 200,000 hp. is obtainable, the second at Wurtzburg, delivering 150,000 hp., and the balance of 150,000 hp. at Frankfort, as against 60,000 hp. if the river is to continue to flow south as at present. Coal-fired installations to produce the same power would require 3,000,000 tons of good-quality coal annually, which at the present price in Germany is worth approximately $70,000,000.

President Wilson has named Secretary Baker as chairman of the Water Power Commission created under the recently enacted water power bill. The other members of the commission are the Secretary of Agriculture and Secretary of the Interior and in addition an executive secretary to be appointed.

Coal miners of France, who have been on strike intermittently for several months, are now said to be all at work. It is computed that the strikes caused the loss of 40,000,000 francs in wages.

John A. Stevens—Authority on Boilers and Power-Plant Design

As a Member of the Original Massachusetts Board of Boiler Rules He Enthusiastically Worked To Form Rules for the Standardization of Boiler Design. Later, his Dynamic Energy Was Largely Responsible for the Successful Formulation of the American Society of Mechanical Engineers' Boiler Code.

Photo by Underwood & Underwood

THERE is a saying that "instead of a man's success being due to a university degree, he often succeeds in spite of it." However, there is a growing opinion that, in the engineering profession, a man rarely attains the highest rank without a thorough technical education. This is true because of the difficulty of obtaining a knowledge of the fundamental principles of engineering outside a high-grade technical school. There have been, however, notable examples of men whose personal ability has pushed them to the top without such help. Such a man is John A. Stevens, the well-known consulting engineer of Lowell, Mass. After graduation from the Saginaw, Mich., high school he attended the University of Michigan for one year, and then left to serve a three-year apprenticeship as a machinist in the shop of Mitts & Merrill of Saginaw; he also worked for about a year as assistant toolmaker with the Pere Marquette Railroad.

Mr. Stevens' experience as a steam engineer began when he turned his attention to marine service on the Great Lakes. He served as engineer on a number of lake steamers, and in 1893 he came East and entered the ocean steamship service in the employ of the International Navigation Co. of New York. He served on a number of this company's liners and received rapid promotion, until in less than three years he was first assistant engineer of the "St. Paul." While in this service he obtained an unlimited engineer's license for ocean steamships—the highest class license issued—at the age of 27 years.

In 1896 he left marine work and became chief engineer of the Merrimac Manufacturing Co., of Lowell, Mass. During the thirteen years he spent in this position, Mr. Stevens practically rebuilt the entire steam plant at Lowell and at the same time superintended the power departments in the company's southern mills.

He resigned his position with the Merrimac Company in 1909 and spent three months in Europe, gathering special information on steam boilers, steam turbines and condensers. On his return from Europe he opened an office as general consulting engineer, specializing however, on light, heat and power work. In this connection he has had a wide experience in power-plant analysis and in the supervision of construction work. Mr. Stevens has also done some original work in the line of invention, having eight patents containing 113 claims on water tube boilers as well as on the American Steam Superheater. He is also co-inventor of the Stevens-Pratt Boiler, which is especially designed for large central-station service.

He is probably best known to the public through his connection with the preparation of steam boiler standardization codes. He was a member of the original Massachusetts Board of Boiler Rules, representing the "boiler-using" interests. This board was created as a result of the efforts of Mr. Joseph H. McNeil, chief of the Massachusetts Boiler Inspection Department. Mr. Stevens describes the first meeting as taking place in a very small hot room in the State House at Boston on July 5, 1907. At this meeting Mr. McNeil, who was chairman, outlined the plan to formulate a standard for boiler design which should be first of all safe, and second commercial. Meetings were held weekly or oftener for practically three years. Suggestions, ideas and data were solicited and received from all known authorities, various pamphlets were issued and finally the board published the issue of the rules of Aug. 5, 1909. This was the last issue made by the original board and contained all necessary information for the manufacture or inspection of stationary steam boilers in Massachusetts at that time.

In 1911 a committee was appointed by the American Society of Mechanical Engineers for the purpose of preparing a standard boiler code in a more complete manner than was possible with the Massachusetts State Board. Mr. Stevens was made chairman of this committee, which position he still holds. This work was carried on along lines similar to those followed in Massachusetts in taking counsel with all possible authorities who would be interested. In addition to numerous meetings, hearings and much correspondence, an advisory committee was appointed. This advisory committee contained engineers representing every branch of industry interested in boilers either as users, manufacturers, insurers or in any other capacity. A comprehensive code was issued in 1914, and has been adopted in a number of the states.

The committee continues to function and periodically issues information and interpretations of the code in answer to inquiries from those interested. As chairman of this committee, Mr. Stevens has put in a great deal of time and thought and is responsible in no small measure for the success of the work.

During the war he was Standardization Engineer of the United States Shipping Board, Emergency Fleet Corporation and assisted in formulating the "Rules for the Inspection of Marine Machinery."

Realizing as he does the importance of research and invention, Mr. Stevens has taken a practical means to encourage effort in this direction. He has created a trust fund with the American Society of Mechanical Engineers to be known as the John A. Stevens Trust Fund, amounting to $20,000, the income of which is to be paid annually, after 1937, to the persons who have in any year invented or been responsible for the invention of a noteworthy progress in engineering, having to do with the conservation of fuels in the generation of light, heat and power.

In 1918, the Association Medal was presented to Mr. Stevens by the National Association of Cotton Manufacturers for his paper on the "Evolution of the Steam Turbine in the Textile Industry." This medal was awarded to Mr. Stevens for having contributed the most to the advancement of the cotton industry during the year 1917.

Mr. Stevens is a vice-president of the American Society of Mechanical Engineers and a member of the American Society of Heating and Ventilating Engineers, the American Society for Testing Materials, the Society of Naval Architects and Marine Engineers and the Old Colony Club of New York; The National Association of Cotton Manufacturers, and the Engineers Club of Boston, the Lowell Board of Trade and the Yorick Club of Lowell, Mass.; the Vesper Country Club of Tyngsboro, Mass.; The Scituate Yacht Club, the Massachusetts Chamber of Commerce, and the High School Building Commission of Lowell, Mass.

Mr. Stevens was born in Galva, Ill., Sept. 16, 1868. Although a Westerner by birth he comes of real New England stock, being a direct descendant of John Alden.

Spontaneous-Ignition Temperatures of Liquid Fuels

It has long been evident to both designer and user of internal-combustion engines that the influence of the spontaneous-ignition temperature of the fuel was of primary importance. The results of a series of tests by Harold Moore appear in the Jan. 30 issue of the *Petroleum Times.*

In these tests a metallic vessel, having a cavity for the reception of the fuel and oxygen charge, was employed. The vessel was placed on a source of heat, and the temperature was raised until ignition occurred upon the introduction of the fuel and oxygen charge. It was found that, even though the vessel temperature was above the temperature necessary to produce automatic ignition, there was an interval of time elapsing between the introduction of the fuel and the explosion. The time interval is largely dependent on the temperature. Table I covers a test with petrol (gasoline).

TABLE I TEST WITH PETROL

Temperature, Deg. C.	Time, Seconds	Drops of Oil	Temperature, Deg C	Time, Seconds	Drops of Oil
284.5	25	1	299	5.8	1
287.5	14	1	305	4	1
289	12.5	2	310	3.2	1
291	11	1	316	1.6	1
295.5	7	1	320	1.4	1

Table II gives the ignition temperatures of a number of the commonly used fuels. Both pure oxygen and air were employed in the tests. Considering the density of the air charge in an engine cylinder, there is no doubt that the temperature shown when oxygen was the agent more nearly represents actual cylinder conditions.

TABLE II IGNITION TEMPERATURES OF VARIOUS FUELS

		Ign. Temp., Deg. C.				Ign. Temp., Deg C.	
Grade of Fuel	Sp. Gr.	With Oxygen	With Air	Grade of Fuel	Sp. Gr.	With Oxygen	With Air
Petrol	0.718	270	361	Texas crude...	0.895	256	387
Paraffin oil	0.807	251	.	Fuel oil.......	0.900	269	430
Petrol......	0.735		362	Mex. crude.	0.908	259	417
Lamp oil..	0.787		367	Texas crude	0.936	268	416
Gas oil		254	358	Mex. fuel oil.	0.948	259	424
Egypt crude	0.851	260		Mexican crude	0.949	258	425
Degboi oil.	0.890	261	384	Calif. crude.	0.952	264	
Persian crude.	0.894	254	408	Calif. crude...	0.961	262	420

In the solid-injection explosive engine, as well as in the Diesel, the temperature at the end of the compression stroke must be high enough to ignite the fuel charge. With the lower pressure hot-bulb engine the temperature during the early part of the compression stroke must not exceed the ignition point. The vaporizer or carburetor engine requires a final temperature below the ignition point.

A curve of the equation $\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)\frac{n}{n-1}$ can be constructed; from this curve the final pressure required in any engine can be fairly determined for any given oil since Table II gives the temperature of spontaneous ignition.

EDITORIALS

Calculating a New Winding for an Induction Motor

IN THE complete design of an induction motor there are in all some nineteen points that must be considered by the designing engineer. Some of these may be compromised to the advantage of the others, depending upon the characteristics it is desired to give to the machine. In fact, the design of any induction motor must be a compromise, since it is impossible to work up a design that will develop high starting torque and operate at high efficiency and power factor, yet will be satisfactory mechanically. If the air gap between the rotor and the stator cover is made of such dimensions as to allow a reasonable wear of the bearing before rubbing will occur between the rotating and the stationary members, then the power factor will be considerably lower than if the minimum clearance is allowed. If the rotor conductors are given sufficient resistance for the machine to develop high starting torque with reasonable starting current, the efficiency of the machine will be low while running. However, some of these features may be favored at the expense of the others to give a design that is best suited to certain applications. Where motors are not required to start under very heavy loads, but run for considerable periods after being started, high starting torque is not as important as high efficiency. Consequently, the motor should be designed to operate at high efficiency. On the other hand, if the motor must start heavy loads at frequent intervals, such as in hoist service, high starting torque with minimum starting current is an important characteristic. Hence efficiency can be advantageously sacrificed to obtain high torque.

In working up a new winding for an old induction-motor core, many of the points that would be considered in a new design are already determined. Furthermore, these designs are in many cases worked up by those who want to know how many turns must be put in the winding and the cross-section of these turns to give a machine that will operate satisfactorily, rather than to achieve refinement in design. A method of "Calculating a New Winding for an Old Induction-Motor Core" is given by A. M. Dudley elsewhere in this issue. Although no attempt has been made by the author to consider all the points pertinent to a finished design, the necessary calculations are given for determining a winding that will give a satisfactorily operating machine in a large percentage of cases. It is the opinion of the author, after fifteen years spent in the commercial design of induction motors and after personal knowledge of many cases of windings roughly calculated by practical winders which performed satisfactorily, that an approximate idea of what is required in a winding to do a certain job can be obtained without involving a great mass of calculation. It should be understood that with the short-cut methods and the abbreviated consideration presented, it is not intended or expected that anyone will produce finished and well-balanced designs; but it is believed that in an emergency, when time is the essence of the consideration and some chances can profitably be taken, the method presented will give an approximation to the correct winding which will be satisfactorily operative in a high percentage of cases. The chief object of the author has been not to elaborate a new system of design calculations, but to tell the fellow whose chief concern it is to make motors run and keep them running, what they may do to help themselves when they are a thousand miles away from a designing engineer and the motor has to be running in the shortest time possible.

Code of Ethics for A. S. M. E.

IN this issue of *Power* is given a summary of the report of the Code of Ethics Committee of the American Society of Mechanical Engineers, together with the complete proposed code. There is nothing new in the idea of such a code. The formal rules of ethics of the various bar associations are well-known precedents. The Mechanical Engineers themselves adopted such a set of rules in 1912, but this document was long and cumbersome and many members, especially those joining the society since that date, have never heard of it.

A reading of the proposed code shows that there is nothing startling in it. It consists of fourteen paragraphs made up of short definite statements of what an engineer is expected to do if he is to have the respect of his fellow engineers. Most of these paragraphs are rules to which any honorable man will agree without question. In fact, the criticism has been made that most of the requirements are so obviously no more than common honor demands that it is unnecessary to formally set them down. It is an unfortunate fact, however, that there are engineers both within and without the society who will violate and who do violate the most obvious of these rules. Such violations of honor are often not violations of law, so that the only punishment is the loss of respect or good will. If a formally stated rule is violated, it is much more likely that the offender will lose his reputation for honorable action than if every individual judged the act according to his own rules.

In general, it is a good code. In fact, it seems to be a very good code. With this idea in mind some criticism of details may be offered for consideration. In the eighth paragraph it is set down that an engineer, before taking over the work of another, should satisfy himself that good and sufficient reasons exist for making the change. It seems that some statement of what would be considered "good and sufficient" reasons is desirable. The tenth paragraph seems contradictory. In the first sentence the engineer is forbidden to regard as his own, information obtained confidentially from a client, while the second sentence allows him to use such information in his own private practice. A few words of explanation might help here also.

The committee, in reporting, suggested that the whole matter should be referred to the Engineering Council or some other body representing all branches of engineering. The code was presented only to carry out instructions, but the committee feels that men in all branches of engineering as well as architects should have a uniform code. There seem to be good reasons for uniform action by all engineering societies. The main idea in preparing the code is to obtain uniformity among the members of the A. S. M. E.; its extension to include the other branches of engineering should enhance its benefits. It is to be hoped, therefore, that the Engineering Council or the Federated Engineering Societies will take the matter up and carry it on to completion. In this connection the proposed form might well furnish at least a starting point for the work of the more general committee.

The No-Accident Drive

EVERY industrial accident is a setback in the struggle for existence. When it involves human injury, it not only inflicts impairment and suffering upon the immediate subject or brings about the bereavement of those to whom he is dear, but it increases the cost of production. This means either diminished profits to the manufacturer or, if cost is, as it ought to be, the basis of the selling price, a higher price to the consumer.

The results are far-reaching and distribute themselves by devious paths. There is the immediate loss of the material or product destroyed; the loss of production due to interrupted service; the loss of man power through the injury to the victim and consequent upon the interrupted work of other men; the cost of hospital service and medical attendance; the enhanced cost of insurance, predicated upon expectancy of accident and increasing as the number of accidents increases; and numerous others that will suggest themselves to those who analyze the subject further.

Aside from the humanitarian motive of preventing loss of life and physical suffering, there is enough of a material inducement to the manager and to the public to keep the number of industrial accidents at a minimum. The employers' liability laws have made the employing class more conscious of this condition. The large companies are paying a great deal of attention to safety methods and apparatus. State industrial commissions, factory inspecting departments, etcetera are doing good work and the National Safety Council an organization of manufacturers, is attacking the problem in a large and systematic way. Under its auspices the Lehigh Valley in Pennsylvania had a Safety Week. commencing May 10. The extent to which accidents are avoidable is indicated by the fact that during this safety week there was a reduction of ninety-two per cent in mining accidents, eighty per cent in electric-railway accidents, thirty per cent in all public accidents and more than ninety per cent in accidents in the largest industrial plants in the district.

One of the most reproachful of the types of accident that has marred the history of American industry is the boiler explosion; flagrant because the experience of other countries, where their use had been subjected to intelligent and expert supervision and regulation, long ago demonstrated that boilers could be used with a much smaller percentage of accidents than was current in the United States. The attitude toward such legislation, which has been opposed as meddlesome and paternal, is rapidly changing. A third of the states have provisions for the inspection of boilers and some of the states for the examination and certification of the men who run them; and others are coming rapidly to see that supervision is a service rather than an interference.

A Good Suggestion

PROGRESS in any line of endeavor depends very largely upon the reliable data available on the subject, and until these are obtained it is difficult for important developments to be made. This is about the condition that we find in regard to the use of higher steam pressures. Practically all the equipment manufacturers are agreed that the problems encountered in the use of higher steam pressures than those now found in common practice can be solved, but no data are available that would encourage the investment in a plant designed for the pressures that have been suggested. The big question is, How is this experience to be obtained?

Some time ago it was suggested that somebody should build a high-pressure steam plant, but apparently no company cared to take the plunge. Later, efforts were made to have the large power companies form a pool to finance the building of such a plant. However, for various reasons this never materialized. In the Prime-Movers Committee report of the National Electric Light Association, presented at the Pasadena Convention, it was suggested that a trial installation might be made by equipping an existing station with a comparatively small high-pressure boiler and turbine, the latter so designed as to exhaust into the main steam header of the station. This scheme has the great advantage of allowing the work to be done at minimum cost and would show up trouble with valves and piping and furnish a great deal of valuable data on which to base future developments

The White Collar Slave

IN A recent issue the *Electrical Review*, of London, says that at a recent dinner James Swinburne, who, unfortunately, is too seldom seen and heard at electrical gatherings nowadays, pleaded the cause of the salaried men with an earnestness and sympathy which demanded attention.

In view of the commotion recently set up by an advertisement in its pages, which placed a technical officer on a pecuniary par with a fitter, and of Mr. Swinburne's remarks, the arrival of a batch of papers from the Electrical Power Engineers Association embodying particulars regarding the National Joint Board which is dealing with the case of the station men and the schedules of wages agreed upon is very timely. The board will play the part of a Whitley Council for the station, technical and clerical staffs, which are therwise unprovided for in this respect, having been omitted from that scheme by an extraordinary oversight.

The high cost of better grades of coal and the uncertainty of delivery are causing greater use of lignite and low-grade fuels where these are available locally. It has practically become an absolute necessity that the coals be used in certain localities Necessity is the mother of invention, and no doubt in this case will create an incentive to develop improved methods of burning the low-grade fuels.

CORRESPONDENCE

Some Pump Experiences

A triple-expansion duplex mine pump began to perform badly on one side, and as an examination of the water end failed to disclose the trouble, an inspection of the steam end was necessary. Upon opening up the low-pressure cylinder, it was discovered that there was a crack about 14 in. long in the cylinder wall. As this cylinder was live-steam jacketed and worked on a vacuum, a heavy blow of steam through the crack had caused the trouble.

This pump was badly needed, so a quick repair was important. The plan adopted was that of drilling and tapping ½-in. holes and screwing in brass plugs, finishing up by chipping and scraping to a templet that had been formed on the undamaged surface. The first hole was drilled to clear the end of the crack and was at once plugged, each succeeding hole being drilled to overlap the previous plug. A fine and reasonably quick job resulted.

In my younger days I operated a small electric-light station—one where the engineer is also fireman, wireman, lineman, etc. I found a small duplex boiler feeder that had been installed with the machinery, but had been disconnected and set in a dirty corner and a pump, rented from a small local foundry, put in its place. The rented pump had been on the job about six years.

Everyone, particularly the man who owned the rented pump, assured me that the discarded duplex was a bad character, therefore I was curious to see it perform. It had no outside valve gear, but the main valves were moved by double-ended auxiliary piston valves moved by the exhaust on opposite strokes. This pump was of a make I have never since seen.

I placed this pump alongside the other one, connected it up and gave it a good overhauling and inspection, but could see nothing wrong. When steam was turned on, it started and ran for a short time all right, but soon stopped. The auxiliary valves had tappet stems extending through the stuffing boxes on the front of the steam chest and by pulling or pushing on these tappets, the pump could again be started, to run for perhaps an hour, perhaps five minutes.

Odd hours for several weeks were spent in experiments, and the trouble was found to be due to the overtravel of the auxiliary valves, which caused them to cover a small port located near the end of the travel. The cure was to drill and tap ¼-in. holes in the outside faces of the auxiliary pistons, screw in ¼-in. bolts and carefully cut them just the proper length so that when the valve had gone far enough the plug would be in contact with the chest covers. That pump worked faithfully for the three years of my stay.

Notwithstanding the amount of valuable information that has been printed relating to proper piping arrangements and care of pumps, bad piping and sometimes worse handling are much too common. A point of importance in piping arrangement, and one that is more often neglected than provided for, is that of placing an air vent of suitable size on the discharge side of the pump, as close as possible, to aid in starting a pump on a line under pressure, such as a boiler-feed line.

A good pump is a fair performer when handling water, but as an air compressor it is a rank failure, the outside-packed plunger type being especially weak in this respect, owing to its large clearance. Therefore, when a pump has a large volume of suction line to clear of air before water can enter, it is of much importance that it should be provided with ample purge outlet on the discharge.

In a case that came to my notice recently, the suction line to the feed pumps came from a large tank outside the boiler house. This tank is supplied with water by a line from the city main, the flow into it being hand-regulated by the head fireman. On this occasion he allowed the tank to run dry. When the pumps got out of water and ran away, they were shut down and the supply valve to the tank was opened wide to fill the tank as quickly as possible.

The fireman then attempted to start the pumps but, strange to relate, there did not appear to be any water in the suction; in fact, there was nothing but air, due to the rapid filling of the tank. Apparently, neither the fireman nor the watch engineer knew what to do or just what was wrong. The engineer was forced to shut down to save the boilers, and at this stage I was sent in to lend a hand.

Fortunately, the fireman was honest and at once admitted that the tank was empty, thus making clear what was wrong. As there were no vents on this line, the question was how to clear it. This was done by loosening up the covers on the discharge-valve pots, having first closed the stop valve on the discharge line. This case makes four, differing only in detail, that have come to my notice. In each instance a properly placed purge and a few elementary instructions on its use, and on why a pump pumps or does not pump, would have saved a costly shutdown.

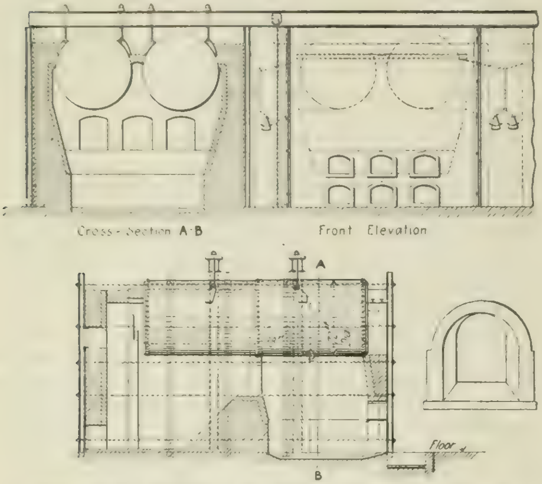
Bellingham, Wash. O. B. Critchlow.

Proposed Setting for Return-Tubular Boilers

Among other power plants we have a boiler house containing six horizontal return-tubular boilers 18 ft. long and 72 in. in diameter. These boilers are from 15 to 20 years old, have been retubed recently, and are in good condition. They have three brackets on each side to support the boiler upon the brick walls of the setting.

The setting is in poor condition, and the side and back walls are badly cracked and bulged. The furnace height (distance from grate to boiler-shell) is 38 in. The condition of the setting is such that extensive repairs will soon be required, amounting to almost entirely new walls. Four of these boilers are set in batteries of two, and the other two units are set singly.

My present idea is not to go to the expense of renewing the present setting and finally have the old installation with all its disadvantages, but to go a step farther and set the boilers as outlined in the accompanying sketch, and have in consequence a fairly modern power house. The present height of the building roof would permit a furnace height of at least 60 in., as compared with 38 in. as now. This increase in combustion volume alone would, it is my belief, increase the efficiency of the boilers.



PROPOSED SETTING FOR TWO RETURN-TUBULAR BOILERS

The boilers would be suspended from beams instead of being supported by the walls, and consequently there would be less strain and fewer cracks on the walls. The radiation losses through the setting and infiltration of air would, in the double setting, be less than in individual settings. This proposed arrangement would combine the advantages of a return-tubular boiler and a water-tube boiler of greater capacity. The capacity of a return-tubular boiler, it is well known, is limited because the shell thickness would increase beyond proportion in boilers of larger diameters than are commonly in use.

I would be glad to read comments about this proposed setting from fellow engineers who may have had experience in this line. M. RIEWERTS.

Passaic, N. J.

Coal Consumption in Institutional Heating Plants

In the April 27 issue of *Power*, page 654, there is an article by G. B. Nichols on "Coal Consumption in Institutional Heating Plants." I think there must be some mistake in the figures given in the tables showing the total savings in ten hospitals. For instance, Manhattan shows the estimated tons of coal consumed as 19,800 and the estimated tons saved as 19,584; Hudson River shows an estimated consumption of 19,051 and an estimate of 2,295 tons saved.

Assuming that the amount saved and price per ton at Manhattan is the same as at Hudson River, the saving at Manhattan would be about 2,376 tons, amounting to $11,832.48 instead of $145,509.12, as shown, or the total saved at the ten institutions would be about 14,117 tons instead of 31,325. The saving would be about $70,302 instead of $200,900. Of course there may be a reason for the saving made at Manhattan, but it is not apparent from the article.

Dannemora, N. Y. FRED CHAPELL.

Recently Inspected Boiler

In a recent issue of *Power* an account of a boiler explosion was published and also a statement by the management of the affected concern that the boiler had lately been inspected. The following may be of interest in showing that a boiler might pass inspection and still have defects that under proper conditions might cause an explosion.

The boiler is of the return-tubular type, 16 ft. long and 66 in. in diameter. It has 105 three-inch tubes; the thickness of the shell is ⅜ in. The boiler is single-riveted lap-joint and is made up of three courses. It is fifteen years old.

Soot is blown from the tubes by means of a steam lance. One night the fireman was blowing tubes and called me in. He then stuck the end of the steam lance in one of the boiler tubes and turned on the steam. There were two things noticed—a whistling sound and water coming out from the front of that tube. The only reason that appeared feasible at the time was that the tube was partly blocked.

A few days later the boiler was cut out of service. On investigation it was found that three of the tubes were leaking from the rear end. After these were removed, the reason for the peculiar behavior of that one tube became apparent. Small pin holes existed all the way around the tube for a distance of nearly two feet from the end of the tube.

The chief looked over the remainder of the tubes as best he could and it was his judgment that eight more ought to be renewed. The inspector came along and gave the boiler an inspection, followed by a hydrostatic test and claimed that the boiler was all right and that there was no need of renewing the other tubes.

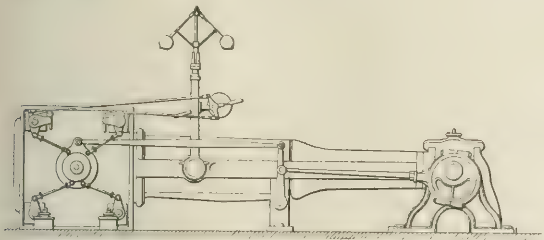
As the chief and the inspector are both human, neither is infallible and either may be right. In view of the fact that the boiler is fifteen years old, safety first would have been a good policy. In conclusion, assuming that, owing to an unforseen cause, that boiler has to be forced for all its worth and a rupture occurs, the management is perfectly right in saying: "It had been recently inspected." Poor consolation for the victims!

Bayonne, N. J. THOMAS M. GRAY.

Testing for Twisted Valve Stems

Setting the valves of a double-eccentric Corliss engine is usually performed according to the idea of the engineer who is doing the work. I have had quite a number of years' experience with both double- and single-eccentric engines and have found that twisted valve stems or incorrectly keyed valve cranks sometimes present perplexing conditions.

In testing Corliss valves for such defects, first plumb both rocker arms and both wristplates. Then take a wrench and a square and, paying no attention to the threads on the rods, the valve lap, or the valve opening, lengthen or shorten the steam and exhaust rods until the steam and exhaust valve cranks and rods stand at right angles, as shown in the sketch. Then look at the lap on the exhaust valves and at the opening of the steam valves, see that both steam rods measure alike, center to center, and also that both exhaust rods measure the same, center to center. If the steam valves show about ⅛-in. opening and the exhaust valves show line and line, they are all right; but if not, either change the keys or put in new valve stems keyed to this position.



ROCKER ARM, WRISTPLATE AND VALVE ARM PLUMB

When this has been accomplished, place the crank on either dead center and move the steam eccentric in the direction the engine is to run until there is a 1/16 in. opening or lead. Then fasten the eccentric to the shaft and turn the engine in the direction the engine is to run until the piston has moved in 2½ in. of its stroke and fasten the exhaust eccentric to the shaft.

Next place the crosshead at a point 22½ in. of its stroke, with the governor resting on the safety latch, and set the knockoff clips so that they will just touch. Next adjust the safety clips, put on the steam and exhaust caps and start the engine. Then take some diagrams and adjust the steam eccentric so that the admission line is at right angles to the steam and back-pressure line. If necessary, move the exhaust eccentric in the direction that will give the proper amount of compression to just take care of the slack of the crosshead and crankpin brasses. J. A. AVERY.

Eaton, Ind.

Operating Diesel Engines

I do not agree with G. J. Trosper in his article on operating Diesel engines, in *Power* of June 8. His ideas as to the proper temperature for the cooling water are correct, but I would dislike to operate a plant where his cooling system is installed.

He shows the cooling water circulating through a closed system and being cooled by a set of coils. Of course it is quite possible to cool the water in this way, but the amount of water handled through the coils will be at best four times the amount circulated through the engine jacket. The power required, and the size of cooling pond or spray system, are correspondingly increased.

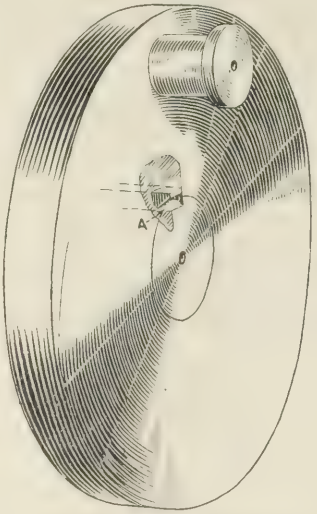
Furthermore, he will find that the thermostatic control regulating the amount of water flowing through the coils is not sensitive to changes in load. It is apparent that with an increase of load, the discharge temperature will rise; this will act on the cooling-coil valve, increasing the flow through the coils, which will lower the temperature in the tank. It will take some time before this increased flow affects the temperature in the box, and in the meantime the jacket temperature will become exceedingly high.

In localities where the water is bad, the proper course is to install a water-treating plant. The cost of treating will not exceed one-half cent per horsepower per day. In England, distillers, using the heat in the exhaust gases, are being manufactured and are coming into general use. With the distiller fresh water is evaporated at atmospheric pressure and, after condensation, is added to the cooling-water system. The distiller is so arranged that scaling is easily accomplished. E. E. SNOW.

New York City.

Two Arc Welding Jobs

On one occasion the plungers of an outside-packed pump became badly scored, due to gravel in the water, some of the grooves being very deep. The deepest grooves were filled by means of the arc welding process, and the metal was then smoothed down by grinding. This enabled the pump to do duty until new plungers could be obtained.



WELDED KEY IN PLACE

The key in the crank of a small vertical double-crank engine became loose and worked out. As the engine had to run until a better opportunity for repairs arrived (a short piece of shaft and reboring the crank was necessary), a small piece was chipped off one side of the key and a little knob of metal built up on the shaft in the keyseat, as shown at *A* in the sketch, which shows the shaft and key, but not the crank.

Toronto, Ont., Canada. R. McLAREN.

Capacity of Steam Pipe with Superheated Steam

Some months ago a reader asked in the columns of *Power* for information regarding the steam flow through a 10-in. extra-heavy pipe, but just what information he desired was not made clear. The calculations given herewith are offered with the hope that they may throw some light on the subject.

It appears that he had been conveying 70,000 lb. of steam per hour through this line, with 105 lb. pressure at the receiving end of the line, with 15 lb. drop in pressure in a 600 ft. line, containing two globe valves. A 10-in. globe valve is equal to approximately 70 ft. of line, which would make this line equivalent to 740 ft. in length. It is evident that there is some error in his measurements, or calculations, as to the quantity of steam that he was using at 600 deg. F.

Kent gives the following formula for determining the weight of superheated steam:

$$D = \frac{1.684 \times P}{t + 461} \qquad (1)$$

where D equals the weight of steam per cubic foot; P equals the pressure, pounds per square inch, absolute; and t equals the temperature in degrees F.

Substituting in the formula and solving for D, we have:

$$D = \frac{1.684 \times 120}{600 + 461} = 0.191 \textit{ lb. per cu.ft.}$$

At 400 deg. F. the weight is 0.234 lb. per cubic foot.

"Steam Piping," by Johnson, page 7, gives the following formula, for determining the weight of steam flow, pounds per minute:

$$W = 87 \left[\frac{p \times D \times d^5}{\left(1 + \frac{3.6}{d}\right) L} \right]^{\frac{1}{2}} \qquad (2)$$

where W equals the weight of steam flowing, in pounds per minute; p equals the pressure drop in pounds; D equals the density, or weight of steam per cubic foot; d equals the internal diameter of pipe in inches, and L equals the length of pipe in feet.

Substituting the known values in the formula and solving for W, we have:

$$W = 87 \left[\frac{15 \times 0.166 \times (9.75)^5}{\left(1 + \frac{3.6}{9.75}\right) 740} \right]^{\frac{1}{2}} = 1{,}370 \textit{ lb. per min.}$$

or 82,400 lb. per hour.

Steam at 120 lb. per sq.in. absolute and 600 deg. F. contains 1,322.4 B.t.u. per pound, and at the same pressure and 400 deg. F. contains 1,222 B.t.u. per pound. If we multiply the number of pounds of steam used at the higher temperature by 1,322.4, we get 108,900,000 B.t.u. Then dividing this quantity by 1,222 will give the weight of steam at 400 deg. F. to give the same heat value, which is 89,100 lb. per hour.

If we substitute all the known values for steam at the lower temperature, in equation (2) and solve for p, the pressure drop, we find that he has a drop of 14.3 lb. approximately, which is only about 7 per cent less drop instead of the 20 per cent that Mr. Remol had calculated he would have. F. C. DEWEESE.

Joplin, Mo.

Lubrication Was Neglected

I read with interest the letter in the June 8 issue of *Power*, page 932, by Hugh G. Boutell, on "Lubrication Devices Neglected." It brings to mind what happened on the tugboat on which I am employed.

I had the after engineer watch, going on at 12 and off at 6 o'clock. The chief had the forewatch, 6 to 12. The tug is equipped with a good steam steering gear, but one day the pilot told me it stuck when put to starboard but would go to port all right. A sight force-feed oiler lubricator was used with the equipment, together with a pressure oiler on the stuffing box. When we tied up in Tonawanda, I took the force-feed pump apart, as I suspected the machine must be dry, and I found that the pipe was nearly filled with dirt. The bull's-eye was plugged, and the bottom check of the pump contained a piece of dirt that prevented the ball from seating. After cleaning all parts, I pumped kerosene through the lubricator. Then I filled the pressure oiler on the gland and cleaned out all oil holes and the steering gear worked satisfactorily.

The reason things got into the condition they did was because the chief refused to overhaul the lubricator on the steering engine, saying it was the mate's job. As we had no mate, I did it. On the same day, before cleaning the lubricator, it was necessary to pass under a temporary bridge that was packed with people; when the steering gear refused to work we hit that bridge.

Buffalo, N. Y. G. S. ROLLINS.

Pure Water for Boiler Feed

Years of practical operating experience have convinced many an engineer that Mr. Rose's version regarding pure feed water, as published on page 784 of the May 11 issue, is correct. Large or small heating boilers using the same water over and over again show signs, on inspection, of pitting. The same boiler will furnish steam in a power plant, using the same water as used in the heating boiler without signs of pitting.

Two boilers formerly used in a theater for lighting and heating purposes gave a very good demonstration of this phenomenon. No signs of pitting were in evidence until about a year and a half after the engines were removed. Then severe pitting took place, due, in all probability, to pure water. Of course, in the 50,000-kw. plant the boilers will be of the water-tube type and perhaps will not pit so rapidly. C. W. PETERS.

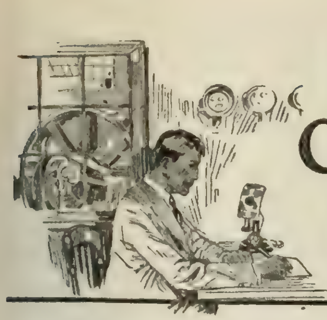
New York City.

A Correction

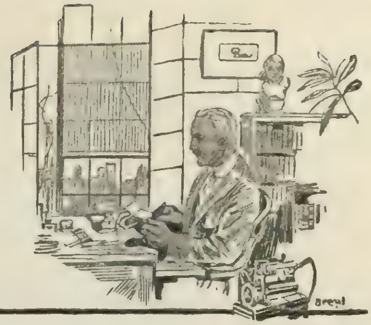
We note with interest in your issue of June 22 an article on "Steam-Jet Air Pumps for Condensers," by DeWitt M. Taylor.

On page 996 the statement is made that the Croll-Reynolds Evactor is manufactured by the Ross Heater and Manufacturing Co., of Buffalo, N. Y. This statement is incorrect, as we are the sole designers and manufacturers of the Evactor. The Ross Heater and Manufacturing Co. formerly manufactured on a royalty basis according to our designs and drawings, a small number of Evactors. The arrangement which we had with this company was discontinued in February of this year, and we would, therefore, ask that you kindly make this correction in your next issue.

New York City. CROLL-REYNOLDS CO., INC.



INQUIRIES OF GENERAL INTEREST



Allowable Blowdown of Boiler Safety Valves—What should be the amount of blowdown of a boiler safety valve? G. N. H.

The amount of blowdown admissible depends on the boiler pressure that is carried. The A. S. M. E. boiler code stipulates that safety valves on boilers carrying an allowed pressure of less than 100 lb. per sq.in. gage must be adjusted to close after blowing down not more than 4 lb.; when carrying pressures 100 to 200 lb., the blowdown must be not over 6 lb.; and when carrying over 200 lb., the blowdown must not be more than 8 pounds.

Causes of Boiler Priming—What causes a boiler to prime or deliver wet steam? M. R.

Priming may be caused by insufficient steam room, insufficient water surface for the disengagement of steam without violent ebullition, improper location of the steam pipe, dirty water, or may result from forcing or overcrowding the boiler. Insufficient steam room and insufficient water surface may be due to faulty design or carrying the water level too high. The use of muddy water or water containing cylinder oil is likely to cause foaming, and the violent ebullition that results from forcing a boiler may cause particles of water to be projected high enough into the steam space to be swept into the steam pipe.

Hollow Walls for Boiler Settings—What is the advantage or disadvantage of hollow walls for boiler furnaces? F. A.

So far as direct loss of heat is concerned, there is rather more heat lost by radiation through air-space walls than through solid walls of the same total breadth, especially if the air space is near the furnace side, as air offers less resistance to radiation than brickwork. A hollow wall is better than a solid wall to prevent cracks from expansion of the brickwork on the furnace side, but when this construction is adopted, the cavity should be filled with solid loose material to prevent radiation of heat from the inner to the outer wall and retard circulation of cold air entering the cavity through openings or cracks that may occur in the outer wall.

Testing Indicator Reducing Wheel—How can the accuracy of an indicator reducing wheel be tested? E. T. B.

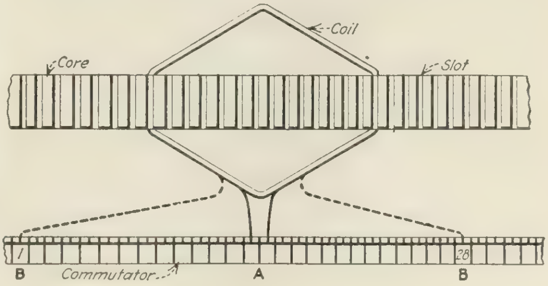
Set the indicator on the engine or any stationary support, and fix a rod or board having a straight edge that will be followed by the cord when drawn out a distance equal to the stroke of the engine, and lay off the length of stroke along the straight edge and divide it into four or more equal parts, and drive small and equal-sized wire nails at the points along the straight edge that represent the ends of the stroke, and at each of the subdividing points. Then, with a spring in the indicator and a blank card on the paper drum, strike a long atmospheric line by drawing out the cord by hand and light pressure on the pencil. Having the cord of proper length so it will not cause the drum to strike its stop when the hook is on either of the nails that represents the end of the stroke, place the hook on one nail after the other, each time lightly pressing the pencil on the card, and making a short mark across the atmospheric line. If the reducing motion is correct, these marks will be equally spaced.

Power Input to Induction Motor—How is a 10-hp. three-phase 440-volt induction motor tested to determine if it is underloaded? Can an ammeter be used for testing? P. M.

An ammeter reading of an induction-motor load is of little import unless the power factor is known. Since the power factor of an induction motor decreases as the load is reduced, the current will not be reduced in proportion to the load. An induction motor operating at 50 per cent load will take approximately 80 per cent of the full-load current, but the power factor will be in the neighborhood of 0.70, where at full load it is about 0.87. The most satisfactory way to measure the power input to an induction motor is with a polyphase wattmeter, and then allow 900 watts per horsepower output, to obtain the mechanical load on the motor. About the only thing that an ammeter would show is whether the motor is overloaded or underloaded.

Reconnecting Direct-Current Generator—We have a 120-volt direct-current generator and wish to reconnect it to operate on 220 volts. The machine has four poles, and in the armature there are 56 coils, and 56 segments in the commutator with the coils grouped in a four-circuit winding. Can the fields and armature coils be regrouped to give the higher voltages? W. O. R.

By regrouping the armature coils into a two-circuit, or series winding, it will develop double the present voltage with the same field density, or 240 volts. The difference between 240 and 220 or 20 volts can be easily taken care of by adjusting the field rheostat. As the coils are now grouped, the leads of each coil are connected into adjacent segments, as shown at *A*, in the figure. Fifty-six coils cannot be connected into a series winding, but 55 coils can, therefore it will be necessary to leave one coil dead in the winding and connect two of the segments together. The leads of the coils will then be connected so as to span 27 segments, or from 1 to 28, as at *B* in the figure. In order that the field coils will operate on the new voltage, they will have to be rewound with the present weight of wire of one-half the cross-section of that now used in the coils. In all probability a new field rheostat will be required for the higher voltage, to obtain proper adjustment of the voltage.



[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Translating Oil Into Steam Must Cease*

By Eugene McAuliffe

Within twelve months the fuel-oil situation, in so far as present and future supply, as well as unit costs, are concerned, has undergone startling changes. One year ago we were alone concerned with the economical consumption of fuel oil. Today there is a national feeling that the period of fuel-oil consumption for steam-making purposes is substantially behind us.

The oil industry of the United States is but sixty years old. On Aug. 28, 1859, Colonel Drake struck oil in a well 69 ft. deep, near Titusville, Pa., the well pumping forty barrels per day and later shrinking to fifteen barrels daily. The oil fields of Pennsylvania, West Virginia and Ohio quickly gained extraordinary prominence. In the early sixties oil was discovered in southern Russia, and a British engineer, working with a Russian photographer, invented an oil burner. Later, Thomas Urquhart, a British locomotive superintendent, equipped certain Russian railway locomotives to burn Russian fuel oil.

For steam-making purposes the tide of oil burning has ebbed and flowed ever since with the discovery and exhaustion of recurring fields, each extraordinary oil development leading to the displacement of coal for steam-making purposes on the part of railways, steamship owners and industrial users. In every instance, when the inevitable exhaustion of the oil fields occurred, steam consumers went back to coal for fuel purposes. Looking back a few years, we have but to recall the famous Spindle Top field, located near Beaumont, Texas, where a small dome-shaped area, approximating 260 acres in extent, produced in a few months 37,000,000 bbl. of oil. This field came cataracting in with the famous Lucas gusher, which flowed 75,000 bbl. daily; later, Heywood No. 2 came in with 96,000 bbl. in 24 hours, this well producing 1,395,000 bbl. of crude oil in its glorious life of ten months.

These were the days of ten-cent oil, and the railroads in southern central territory followed the example of Urquhart, by taking advantage of cheap fuel produced at their very doors. In the meantime southern California was developing heavy oil production in a territory where coal, owing to long rail hauls over mountain grades, was relatively high-priced, and the railroads reaching California territory joined the ranks of fuel-oil consumers. Later, the famous Glenn, Oklahoma, field swung into line, the exhaustion of that field followed by the development of the great Cushing field, which, when it began to decline, was followed by the development of the Burke-Burnett, Texas, field.

Development of the Mexican Fields

In 1909 and 1910 the great oil development in Mexico was well under way. In November of last year Juan Caisno No. 4, after producing 75,000,000 bbl. of oil, went to salt water in a few hours. This startled the Mexican oil producer, and gradually the news trickled out to the oil-consuming world that the great Mexican oil fields had limitations, such as those experienced in the fields developed north of the Rio Grande. A month later Portrero del Llano, of the Mexican Eagle Oil Co., Lord Cowdray's British organization, after producing 110,000,000 bbl. of oil at the rate of 16,000,000 bbl. annually, swung over to salt water in a few hours. Then, on Feb. 21 of this year, Tepetate No. 1, of the Cortez Oil Corporation, followed suit. Meanwhile numerous less-prominent producers have gone the way of all good oil wells.

While the effect of this situation was startling, perhaps the rude awakening suffered by the Navy Department more thoroughly alarmed the oil consumers of the country than did anything else. After practically effecting the consummation of a very extensive oil-burning program, the Navy Department asking in March last for Pacific Coast bids on 4,500,000 bbl. of fuel oil, received but one bid covering a delivery of but 602,000 bbl., at a price of $1.95 per barrel. In April bids were requested for Atlantic Coast deliveries. Five tenders were returned, covering an entirely insufficient supply, the price for bunker oil ranging from $2.07 to $3.76 per barrel of 42 gallons. A similar fuel problem confronts the American merchant marine, the completed program of the United States Shipping Board aggregating 10,000,000 dead-weight tons, of which 2,000,000 tons will consist of coal-burning vessels, and 8,000,000 tons of oil-burning vessels. The estimated fuel-oil requirements of the Shipping Board for the year 1920 are forty million barrels; for 1921, sixty million barrels.

When it is considered that the necessity for maintaining a navy will not cease until the end of the existing generally used form of government, or until the millennium arrives, both of which are perhaps quite remote, it would seem plain that the requirements of the United States Navy, equipped to carry and burn oil will take precedence over any other demand, and it is equally reasonable to assume that after the American people have spent billions in the upbuilding of an American merchant marine, its fuel-oil requirements will take position only second to that of the battleships. The statement of men who should know, that 1920 and 1921 will mark the peak period of oil production, with a steady decadence from this time forward, justifies serious consideration of the oil problem. The United States Geological Survey estimates that with the close of the year 1919 we have taken approximately five billion barrels of oil out of the ground; the estimated oil reserve yet in the ground is six and one-half billion barrels.

Fuel-Oil Situation Precarious

Dr. George Otis Smith, in a paper presented before the American Institute of Mining and Metallurgical Engineers, said:

". . . the position of the United States in regard to oil can best be characterized as precarious. Using more than one-third of a billion barrels a year, we are drawing not only from the underground pools, but also from storage, and both of these supplies are limited. In 1918 the contribution direct from the wells was 356,000,000 bbl., or more than one-twentieth of the amount estimated by the Survey geologists as the content of the underground reserve; we also drew from storage 24,000,000 bbl., or nearly one-fifth of what remains above ground.

In a single decade the consumption of fuel oil by railroads has more than doubled; the consumption of gasoline has increased sevenfold. We may lessen the increase in coal or oil consumption for generating power by harnessing the water powers of the country, but these prime movers, whether driven by steam or water, require lubrication. With the rapidly increasing use of machinery to make labor more productive, with the almost universal use of the automobile, hardly foreseen a decade ago, and with the expected increase in railroad and steamship traffic, who can venture an estimate of petroleum requirements ten years hence in terms of lubricating oil alone?

While we have great reserve of oil shales as an independent source of fuel oil, gasoline and lubricating oil, to develop this supply on a scale comparable in output with our present oil supply would require an industrial organization greater than our entire coal-mining organization. Plainly, the country cannot afford to support another such army of workers until we reach another stage in our industrial development.

Between 1909 and 1918 the number of automobiles and trucks increased 1,700 per cent; and the consumption of gasoline for automobile purposes jumped from 13,000,000 to 85,000,000 bbl., or 650 per cent, while the production of crude oil increased 95 per cent. Today we operate 7,600,000 automobiles and motor trucks and 350,000 tractors, and the 1920 construction program totals 2,000,000 automobiles and motor trucks. The Government has thrown open for drilling 6,500,000 acres of national oil reserve, but these lands located in California and Wyoming will not add materially to the supply. In 1919 29,000 wells were driven to success or failure. Of these 6,000 were dry and 2,000 returned gas without oil. The drilling expense is estimated at $600,000,000.

Only twelve years ago it was difficult to force the skimming plants of Texas and Oklahoma to take sufficient gasoline out of the crude to make its use on a locomotive safe. The railroads, which then absorbed the residue left after the taking off of the lighter distillates, built up a comfortable refinery traffic for their rails, but a complete return to coal fuel is now imminent.

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*Excerpts from paper presented before International Railway Fuel Association, Chicago, May 24-27.

Standardization of Pipe Flanges, Fittings and Shafting

The American Society of Mechanical Engineers has been requested by the American Engineering Standards Committee to assume sponsorship in the standardization of pipe flanges and fittings and shafting. In 1914 the society issued a report covering a schedule of pipe flanges and fittings, for diameters from 1 in. to 100 in. for 125 lb. pressure, and also a schedule for extra-heavy pipe, covering a range from 1 in. to 48 in. diameter, and for 250 lb. pressure. In 1918 a supplementary report was published for working pressures of 50, 800, 1,200 and 3,000 pounds.

While the work has not been active during the last year, it is now proposed that it be continued, the society being formally recognized as sponsor, under the rules of procedure of the A.E.S.C.

The society has already done a considerable amount of work on a set of standard diameters for transmission and machinery shafting. It is proposed that the work, which will be carried out by a sectional committee working under the rules of procedure of the A.E.S.C., shall be broadened to include the standardization of the method of determining what diameters of transmission shafting should be used for given loads, the dimensions of shafting keys and keyways, and the setting of dimensional tolerances.

German Turbine of 75,000 Horsepower*

The large steam-turbine units built in Germany during the war are headed by the 75,000 hp. turbines of the Goldenbergwerk of the Rhenish Westphalian Electric Supply Co., in the vicinity of Cologne.

Fig. 1 gives a view of this machine, the proportions of which may be gaged by the human figures standing alongside. Turbine and generator are designed for an output of 60,000 kva., corresponding to roughly 75,000 hp. at 1,000 r.p.m. The potential of the alternators is 7,000 volts between phases. The steam pressure amounts to 170 lb. per sq.in. and the steam temperature to 617 deg. F. The turbine is provided with two condensers, of 32,000 sq.ft. of cooling surface each, corresponding to a cooling-water temperature of 27 deg. C. The weights of the principal parts are:

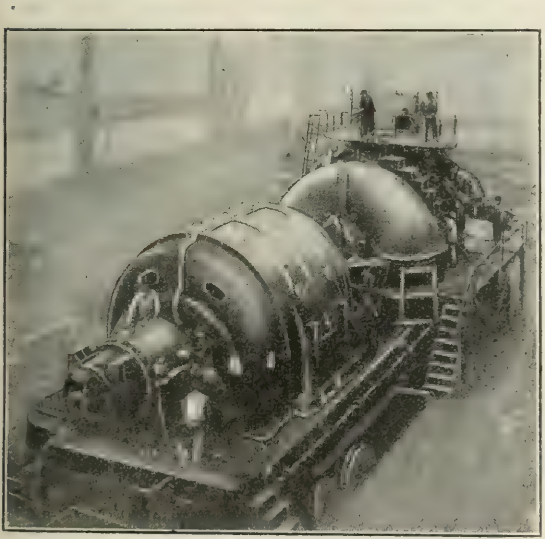

FIG. 1. GERMAN TURBINE OF 75,000 HP. (60,000 KVA.) 1,000 R.P.M. OF STANDARD A. E. G. CONSTRUCTION

Turbine complete, 250 tons; turbine rotor, 49 tons; dynamo complete, 225 tons; dynamo rotor, 106 tons; condenser, 100 tons.

The turbine is fitted with ten runner wheels—one double-bladed wheel for the high-pressure stage, and nine single-bladed wheels toward the low-pressure end. The diameter of the wheels is between 3,400 and 3,800 mm., corresponding to a circumferential velocity of 590 to 655 ft. per sec. at 1,000 r.p.m. As no high-grade nickel-steel was available for the blading, as before the war, the design of the blades at the point of maximum strain had to be altered to suit the circumferential pressure of the steam and the centrifugal forces in the rotor. This was accomplished by milling the blade out of a solid piece of steel equal to the thickness of the blade plus the thickness of the filling piece. The blade and filler were thus made in one piece and the blade was chamfered down toward the tip. Only about 15 per cent of the original metal was left after the blade and filler had been finished in this way.

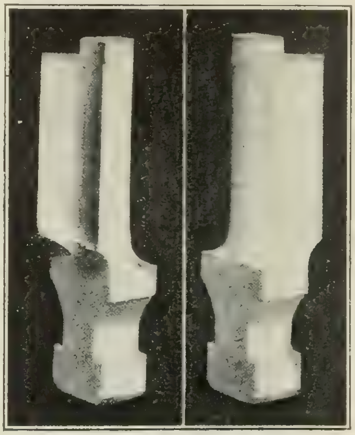

FIG. 2. THE BLADE AND FILLER WERE MADE OF ONE PIECE

Fig. 2 shows blades of this description. The bearing surfaces of the rotor have a diameter up to 600 mm. with a circumferential velocity of about 100 ft. per sec. Each turbine has two outlets for the exhaust steam, of 2,500 mm. diameter each, one for each condenser.

It is typical of this design that the entire power is generated in one turbine case and in one alternator. The design is the standard Allgemeine Elektrizitäts-Gesellschaft (A. E. G.) construction with three main bearings, the center one being designed as a double bearing to reduce the specific bearing pressure. According to A. E. G. practice the two rotors are connected by a rigid flange coupling mounted between the bushes of this center-bearing.

The governing is on the standard A. E. G. method; that is, by throttling the steam nozzles singly or in groups by valves which are closed, one after another, by a camshaft. This camshaft is driven by a servomotor.

National Electrical Safety Code Almost Completed

The present edition of the "National Electrical Safety Code" was issued in 1916 for examination, trial and constructive criticism. It was realized that the code was not a perfected document and that experience should be obtained with it before the rules were made mandatory. War conditions delayed the expected trial, and although revision has been almost continuously under way, it was not until the present year that sufficient information and consideration of the rules could be obtained to warrant the publication of the new edition.

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*From *Engineering Progress*.

The text of the new edition is now almost completed. Two sets of proposed changes in the various parts of the code have been circulated for criticism, the latter of these being issued in May of this year. Comments upon these have now been received, and the bureau is about ready to go to press with the revised edition. Points upon which disagreement exists have been solved almost entirely, with respect to the rules governing power stations and those governing utilization apparatus and the grounding of circuits and equipment. The rules dealing with overhead-line construction have always been the most difficult to handle on account of the widely differing opinions regarding such construction on the part of the various utilities. It has not been possible to secure complete agreement on this part of the rules, and future revisions in this part of the code will, no doubt, be more intensive than in the other parts. They will involve the collection of more complete data and probably the carrying out of experiments to determine appropriate strength requirements.

It is expected that copies of the new edition of the code will be available late in the summer. It will be printed in pocketbook size, and the discussion of the rules will be entirely segregated from the rules themselves, probably being placed under a separate cover. A pictorial edition of the code, in which the meaning of the rules will be shown largely by illustrations, is in contemplation.

A. S. M. E. Discusses Proposed Code of Ethics

At the spring meeting of the American Society of Mechanical Engineers in Detroit, June, 1919, a committee was authorized to prepare a Code of Ethics for Mechanical Engineers. At the meeting of the society in St. Louis, May, 1920, this committee reported and submitted a brief code. The report suggested that such a code should be a brief, positive statement of the professional relations of engineers to the public, to their clients or employers, and to one another.

Since the work of engineers of every branch of the profession as well as that of architects is closely associated with the mechanical engineer's practice, the committee considers that such a code should be common to all these branches. It was therefore recommended that the matter be referred to the Engineering Council or a similar joint professional body for action to be later approved by the society.

In case such action appeared to be undesirable, the committee submitted the appended code for the society's consideration. The code, as presented, was accepted as a first reading at the St. Louis meeting and will come up again at the annual meeting. It was also referred to the Engineering Council for recommendation to the Federated Engineering Societies.

1 The mechanical engineer should be guided in all his relations by the highest principles of honor, of fidelity to his client, and of loyalty to his country.

2 His first duty is to serve the public with his specialized skill. In promoting the welfare of society as a whole he advances his own best interests, as well as those of the whole engineering profession.

3 He should consider the protection of his client's or employer's interests in professional matters his essential obligation, provided these interests do not conflict with the public welfare.

4 He shall refrain from associating himself or continuing to be associated with any enterprise of questionable or illegitimate character.

5 He can honorably accept compensation, financial or otherwise, from only one interested party unless all parties have agreed to his recompense from other interested parties.

6 He must inform his clients of any business connections, interests or circumstances, such as might influence his judgment or the quality of his services to his clients.

7 He must not receive, directly or indirectly, any royalty, gratuity or commission on any patented article or process used in the work upon which he is retained without the consent of his clients or employers.

8 He should satisfy himself before taking over the work of another consulting engineer that good and sufficient reasons exist for making the change.

9 He must base all reports and expert testimony on facts or upon theories founded only on sound engineering principles and experiences.

10 He must not regard as his own any information which is not common knowledge or public property, but which he obtained confidentially from a client or while engaged as an employee. He is, however, justified in using such data or information in his own private practice as forming part of his professional experience.

11 He should do everything in his power to prevent sensational, exaggerated or unwarranted statements about engineering work being made through the public press. First descriptions of new inventions, processes, etc., for publication should be furnished only to the engineering societies or to the technical press.

12 He should not advertise in an undignified, sensational or misleading manner, or offer commissions for professional work, or otherwise improperly solicit it.

13 He should not compete knowingly with a fellow-engineer for employment on the basis of professional charges or attempt to supplant a fellow-engineer after definite steps have been taken toward the other's employment.

14 He should assist all his fellow-engineers by exchange of general information and valuable experience or by instruction through the engineering societies, the schools of applied science, and the technical press.

Standardization Organizations in Europe

In a report to the American Engineering Standards Committee outlining the meeting of the International Electrochemical Commission in Brussels, P. G. Agnew, secretary of the American Engineering Standards Committee, also makes note of the various European societies and organizations engaged in the promotion of standardization in engineering practice.

In 1919 the Comite Central Industrial de Belgium, an organization which is playing an important rôle in Belgian reconstruction, organized the Association Belge de Standardisation. There is a main committee and working committees. The actual standardization work is carried out under the direction of the main committee and the details of administration are handled by the central office. Comprised in the work already carried out are a standard series of bolts and rivets. Work now on hand includes reinforced concrete, mechanical power transmission, water-pipe fittings, specifications for steel bridges, economics in coal consumption and steel sections.

The Commission Permante de Standardization of France differs from other national standardizing organizations in that it is strictly an official body and supported wholly by government funds. It is attached to the Ministry of Commerce, Industry, Posts and Telegraphs, Maritime Transport and the Merchant Marine. The actual technical work is in charge of fourteen subcommittees.

The main committee for standardization in the Netherlands, known as "Hoofdcommissie voor de Normalisatie in Nederland," was organized in 1916 by the Society for the Encouragement of Industry and the Royal Institute of Engineers.

Each of these societies names two members of the main committee the total membership of which is fifteen. The other eleven members are appointed by the committee itself. The president, vice president and treasurer form a small executive committee which meets frequently. There are four regular meetings of the main committee each year. The main committee is not responsible for details, but is responsible for procedure and for the representative character of the committee in immediate charge of the detailed work.

The British Engineering Standards Committee was organized in 1901 by five leading technical societies. In 1918 the name was changed to Association. The general direction of affairs is in the hands of the main committee, which constitutes the sole executive authority. Sectional committees are responsible for the technical work.

Fuels Section of the A. S. M. E. Adopts Program

A meeting of the subcommittee on Meetings and Papers of the Fuels Section of the American Society of Mechanical Engineers was held at the headquarters of the Society on Friday, June 18, Prof. George A. Stetson, David Moffat Myers, Henry Kreisinger, W. E. Bullock, assistant secretary, and C. E. Davis, of the office staff, being present. The participation of the section in the program of the annual meeting in December was discussed, and the papers outlined as follows:

1. Fuel Supply of the World—A census or, rather, an inventory, of the world's supply of fuels, coal, lignite, peat, oil, oil shale, natural gas, alcohol, etc. This subject would be treated from the standpoint of location of supply as related to localities of consumption and should be a broad survey from the world's standpoint with reference to loss of economy in distribution from points of supply to points of consumption, and suggestions for improvement.

2. The Low Temperature Distillation of Coal, showing what has been done and what is possible in reclaiming the byproducts of coal and lignite. A special point should be made of what the United States Government has done and what it may appropriately do in connection with individuals and industries in developing a more economic use of fuels by means of recovery.

3. Fuel Conservation vs. Money Conservation, showing how the monetary consideration interferes with fuel economy and how, frequently, fuel can be saved if expense did not have to be considered. If an enormous tax were placed on coal, the waste of coal would stop. A broad treatment of the subject of possible fuel saving by generating electricity at the mines is suggested. This is to be considered under two heads—where the distant consumer requires power alone, and where the distant consumer requires heat as well as power.

4. What Is the Effect of the Cost of Freight Per Ton of Coal on the Cost of a Kilowatt-Hour, as Against the Cost of Transmitting the Kilowatt-Hour from the Mines to the Point of Consumption, Including Transformation and Transmission Losses?

Profiteering of the Mines

A statement of unusual interest was issued by the Department of Justice on June 24. It follows in its entirety:

> In connection with the recent instructions from Attorney General Palmer to all United States attorneys to procure indictment of soft-coal operators charging unreasonably high prices for coal, the following statement has been issued by the Department of Justice:
>
> The instructions referred to were issued because of reports that soft coal was being sold at the mines at prices as high as from $7 to $11 per ton and in some instances even higher. The Lever Act, under which the indictments of offending operators are to be obtained, prohibits the taking of an *unreasonable* profit. An unreasonable profit results when the selling price unreasonably exceeds the cost of production. The cost of production cannot possibly justify the reported prices at the mines, as is shown by the following:
>
> The production-cost figures gathered by the Federal Trade Commission from 1,589 bituminous-coal operators in the principal producing regions, mining roughly about 60 per cent of the annual output, show that during January, 1920, their costs per ton averaged $2.32 at the mines. Since then there has been an increase of 27 per cent in the cost of labor, enhancing the production cost $2.79 per ton. During the month of April, when the cost was $2.79 per ton, operators are reported to have sold their coal for between $3 and $4 per ton at the mines. Since then, as above stated, it is reported that their selling prices have been forced as high as from $7 to $11 per ton, and even higher.
>
> Excuses offered for taking profits which are unreasonably high in comparison with the cost of production are not defense to the charge of profiteering—the purpose of the Lever Act was to prevent taking advantage of such excuses to mulct the public.
>
> Moreover, the public should be advised that the claims of shortage of production, car shortage and export demands do not furnish any real excuse for the continuance of the high prices above referred to.
>
> 1. *Alleged Shortage of Production*—The production of soft coal for the first four months of the present year has exceeded the production for the corresponding period of any recent year excepting 1917 and 1918. To quote the report of the Geological Survey, the Governmental agency charged with the collection of compiling of such information, for the week ended May 15, 1920:
>
> The production of bituminous for the first four months of 1920—173,574,000 tons—although smaller than in 1917 and 1918, exceeded both 1919 (138,936,000 tons) and the *pre-war years.*
>
> 2. *Car Shortage*—Service orders numbers 6 and 7 of the Interstate Commerce Commission, dated June 19, 1920, ought to result in an adequate supply of cars for coal for domestic consumption, if there has not heretofore been such a supply. Order No. 7 that, for thirty days beginning June 21, 1920, the railroads should furnish suitable cars to coal mines in preference to *any other use,* and should discontinue the use of coal cars for other commodities, thus giving the coal-mine operators full car service. Order No. 6 made rules for the railroads to follow after June 24, 1920, so as to give preference to the transportation of coal for *domestic* consumption.
>
> By bearing in mind the foregoing points, and by refusing to be influenced by propaganda (which has appeared in certain quarters) into bidding against one another for coal at enormous prices (as is reported to have been done in some cases) consumers of soft coal can help to reduce prices to a reasonable level.

Canadian Association of Stationary Engineers' Convention

The thirty-first annual convention of the Canadian Associaton of Stationary Engineers was held at Woodstock, Ont., June 22, 23 and 24. The Oxford Hotel was the headquarters, and less than a block away was the Woodstock Market, the main floor of which was occupied by the Canadian Exhibitors' Association in the display of the latest mechanical devices and power-plant equipment. The executive sessions of the engineers were held in the City Hall, directly opposite to the exhibition building. The local committee are to be congratulated upon the unusual convenience of its arrangements.

There were upward of forty delegates in attendance. The principal feature brought before the body was a discussion on the advisability of amendments being made to the existing license laws, and the growing necessity for high-class engineers. The educational committees were urged to continue in the good work accomplished during the past year, and were advised to get into closer relationship with the Northwestern Association of Mechanical and Electrical Engineers of Edmonton. There were also warm discussions on proposed changes in the preamble.

The exhibition hall was open from 9 a.m. until 10 p.m., and considerable interest was manifested by the delegates and visitors in the display at the various booths.

On Tuesday evening there was an educational meeting and smoker. W. H. Auger read an interesting paper on "Parallel Lines," and Hartley B. Gardner created a general discussion on the reading of his instructive paper on "Combustion," the discussion being opened by A. M. Wilkins. An entertainment was furnished by Mr. Fletcher, of the Garlock Packing Co.; Bob Jones, of the France Packing Co., and Jack Armour, of *Power.*

On Wednesday afternoon the convention was entertained by the Exhibitors' Association at Southside Park. Outdoor sports of many kinds were indulged in, with prizes for the winners of each event. Refreshments were served at intervals during the afternoon.

On Wednesday evening an entertainment was held in the City Hall. Mayor A. J. Gahagan welcomed the convention to the city and acted as master of ceremonies, introducing the several entertainers. At the conclusion of the performance prizes were distributed and dancing followed.

John McCalley, president of the local association was the recipient of a silk umbrella, the gift of the supplymen.

The engineers elected officers as follows: George Moll, past president, London; R. C. Leach, president, Toronto; Fred Harper vice president, Kingston; L. J. Ellis, secretary-treasurer, Hamilton; W. Fyfe, conductor, Montreal; R. E. Rodney, doorkeeper, Ottawa.

At the supplymen's meeting on Thursday morning the following officers were elected: Calvin B. Turner, president; Grant F. Cole, first vice president, Edward B. Curzon, second vice president; Gordon C. Keith, secretary; David M. Archibald, treasurer; Robert Jones, assistant treasurer.

Ottawa was selected as the next convention city in June, 1921.

Connecticut State N. A. S. E. Convention

The twenty-fifth Annual Convention of the National Association of Stationary Engineers, Connecticut State Branch, Bristol Local, was held at Bristol, June 25-26.

The convention was opened Friday evening by President David A. Wilcox. The meeting was thrown open for informal discussion, which centered on the coal situation and the relative advantages of coal and fuel oil. The performance of various types of boilers and ways and means of changing from coal to oil as a fuel were discussed. At the close of the session, Jack Armour, of *Power*, furnished entertainment, which was very much enjoyed. On Saturday morning the second session of the convention was held at the Red Men's Hall. Routine business and reports of committees were heard and the session closed with the election of officers, which resulted as follows: B. M. Doyle, Waterbury, president; John Donahue, Hartford, vice president; Fred Sutorius, New Haven, secretary-treasurer; Harry J. Petit, Bristol, conductor; N. A. Cunningham, Waterbury, doorkeeper. David Wilcox, the retiring president, automatically became a trustee, superseding E. E. Thomas, of New Haven. Oscar A. Thomas of Bristol was elected State Deputy.

At the close of the morning session the members and delegates boarded a special car for Lake Compounce, a beautiful little lake, twenty minutes' ride from Bristol. Here the big time of the convention was staged. Dinner was served and swimming, boating and outdoor games were the order of the afternoon and evening. The next convention will be held on the last Friday and Saturday in June, 1921, at Hartford.

Navy Department Awards Fuel-Oil Contract

Awards for 5,200,000 bbl. of fuel oil as result of recent bids submitted are announced by the Navy Department.

To avoid further increasing the price of oil and gasoline by decreasing the amount of American oil available for commercial purposes, the Navy Department, in awarding its contract for the coming year's supply, by a slight modification of its standard specifications has been able to utilize a large amount of crude Mexican oil hitherto unavailable for naval purposes. In addition the Navy will receive as a byproduct in refining this oil for fuel use during the coming year, 15,792,000 gal. of gasoline, which will not only meet the Navy's full demand, but leave sufficient to relieve the needs of other Government departments to a considerable extent at a price of approximately the actual cost of manufacturing and transportation.

The department has also inserted a clause in the contract by which the company refining the oil for the Navy, agrees to instruct specially detailed naval officers in every detail of manufacture and to give the Navy the use of any patented or secret processes should it later seem advisable to go into the refining business on its own account. In this way for the first time exact and accurate knowledge of the cost of fuel oil and gasoline will be ascertained, and in future years the Navy will be in possession of indisputable data as to what should be a proper cost for both oil and gasoline and will have the nucleus of a personnel to carry on research work of its own.

Waterbury Section A. S. M. E. Holds Annual Meeting

The annual meeting of the Waterbury Branch, Connecticut Section of the American Society of Mechanical Engineers, was held at beautiful Lake Quassapaug, Saturday, June 26. The members were the guests of William H. Bristol, Mr. Thompson and Frederick S. Chase at Mr. Bristol's cottage on the lake. The meeting was of an informal character, and baseball was enjoyed on the spacious lawns during the afternoon. A motor launch was also provided, and the visitors were given an opportunity of a sail around the lake. An outdoor dinner was followed by a short business meeting and election of officers.

Mr. Thompson was re-elected chairman, and E. O. Goss was made vice chairman, superseding Frederick S. Chase. The following were re-elected: treasurer, Howard Isbell; and secretary, John R. Putnam. A meeting committee was appointed as follows: Frederick S. Chase, chairman; William H. Bristol, D. Delancy, Edwin Sanderson, I. W. Day, Capt. George J. R. Sheldon and Roger Sperry.

After the meeting the members repaired to Mr. Bristol's country home in the suburbs of Waterbury via motor cars, and an invention of Mr. Bristol's was demonstrated; namely, the synchronization by electricity of a vocal selection on a phonograph with the music played by an electric organ. Following this interesting entertainment the members visited the Bristol Company's laboratory to view Mr. Bristol's talking moving pictures. The talking pictures, while developed to a point where successful demonstration is possible, are still in a rough stage and it will be some time before the invention will be put to commercial use for the entertainment of the public.

Natural Gas Production in the United States

The production of natural gas in the United States gradually increased from 1906 to 1917, but declined in 1918. The greatest producers, named in order of quantity produced, have been West Virginia, Pennsylvania, Oklahoma, Ohio, Kansas, California and New York.

An increase in the number of producing wells totaling 135 per cent from 1906 to 1918 is reported, and the area of developed natural-gas land has increased 177 per cent since that date. The total area in 1918 was about 14,500 acres.

The average annual consumption of natural gas for domestic use has been about one-third of the total consumption, and the average annual consumption for industrial use about two-thirds.

The total amount received for the two-thirds consumed for industrial use is smaller than that received for one-third consumed for domestic use, a fact that indicates that the industrial gas was sold at very low rates.

Over 2,500,000 domestic consumers and more than 201,000 industrial consumers now use natural gas, an increase since 1906 of 187 per cent in the domestic class and of 83 per cent in the industrial class.

To a large extent the industrial consumption reaches its maximum in summer and its minimum in winter, owing to the decrease of the domestic demand in summer, which leaves more gas available for industrial use.

The average annual domestic consumption per consumer from 1906 to 1918 was 105,000 cu.ft., and the average industrial consumption per consumer from 1906 to 1918 was 2,428,000 cubic feet.

The average price of domestic gas is between 30 and 40 cents a thousand cubic feet, that of industrial gas is between 15 and 20 cents.

About 76 per cent of the total natural gas consumed in the United States is not consumed in the states where it is produced, but is piped to other states.

The United States produces about 95 per cent of the natural gas produced in the world and thus has a monopoly of this resource, as Russia has a monopoly of platinum, Germany of potash, and Chile of nitrate.

Oils for Power Plants*

By C. B. Whitman†

Take a wine glass, dip your finger in water and as you rub it over the edge of the glass notice that the friction is pronounced; now wipe the finger dry and dip it in glycerin and again rub the glass—the friction is about the same. Dip the finger in lubricating oil and rub the glass. You find that the friction is almost imperceptible, which demonstrates that while glycerin has a viscocity far greater than the oil, its lubricating quality is lacking, because the surface tension of either water or glycerin is not strong enough to form a substantial film, even under very light loads, for they are both lacking in capillarity and in molecular attraction. For this reason many very viscous liquids fail to form a good lubricating film.

This also demonstrates that to be a good lubricant a liquid must have nearly as great a surface tension as a solid, also that its lubricating value depends on the thickness of the layer it forms when spread over the surface and the resistance it offers to the efforts of the load to expel it from between the solid surfaces.

Little is known about the properties of liquid films other than that which is obtained from the frictional data. The static friction of solid surfaces when lubricated with lard oil and sperm oil prove that the lard oil gives the lowest coefficient and therefore must form the thickest film. Experience teaches that when the superfluous oil has drained away the combined capillary and molecular attraction comes to the aid of the viscosity and increases the tensile strength which tends to prevent rupture.

Molecular and capillary attraction are possessed to a greater extent by mineral oils when properly refined, than by either animal or vegetable oils, but mineral oils are deficient in oiliness and will not keep the static friction as low as do animal or vegetable oils.

At speeds of 500 or more per min., under normal loads, and with bath lubrication, lard oil will sustain a film of only 0.005 in. thick, whereas a pure mineral oil of the proper viscosity will sustain a film of about 0.007 in. thick, which proves that for all ordinary machine bearings running under normal conditions, a mineral oil of the proper viscosity is a better lubricant by two-fifths than one of the best-known fixed oils. This has led to the blending and compounding of mineral oils. Blended oils are a mixture of mineral oil and fixed oils in proportions that will thoroughly neutralize; compounded oils are a mixture of mineral oil with metallic soaps of different kinds for the purpose of increasing the viscosity; experiment alone can tell as to the value of the mixture; often they are more detrimental than beneficial from a lubricating point of view.

As lubrication is of value only as its ability to reduce friction, we must consider the circumstances that influence friction. Cohesion is aggravated rather than diminished by efforts to produce smooth surfaces, for the more perfect the surface the greater will be the points of contact. At minute distances molecular attraction increases, which causes the surfaces to adhere and resist motion. For example, pieces of marble with polished surfaces will adhere when pressed together and their cohesion is so great that one piece when suspended will sustain the weight of the other. Again take two pieces of lead, scrape them clean and press them together in a vise and they will adhere almost as firmly as if they were one.

Of course the pressure to accomplish this is far greater than we get on a bearing, and I merely use these examples to show that there is cohesion between smooth surfaces. In a bearing the increased friction caused by motion generates heat, which increases the tendency of the surfaces to adhere, the area affected rapidly spreads and the surfaces seize or abrade each other. This happens in a "hot box."

The coefficient of friction of motion is the only one of interest from a lubricating point of view, and it is defined as that value which, when multiplied by the pressure normal to the surfaces in contact, gives the measure of the maximum frictional resistance to motion.

The value of viscosity and density of oils depends on the viscosity of the lubricant, the relative speed of the surfaces, their area and inclination to each other, thickness of the lubricating film. When these conditions are known, the resistance to the motion of any given body can be easily calculated.

To properly lubricate the different bearings found in modern practice, it is necessary for the lubricating engineer to know, first, the oiliness or greasiness of all lubricants, the frictional effects due to the viscosity of the lubricant, effects due to the different methods of application, the effects produced by different metals working in contact, the effects of temperature on friction and viscosity, and the effects due to different speeds under given loads. When the speed of the rubbing surfaces is less than ten feet per minute, the lubricant, instead of being forced between the surfaces and keeping them apart, is swept on under pressure, and the lubricant depends as much on its oiliness as on the viscosity.

Solid lubricants such as mica, graphite and soapstone have great carrying power at low speeds, but their value depends as much on the nature of the surfaces. Graphite, for instance, gives the best results when used on cast-iron surfaces, which are naturally very porous and hold the graphite, but the frictional loss and wear are great. Solid lubricants mixed with animal fats, greases, vaseline or rosin oil are suitable for low speeds and heavy loads, as they give a low coefficient and do not waste away rapidly by evaporation nor run off the bearings. Greases compounded from animal and vegetable fats, or mineral oils emulsified with water soap and alkali enough to neutralize them, are good lubricants for slow-moving bearings with excessive loads, provided the oils do not contain too much water and are not adulterated with foreign substances; the oil should not run down and leave the soap, which is liable to occur in poorly made greases.

Properties of Lubricating Oil for Low Speeds and Heavy Loads

In selecting an oil for low speeds and heavy loads, viscosity is the first guide, and next is oiliness. At speeds of 100 ft. per min., with proper application, as before stated, the oil forms a fairly thick film, and when the load does not exceed 250 lb. per sq.in., the formation of the film and the friction are wholly due to the viscosity; but at heavy loads the bearing surfaces are brought into contact at a point on one side of the bearing and the lubricant should possess oiliness to a greater degree to prevent seizing. In cases of flat surfaces, such as the guide on reciprocating engines, the viscosity is not quite so important as the oiliness; at loads of 75 lb. per sq.in. a blended lubricant is best.

For motors, generators, turbines and the crankcase type of high-speed engines, best results are had by using a straight mineral oil of the proper viscosity. For motors and generators with bath-ring oiling devices best results are obtained by using a pure mineral oil of a viscosity of from 120 to 198 (Saybolt) according to speed and load. Turbines having either forced or circulating lubrication should have a light oil for two reasons: First, because the lighter oils maintain their viscosity better at the relative high temperatures, and second, on account of the high speeds. It must also be an oil that will not emulsify and one that will readily separate from water, as there is leakage of steam in most turbines. The viscosity should not be less than 98, nor more than 120 at 100 deg. F.

For steam-cylinder lubrication there are four conditions met with in modern practice that form a guide in selecting a proper oil; namely, steam supersaturated, saturated, dry, and superheated. For a supersaturated condition the oil should be heavily blended with pure tallow to give good results; for a saturated condition a light blend of tallow and blown rape will give good results; for dry steam about 6 per cent blown rape gives good results, but for superheated steam one must have a pure steam-refined mineral oil, otherwise the intense heat will burn off the animal and vegetable oil, release the acids they contain and pit the cylinder walls.

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*From a paper read at Buffalo, N. Y.

†Chief lubricating engineer, Sinclair Refining Co., New York Division.

New Publications

PROCEEDINGS OF THE AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION, 1919. Published by the Engineering Association, West Fortieth St., New York City. Cloth, 6 x 9½ in., 416 pages.

A number of interesting papers covering power distribution, supply, generation, etc., which were read at the 1919 convention at Atlantic City, are contained in the publication. A summary of previous proceedings of the association is given, together with an alphabetical list of papers that were presented at meetings since 1911.

DIESEL ENGINE DESIGN. By H. F. P. Purdy. Published by D. Van Nostrand Co., New York City. First edition; 295 pages, 271 illustrations.

As the author states in his preface, this volume was written for the Diesel-engine designer. It contains much useful and heretofore unavailable data. Chapters 1 to 3 are devoted to the thermodynamics involved. Chapter 4 takes up the theory of similitude which, apparently, is not generally observed by the designer. The remainder of the volume covers the design of the various engine parts; the chapters devoted to crankshafts, connecting rods and pistons are especially meritorious. It is unfortunate that the subject of fuel systems is dismissed with so little discussion. The fuel pump and injection valve are the most important parts of the engine, and it is somewhat surprising to find practically no information offered. The book as a whole is remarkably well written and should be of interest both to the designer and to the operating engineer.

MILLWRIGHTING. Published by McGraw-Hill Book Co., Inc., 239 West 39th St., New York City. Second edition. Cloth, 6 x 9 in.; 454 pages, 158 illustrations.

Several changes and corrections have been made from the former edition, with the addition of a chapter on the installation of electric motors and methods of adapting millwright practice to the changed conditions of recent years. The book is intended as a guide to the modern millwright, who is expected to execute the more or less perfect plans of the consulting engineer and, in many instances, provide the details and supply most, if not all, of the minor engineering of factory location, laying out and erecting buildings, provision for foundations and supports for machinery, framing, laying out shafting, belts, steam and waterpipe fitting, erection of engines, setting of boilers, installation of waterwheels, and erection, connection and care of electric motors. While the work is primarily addressed to engineers engaged in new mill contruction, it will be found of especial value to operating engineers, master mechanics and consulting engineers who are interested in practical operations required for extension, alteration or maintenance of industrial plants and installation of their mechanical equipment.

Personals

B. V. E. Nordberg has been appointed sales manager of the Nordberg Manufacturing Co., Milwaukee, Wis.

H. W. Dow, formerly sales manager, recently resigned to become vice president and engineer of the Forest Products Chemical Co., Memphis, Tenn.

Charles E. Prout, Jr., has become advertising manager of Gillis & Geoghegan, West Broadway, New York City, manufacturers of telescopic hoists. He was formerly connected with the Ingersoll Watch Company.

C. T. Stiles, formerly first lieutenant, Engineering Division, Ordnance Department, has joined the Mechanical Goods Division of the United States Rubber Co., being located at their Philadelphia office.

Edward Caldwell, treasurer of the McGraw-Hill Co., Inc. publishers of *Power*, and the Mc-Graw-Hill Book Co., was tendered a dinner by his business associates celebrating his thirty years' service with the McGraw interests.

Alois Hauser has been appointed assistant to the works manager in charge of engineering, of the Timken Roller Bearing Co., Canton, Ohio. For the past several years, Mr. Hauser has been efficiency engineer at the Saucon plant of the Bethlehem Steel Company.

Commander R. D. Gatewood, of the Construction Corps, U. S. Navy, has been selected by Chairman Benson as Director of Construction and Repair of the Emergency Fleet Corporation, relieving R. L. Hague, of San Francisco. During the war Commander Gatewood was superintendent of motive power for the Panama Railroad in charge of the large shops and drydocks at both ends of the Isthmus and made an enviable record in connection with extensive repair and refitting work on merchant vessels.

Society Affairs

The American Peat Society's annual meeting, which will be held at Madison, Wis., has been advanced to Sept. 2, 3 and 4.

The American Society of Mechanical Engineers, Connecticut Section, Bridgeport Branch, will hold a shore outing, on Friday afternoon, July 16, at the Momauguin, just east of New Haven. Field sports, bathing and dancing have been arranged for the amusement of the members. The annual election of officers will be held by letter ballot.

Engineering Council at its meeting on June 17 indorsed the plan of the organization of the Federated Engineering Societies and the American Engineering Council, adopted by the organizing conference of technical societies in Washington June 3 and 4, and authorized its executive committee to render such assistance as was practicable in completing the work of the Organizing Conference and of the Joint Conference Committee of the Founder Societies in establishing the American Engineering Council.

Additions to Standards Committee—Five additional bodies have been admitted to representation on the Main Committee of the American Engineering Standards Committee. They are: Electrical Manufacturers Council (Electric Power Club, Associated Manufacturers of Electrical Supplies, Electrical Manufacturers Club); Fire Protection Group (National Fire Protection Association, National Board of Fire Underwriters, Associated Factory Mutual Fire Insurance Companies, Underwriters Laboratories); National Electric Light Association; National Safety Council; Society of Automotive Engineers. These, with the five engineering societies who founded the committee (American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing Materials), and the three Government departments, added later (Commerce, Navy and War), make a total of thirteen organizations having representation on the Main Committee.

Business Items

The Goetze Gasket and Packing Co., New Brunswick, N. J., announces the opening of new branch offices in New York City at 242 Lafayette St. The new offices will include sales and stock rooms.

The Carborundum Co., Niagara Falls, N. Y., recently acquired from the Alien Property Custodian the plant formerly owned and operated by the Didier-March Co., at Perth Amboy, N. J. This will be taken over at once and converted to the manufacture of a complete line of carborundum refractories.

The Board of Directors of the SKF Industries, Inc., at a special meeting held May 13, accepted the resignation of B. G. Prytz, as president, Mr. Prytz having been elected managing director of the parent company, with headquarters at Gothemberg, Sweden. At the same meeting F. B. Kirkbride, vice president since the organization of the company, was elected president to succeed Mr. Prytz.

The Economy Fuse and Manufacturing Co., of Chicago, manufacturers of Economy renewable fuses, announces the appointment of F. L. Easton as district sales manager of its Denver office, 205 Commonwealth Building. Mr. Easton succeeds R. M. Olsen, who resigned recently. Mr. Easton formerly was connected with the Economy Fuse and Manufacturing Co., but more recently has been doing sales promotion work for the Gates Rubber Co.

The Freeman-Riff Co. is just completing its new plant at Terre Haute, Ind. The company manufactures conveying machinery, specializing in the design, manufacture and installation of complete conveyor installations, particularly for the handling of coal in boiler plants and retail coal pockets. J. B. Freeman, the president of the company, will be in direct charge of plant operation and production.

Midstates Engineering Company, Westminster Building, Chicago, has recently incorporated as consultants, specializing in industrial, power and plant engineering. The equipment and commercial division activities will be directed by J. H. Milliken, who is well known in this field as an industrial sales manager. The engineering work will be executed by R. J. Gaudy, president, who is widely known through his activities with the Sessions Engineering Co., and his connection with many notable engineering projects.

The Chicago Pneumatic Tool Co., New York, announces the election of Allan E. Goodhue as vice president in charge of sales. Mr. Goodhue since May 1, 1919, has been managing director of the company's English subsidiary, the Consolidated Pneumatic Tool Co., London; also director of European sales for the Chicago Pneumatic Tool Co. Mr. Goodhue was formerly connected with the sales department of the Midvale Steel Co. and Midvale Steel and Ordnance Co., in Philadelphia, Chicago and Boston.

The Westinghouse Electric International Co. has made several changes in the personnel of the company. At East Pittsburgh they are as follows: H. F. Griffith, assistant to general manager; R. W. Everson, manager of merchandising department; H. C. Soule, manager apparatus department, and H. S. Reizenstein, manager price department. In New York they are: G. H. Butcher, assistant to general manager; J. H. Payne, supervisor of agencies; and F. M. Sammis, manager of incandescent lamp department. A. B. Cole, assistant manager, department of publicity, Westinghouse Electric and Manufacturing Co., has been placed in charge of the advertising and promotion work for the Westinghouse International Company.

Trade Catalogs

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., has ready for distribution a new 24-page catalog, No. 5-A-1, describing the Westinghouse line of insulating materials and supplies. A copy will be sent on request.

"Shuveloder, The Mechanical Mucker," is the title of a new 15-page catalog now ready for distribution by the Lake Superior Loader Co., Duluth, Minn. Descriptions and photographs of the various types of mucking machines handled by the company are given.

The Pennsylvania Pump and Compressor Co., Easton, Pa., has issued a new 12-page pamphlet entitled "Pennsylvania Air Compressors." Class 3A, single stage, belt drive are shown, together with charts showing size of cylinders (diameter and stroke), revolutions per minute, air pressure, cubic feet free air per minute, etc. A copy will be sent on request.

"W.S.M. Hydraulic Turbines" is the title of a new 88-page catalog just issued by the Wellman-Seaver-Morgan Co., Cleveland, Ohio. Illustrations and blueprints of turbines, horizontal or vertical units with spiral casings of cast steel, cast iron or steel plate are shown, also vertical units with concrete spiral casings or open flumes equipped with cast steel, cast iron or bronze runners are described.

The Traylor Engineering and Manufacturing Co., Allentown, Pa., has ready for distribution a new 50-page bulletin, No. 101, entitled "The Superpump and Hydraulic Machinery." The bulletin contains a comprehensive description of the constructional details of the Traylor superpump. Contained in the booklet is subject matter which should prove of practical value to the operating engineer and will also give the purchaser data of value. A copy will be sent on request.

George B. Carpenter & Co., manufacturers and distributors, of Chicago, are issuing catalog No. 110, 1920 edition, containing 1,088 pages, devoted to equipment and supplies for railroads, steamships, contractors, mills, mines, power plants, machine shops and all forms of industrial activity. The powerplant list is quite diversified, including such items as return-tubular boilers, boiler tubes, grates, motors, pipe fittings, valves, pipe hangers, pumps, gages, lubricators, oil filters, force feed oil pumps, oil cups, etc. As an illustrated reference for equipment and supplies, the catalog should prove of great value to the engineer.

Coal Scarce and Expensive

Little improvement is to be noted over last week. Lack of cars is still the predominant inconvenience. The coal shortage is most acute in the bituminous market.

New York—The present unrest in the anthracite market is attributed to a shortage of bituminous rather than an anthracite coal, but conditions are no better than last week. Nearly all producers complain of lack of cars, which lack has the effect not only of preventing adequate distribution but of causing restlessness among the workers as well. The larger dealers are frequently without one or another of the larger sizes. There was an active market last week for steam sizes although no heavy tonnages were available. Independent buckwheat was quoted at from $4.25 to $4.75; rice $3.25 to $3.75 and barley around $2, all at the mines. The prices of company coal per gross ton at the mine are $4 to $4.10 for buckwheat, $3 to $3.50 for rice and $2.25 to $2.50 for barley.

Considerable uneasiness has developed in the bituminous market because of agitation by the press. Numerous conferences with the Interstate Commerce Commission brought about an understanding that the situation would be taken care of even if it were necessary to issue priority orders.

Philadelphia—The anthracite trade has been crippled by an outlaw strike of freight crews that occurred suddenly on the railroads entering this city, on June 19, resulting in an embargo on anthracite which has not yet been raised. There is a most urgent demand for all sizes of steam coal with buckwheat in the lead. The railroads have endeavored to move steam sizes to the essential industries which are running on an extremely close margin.

The bituminous situation is even more serious than the anthracite, with very little tonnage entering the city. Some sales have been made as high as $13 a ton at the mine, although for the most part prices have been closer to $11.

Chicago—During the week the railroads serving Chicago placed a number of embargoes. It is said that neither Indiana nor Illinois coal can enter Michigan until further notice. The market is uniformly strong with several advances.

Pittsburgh—The effect of embargoes against the East has decreased bidding by export buyers. The recent high prices for the Pittsburgh district have been due largely to wild bidding by these buyers. It is stated that a relatively small further increase in car supplies would ease the market greatly. Steam coal is now quoted at $7.50 to $8.50 spot at the mine.

Buffalo—The bituminous situation has not improved, but has actually grown more serious, with transportation the main difficulty. It is stated that if the car supplies were increased 50 per cent the $10 maximum prices for coal would decrease to $4. Under the circumstances there is no settled price.

There is a heavy demand for anthracite from Canada, but Canadian dealers are having difficulty in obtaining coal. Last week the Lake movement amounted to 124,800 net tons of which 38,600 cleared for Chicago, 30,800 for Duluth Superior, 29,900 tons for Milwaukee, 11,500 tons for Port William, 7,500 tons for Ashland and 6,500 tons for Sheboygan.

St. Louis—Many plants are hard pushed for steam sizes in St. Louis. Buyers from Chicago and Northern cities are in St. Louis in large numbers and are offering fancy prices. Standard is moving North at $5 to $5.50 for all sizes. In the Mount Olive field prices are about $3 to $3.75 for all sizes, the regular trade being given preference. The mines work on commercial coal from one to one and a half days a week, while the railroad mines get four to five days. Practically no anthracite, smokeless or Arkansas fuel is coming into St. Louis.

Boston—The Interstate Commerce Division issued an order effective June 24 calling for priority for cars bearing coal via Tidewater for New England points for the relief of the railroads and industries in that section. The market is extremely active for spot coal. In the main there is a distinct gain in the time necessary for moving cars.

New Construction

PROPOSED WORK

Mass., Belchertown—The Committee on Mental Diseases, 36 State House, Boston, will soon award the contract for a 2 story, 90 x 117 ft dormitory, etc., including a steam heating system, for the Commonwealth of Massachusetts. About $250,000. Kendall, Taylor & Co., 93 Federal St., Boston, Archts. and Engrs.

Mass., Boston—The School House Comn. received bids for installing new boilers and other changes from J. P. Dwyer, 80 Boyl St., $7.588; Pearse & Cox, $7,687; J. J. Hurley & Co., 104 B'way., $7,754. Noted June 29.

N. Y., Dannemora—Charles F. Rattigan, Supt. of the State Prisons, Capitol, Albany, will soon award the contract for a refrigeration plant and cooling rooms in the kitchen building at the Clinton Prison here. One refrigerating machine, brim coils, etc., will be installed in same.

N. Y., Iroquois—W S Lawton, Pres. of the Bd. of Mgrs., will soon award the contract for additions and equipment for the water supply system including a deep well and pumping apparatus consisting of a new motor, well cylinder and well pipe, 10 hp. motor at the Thomas Indian School, here.

N. Y., Lockport—The Lockport Boiler & Welding Works, 237 Market St., is in the market for one 30 hp. vertical or locomotive type boiler.

N. Y., Schenectady—D. J. Bondy, 82 Wall St., New York City, plans to build 2 theatres including a steam heating system. About $600,000. DeRosa & Pereira, 110 West 40th St., New York City, Archts. and Engrs.

N. J., Cape May—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for repairing the power house equipment at the United States Naval Section Base, here, from the B. E. Eng. Co., 22 Leight St., New York City, $5.482; George S. Curtis, $3.552; Frank J. Eisinger, 141 7th Ave., Brooklyn, $1.231

N. J., Trenton—The City Comn. will receive bids until July 23 for a 10,000,000 gal. triple expansion vertical type, E. P. Allis steam pump. J. R. Fell, Engr.

N. J., Trenton—The State received only bid for the installation of a heating system in the proposed 4 story, 50 x 300 ft. capitol building on West State St., from W. G. Royer, 167 Rosemont Ave., $17,406.

Pa., Blairsville—The Western State Hospital for the Insane plans to build a power house, ward buildings, etc., in connection with the Farm Colony 1 at Torrance near here.

Pa., Charleroi—The First Nat'l Bank of Charleroi is having plans prepared for altering the present bank building including a steam heating system. About $500,000. W. L. Stoddart, 9 East 40th St., New York City, Archt. and Engr.

Pa., Elmhurst—The St Nicholas Greek Catholic Church of America plans to build a 3 story, 100 x 250 ft. orphanage, including a steam heating system, on Elmhurst Ave. About $300,000.

Pa., Erie—The Second Natl. Bank, 8th and State Sts., will soon award the contract for a 1 story, 60 x 130 ft. bank including a steam heating system on 9th St. About $400,000. W. L. Stoddart, 9 East 40th St., New York City, Engr.

Pa., Philadelphia—The Stanley Co of America, 1214 Market St., is having plans prepared for a 16 story theatre including a steam heating system on Market and 11th Sts. About $1,000,000. Hoffman & Henon, Finance Bldg., Archts.

Pa., St. Marys—F. Arthur Rianhart, Archt., Masonic Temple, Williamsport, will receive bids until July 26 for converting monastery into a hospital and building a power house for the Andrew Kaul Memorial Hospital here. Separate bids for heating, electrical and plumbing work will be received. About $100,000. Sedgwick Kistler, Pres.

Pa., Uniontown—Albert Kahn Archt., Marquette Bldg., Detroit, will soon award the contract for a 9 story, 38 x 56 ft. mercantile building including a steam boiler, etc., for heating system, on Gallatin Ave. and Main St., for the Aaron Furniture Co.

Md., Baltimore—The city is having plans prepared for a 3 story, 100 x 500 ft. high school including a steam heating system on Poplar Grove St. About $600,000. Edward H. Glidden, Amer. Bldg., Archt.

Md., Baltimore—Samuel T. Williams, 223 North Calvert St., is in the market for a duplex, compound, belt-driven air compressor, 270 to 400 cu.ft. of free air permitted to 100 lb. pressure (used).

S. C., Paris Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for improvements to power plant at the Marine Barracks here from Noland Clifford, 330 28th St., Newport News, Va., (1) work complete, $149,452, (2) deduct $2,000, (3) $5,000. Noted June 15.

Fla., Jacksonville—The city is having plans prepared for remodeling the Home for the Aged and installing laundry equipment, heating system, etc., in same. About $50,000. J. H. Lynch & Son, Dolph Bldg., Archts. and Engrs.

O., Akron—The Akron Prospect Co. plans to construct a hotel and theatre building, including a steam heating system. About $1,250,000. John Eberson, 64 East Van Buren St., Chicago, Archt.

O., Canton—The Bd. Educ. plans to build a 2 story grade school, including a steam heating system. About $250,000. C. Lane, Clk. Thayer & Johnson, 5716 Euclid Ave., Cleveland, Archts.

O., Euclid—The Sisters of the Good Shepherd, East 30th St. and Carnegie Ave., Cleveland, has purchased a site at Stop 10½ Euclid Ave., and plans to build a 3 story convent and school including a steam heating system on same. About $300,000. Address Mother Berdanars.

O., Cleveland—The Bd Educ., East 6th St. and Rockwell Ave., plans to construct a 1 story school on Howard and East 146th St., a 3 story school on Parkview and Mt. Auburn Sts. and a 1 story school on East Woodland and East 128th St. Steam heating systems will be installed in same. About $2,750,000. W. R. McCormack, Archt.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., plans to build a 3 story school on East [illegible] St. near St. Clair Ave. and one on East [illegible] St. and Castalia Ave. Steam heating systems will be installed in same. About $[illegible] each. W. R. McCormack, Archt.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., plans to build a 3 story junior high school at Woodland Hills Park, East 116th St. and Corlett Ave., Holmes Ave. and on Hyde Ave. and West 11th St. Steam heating systems will be installed in same. About $[illegible] each. W. R. McCormack, Archt.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., received bids for the installation of a steam heating system in the proposed 1 story, [illegible] x [illegible] ft. school on East 92nd St. and Parkgate Ave., from J. Roemer Heating Co., East 22nd St., $163,127. Noted May 18.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., plans to construct a 1 story school including a steam heating system on Sandusky Ave. About $1,000,000. F. G. Hogan, Dir., W. R. McCormack, Archt.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., plans to construct a 1 story school including a steam heating system on Lake Ave. About $500,000. F. G. Hogan, Dir., W. R. McCormack, Archt.

O., Cleveland—B. Lederman, 10709 Pasadena Ave., is having plans prepared for a 6 story, 60 x 200 ft. hotel including a steam heating system on East 105th St. and Euclid Ave. About $500,000. M. Weiss, 618 Union Bldg., Archt.

Ind., West Hammond—R. G. Pierce, Archt., 10 South La Salle St., Chicago, will soon award the contract for a 1 story, 210 x 560 ft. steel plant including a steam heating system, for the La Salle Iron Works, 2305 South Halsted St., Chicago.

Mich., Bay City—The Wildman Rubber Co. is having plans prepared for a 1 and 3 story rubber manufacturing plant including a steam heating system. About $2,000,000. W. W. Wildman, Brook Bldg., Detroit, Pres. Osborn Eng. Co., 2848 Prospect Ave., Cleveland, O., Archt. and Engr.

Mich., Detroit—The Standard Reamer & Tool Co., Elmwood Ave. and Hendric St., will soon award the contract for a 1 story, 50 x 100 ft. tool factory including a steam heating system and motors for power on Elmwood Ave. About $15,000. Pollmar & Roper, 45 State St., Archts.

Mich., Saginaw—The Second Natl. Bank, 110 North Washington St., had plans prepared for a 16 story, 120 x 120 ft. bank and office building including a steam heating system. About $2,250,000. Weary & Alford, 1732 South Michigan Ave., Chicago, Archts.

Ill., Chicago—The Standard Oil Co. of Indiana, 910 South Michigan Ave., had plans prepared for a 9 story, 133 x 238 ft. addition to office building including a steam heating system. About $1,250,000. Marshall & Fox, 721 North Michigan Ave., Archts.

Ill., Chicago—John P. Talke Co., 759 South Washtenaw Ave., is having plans prepared for a 2 story, 112 x 120 ft. office building and garage including a steam heating system on Washtenaw Ave. and Polk St. About $600,000. Graham, Anderson, Probst & White, 1417 Ry. Exch. Bldg., Archts.

Ill., Evanston—The Glenview Golf Club is having preliminary plans prepared for a 1½ story clubhouse including a steam heating system. About $200,000. Holabird & Roche, 104 South Michigan Ave., Chicago, Archts.

Wis., Appleton—St. Elizabeth Hospital is having plans prepared for a 4 story hospital including a steam heating system. About $500,000. V. J. Klutho, Syndicate Trust Bldg., St. Louis, Mo., Archt.

Wis., Iron River—T. H. Okerstrom, Port Wing, is having preliminary plans prepared for a dam and power plant here. J. C. Jacobson, 533 Metropolitan Bank Bldg., Minneapolis, Minn., Engr.

Wis., Two Rivers—The Bd. Educ. will receive bids about Aug. 15 for a 3 story, 144 x 198 ft. high school, including a steam or vapor heating system or both. About $400,000. John Chubb, Dearborn St., Chicago, Archt.

Minn., Pipestone—S. W. Funk, Clerk, will receive bids until July 1[illegible] for a waterworks system including a water tower, 150,000 gal. tank, a [illegible] gal. capacity reservoir and a pumping plant for the city. About $[illegible]. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, Engr.

Mo., St. Paul—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until July 16 for repairing the boiler plant at the United States Marine Hospital here.

Tex., Breckenridge—The Guaranty State Bank is having plans prepared for a 6 or 7 story, 100 x 150 ft. bank including a steam heating system on Walker St. About $250,000.

Tex., Dallas—The Dallas Brass Mfg. Co., 1101 Ross Ave., is in the market for one 5 hp., 220 volt, a.c. motor, etc. (used).

Tex., Port Arthur—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., received only bid for installing a boiler from William Wilby, Selma, Ala., $2,595.

Wash., Puget Sound—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for the installation of auxiliary equipment and piping for the air compressor, from the Carroll Electric Co., 714 12th St., Wash., D. C., $49,800; Charles C. Moore & Co., Sheldon Bldg., San Francisco, Cal., $59,861. Noted June 1.

Que., Shawinigan Falls—The Shawinigan Water & Power Co. plans to issue $4,000,000 bonds to be used for expansion and improvements, including the construction of a second transmission line from here to Montreal and the installation of a new 50,000 hp. unit at the local plant.

Ont., Alexander—The town plans to install a local electrically driven pumping plant. The Hydro Electric Power Comn. of Ontario will furnish the energy. Major Palmer, Mgr.

Ont., Kingston—The Dominion Government has voted $265,000 bonds to construct a 3 story addition including a steam heating system, to the Royal Military College here.

Ont., Kitchener—The Lasky Film Corp., King St., plans to build a 1 story motion picture theatre including a vacuum steam heating and mechanical ventilating system, etc. About $350,000.

Ont., Toronto—The Ontario Hydro Electric Power Comn. plans to purchase the Niagara, St. Catharine and Toronto Ry., the Toronto Suburban Ry. and the Eastern Ry. and to make extension to the properties.

CONTRACTS AWARDED

N. Y., Brooklyn—The Bd. Educ., 500 Park Ave., New York City, has awarded the contract for a school on River Blvd. and 86th St., including a steam heating system, to James McArthur & Co., 22 Ormond Pl. About $650,000.

N. Y., Jamestown—The city has awarded the contract for furnishing and installing a heating plant in the Jones General Hospital here, to the Warren Constr. Co., at $15,800. Noted April 27.

N. Y., New York—The Bd. of Estimate, Municipal Bldg., has awarded the contract for a court house including a steam heating system on Center, Worth, Baxter and Pearl Sts., to Rodgers & Hagerty, Inc., 103 East 125th St., at $2,000,000.

N. Y., New York—The Federal Reserve Bank, 15 Nassau St., has awarded the contract for a 63 x 72 ft. storage building including a steam heating system, on Maiden Lane and Gold St., to M. Eidlitz, 30 East 42nd St., at $350,000.

N. Y., Olean—The Bd. Educ., Union Free School Dist. 1, has awarded the contract for installing a heating system in the school buildings Nos. 1, 2, 3, 4 and 7, to the Power Efficiency Corps, White Bldg., Buffalo, at $148,201. Noted June 15.

N. J., Lakehurst—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has awarded the contract for a power house building and quarters shop at the Naval Air Station here, to the Hughes Foulkrod Co., Commonwealth Trust Bldg., Philadelphia, Pa., at $477,000. Noted March 30.

N. J., Lakehurst—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has awarded the contract for installing power plant equipment at the Naval Air Station here, to the Lord Electric Co., 105 West 40th St., New York City, at $391,205. Noted June 8.

N. J., Morristown—The Manhattan Rubber Co., Willett St., Passaic, has awarded the contract for a plant including a steam heating system, to Stone & Webster, 120 B'way, New York City, at $1,000,000.

Pa., Harrisburg—The State has awarded the contract for a 3 story, 100 x 500 ft. office building including a steam heating system, to S. W. Shoemaker, 1545 North 6th St., at $684,000.

O., Cleveland—The Cleveland Electric Illuminating Co., 75 Public Sq., has awarded the contract for a 1 story, 45 x 70 ft. power house addition on West 65th St. and Madison Ave., to F. Hanselman, 408 Illuminating Bldg., at $75,000.

O., Cleveland—I. Margolin, 10527 Churchill Ave., will build an 8 story, 45 x 220 ft. hotel, including a steam heating system on the East Blvd. About $1,500,000. Work will be done by day labor.

O., East Cleveland (Cleveland P. O.)—The Natl. Lamp Co., Nela Park, has awarded the contract for a 1 story, 48 x 86 ft. heating plant at Nela Park, to the Heller Bros., East 152nd St. and St. Clair Ave., Cleveland. About $75,000.

Wis., Manitowoc—George Bros. Co., 913 South 8th St., has awarded the contract for a 1 story, 115 x 130 ft. theatre including a steam heating system on 58th St., to the Badger State Constr. Co., c/o A. V. Lill, 1115 Washington St. About $300,000.

Wis., Wauwatosa—The Milwaukee Co. Bd. of Administrators has awarded the contract for intercepting sewers and force main, to Brogan & Burns, 700 Donsman St., Green Bay, at $13,989, and for pumping station to Brill & Tanghe, 86 Michigan St., Milwaukee, at $1,790. Noted June 15.

Minn., Minneapolis—The Bd. Educ. has awarded the contract for installing a steam heating system in the proposed 2 story, 75 x 220 ft. Miles Standish School on 22nd Ave., South, to H. Kelley & Co., 925 Plymouth Bldg., $30,135; and in the Minnehaha School on 31st St. and 29th Ave., from Bjorkman Bros., 712 South 10th St., $29,025. Noted April 13 and March 30.

Mo., St. Louis—The Blanton Oleomargarine Co., 1st and Spruce Sts., has awarded the contract for a 5 story, 72 x 151 ft. power plant and industrial building, to the Kellerman Constr. Co., International Life Bldg., at $300,000.

Mo., St. Louis—The Bd. Educ., 911 Locust St., has awarded the contract for a 2 story, 132 x 175 ft. school, including a low pressure steam heating system at 226 South Euclid Ave., to the Kellerman Constr. Co., International Life Bldg., at $312,000.

Tex., Dallas—The Breckenridge City Waterworks Co. has awarded the contract for installing a distributing system, pump equipment, stand pipe, etc., in connection with the proposed dam across the Clear Fork of the Brazos River, to John W. Moore, Breckenridge, at $350,000.

Cal., Colton—The Pacific Fruit Express Co., 65 Market St., San Francisco, has awarded the contract for ice plant equipment including steel tanks, coils, air blowers, motors, etc., to C. M. Gay & Son, 2650 Santa Fe Ave., Los Angeles, at $42,056.

Cal., Los Angeles—The Pacific Fruit Express Co., 65 Market St., San Francisco, has awarded the contract for ice plant, equipment here, including steel tanks, coils, motors, etc., to C. M. Gay & Son, 2650 Santa Fe Ave., at $30,300.

Cal., Los Angeles—The Robertson Cole Studios, Inc., Currier Bldg., has awarded the contract for a moving picture studio including a power plant, on Gower St. and Melrose Ave., to the Milwaukee Bldg. Co., 403 South Hill St., Los Angeles. About $100,000.

Cal., Roseville—The Pacific Fruit Express Co., 65 Market St., San Francisco, has awarded the contract for ice plant equipment here including steel tanks, air blowers, coils, motors, etc., to C. M. Gay & Son, 2650 Santa Fe Ave., Los Angeles, at $35,173.

Ont., Leamington—The Bd. Educ. has awarded the general contract for a 2 story school, to John Burroughs, Windsor, at $88,290. A steam heating system with electrical motor and blower for mechanical ventilation will be installed in the same, cost, $17,224.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE

	Fire	50-Ft. Lengths
Underwriters' 2½-in		85c. per ft.
Common, 2½-in		30%

Air

	First Grade	Second Grade	Third Grade
½-in per ft	$0 60	$0 40	$0 30

Steam—Discounts from List

First grade	20%	Second grade	30%	Third grade	45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	30–10%		

LEATHER BELTING—Present discounts from list in fair quantities (½ doz. rolls):

Light Grade	Medium Grade	Heavy Grade
30%	25%	20%

RAWHIDE LACING
- For cut, best grade, 25%, 2nd grade, 30%
- For laces in sides, best, 79c per sq. ft.; 2nd, 75c.
- Semi-tanned: cut, 20%; sides, 83c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	1 70
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1 70
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1 50
Rubber sheet	50
Rubber sheet, wire insertion	70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 30
Asbestos wick, ½- and 1-lb balls	.85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		List
For low-pressure heating and return lines	4-ply	50% off
	3-ply	52% off
	2-ply	54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham
Cup	8½	6.6	8¼@ 9½	8½
Fiber or sponge	8½	8.6	8¾@ 9½	8½
Transmission	10	8.1	12@14	8½
Axle	...	4.8	5¾@ 6½	5¼
Gear	6½	6.1	6¼@ 6¾	8½
Car journal	12(gal.)	4 7	8¾@ 9½	4½

COTTON WASTE—The following prices are in cents per pound:

	New York Current	New York One Year Ago	Cleveland	Chicago
White	11 00@15 50	13 00	16 00	11 00 to 14 00
Colored mixed	7 00@10.50	9 00 to 12 00	12 00	9 50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¾ x 13¾	13¾ x 20¾
Cleveland	$55 00	[illegible]
Chicago	41 00	43 50

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Chicago Current	Chicago One Year Ago
Raw in barrels (5 bbl. lots)	$1.63	$1.90	$2.02	$2 10
5-gal. cans	1.65*	2.03	2.27	2.30

*To this *oil* price must be added the cost of the cans (returnable), which is $2.25 for a case of six.

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb keg	15 50	17 00	13.00	14 50	15 50	13 00
25- and 50-lb. kegs	15 75	17 25	13 25	14.75	15 75	13 25
12½-lb. keg	16 00	17.50	13 50	15 00	16 00	13 50
1-lb. cans	18 50	20.00	15.00	16.50	15 00	15 00
5-lb. cans	20.50	22 00	16 00	17 50	16 00	16 00

500 lb. lots less 10% discount; 2000 lb. lots less 10–2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel $\frac{7}{16}$ and smaller	30%	30%	30%
Tinned	30%	30%	30%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York $6.00 Chicago $5.62 Pittsburgh $4 72

Structual rivets, same sizes:

New York $7 10 Chicago $5.72 Pittsburgh $4 82

REFRACTORIES—Following prices are f. o. b. works,

Bauxite brick, 56% alumina, f.o.b. Pittsburgh	M.	$145
Chrome brick, f o b. Chester, Pa., carlots	net ton	90– 100
Chrome brick, 9 in. strs. and sizes, f.o.b. Baltimore	net ton	80 90
Fire clay brick, 1st quality, 9 in. shapes. f.o.b. Pennsylvania, Ohio and Kentucky works	M.	45 53
Fire clay brick, 1st quality, f.o.b. St. Louis	M	45– .
Fire clay brick, 1st quality, f.o.b. New Jersey	M.	75– ...
Fire clay brick, 2d quality, 9 in. shapes. f.o.b. Pennsylvania, Ohio and Kentucky works	M.	40
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	90 —
Magnesite brick, 9 in. sizes and shapes larger than 9 in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90 100
Silica brick, 9 in. and 9 in. sizes, f.o.b. works, Chicago district	M.	55–
Silica brick, f.o.b. Birmingham	M	51– 55
Silica brick, f.o.b. Mt. Union, Pa	M.	50– 55

BABBITT METAL—Warehouse prices in cents per pound:

	New York Current	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Best grade	90 00	87.00	74 50	79 00	60 00	75 00
Commercial	50 00	42 00	21.50	17.50	15 00	15 00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$20.00	25.50–30.00
Cleveland	20 00	20.00
Chicago	21.00	16 50

In coils an advance of 50c. usually is charged

Domestic iron (Swedish analysis) is selling at 12c. per lb.

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

	Large Mill Lots Pittsburgh	New York Current	New York One Year Ago	Cleveland	Chicago
Blue Annealed					
No. 10	3.55–6 00	7.12@8.00	4.57	7.55	7.02
No. 12	3.60–6.05	7.17@8.05	4.62	7.65	7.07
No. 14	3.65–6.10	7.22@8.10	4.67	7.70	7.12
No. 16	3.75–6.20	7.32@8.20	4.77	7.80	7.22
Black					
Nos. 18 and 20	4 15–6.30	8.50@9.50	5.30	8.20	7 80
Nos. 22 and 24	4 20–6.35	8.55@9.55	5.35	8.25	7.85
No. 26	4.25–6.40	8.60@9.60	5.40	8 30	7.90
No. 28	4.35–6.50	8.70@9.70	5 50	8 40	8.00
Galvanized					
No. 10	4.70–7.50	9 75@11 00	5 50	8 50	8.15
No. 12	4.80–7.60	9 85@11 00	5 55	8 60	8 20
No. 14	4 80 7 60	9.85@11 10	5 50	8 60	8 35
Nos. 18 and 20	5.10–7.90	10 10@11 40	5 90	8.90	8 65
Nos. 22 and 24	5.25–8.02	10 25@11 55	6.05	9 05	9 05
No. 26	5.40–8.20	10 40@11.70	6.20	9 20	9.20
No. 28	5.70–8.50	10.70@12.00	6.50	9 50	9 50

*For painted corrugated sheets add 30c. per 1000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

STEEL AND IRON—The following discounts are to jobbers for carload lots on the Pittsburgh basing card, discounts on steel pipe, applying as from January 14, 1920, and on iron pipe from January 7, 1920:

BUTT WELD

Inches	Black	Galv	Inches	Black	Galv.
¾ to 3	57 @54	44@41½	¾ to 1½	34½@24½	18½@ 8
			2 and 2½	33½	17½

LAP WELD

2	50½@47	38@34½	2	28½@20½	14½@ 6½
2½ to 6	53½@50	41@37½	2½ to 6	30½@22½	17½@ 9½
7 to 12	50½@47	37@33½	7 to 12	27½@19½	14½@ 6
13 and 14	41 @37½	....			
15	38 @35	....			

BUTT-WELD, EXTRA STRONG, PLAIN ENDS

½ to 1½	55½@52	39½	½ to 1½	34½@24½	19½@ 9
2 to 3	56½@53	44@40½	2 and 2½	34½@24½	19½@ 9

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	48½@45	37@33½	2	29½@21½	16½@ 8½
2½ to 4	51½@48	40@36½	2½ to 4	31½@23½	19½@11
4½ to 6	50½@47	39@35½	4½ to 6	30½@22½	18½@10½
7 to 8	46½@43	33@29½	7 to 8	22½@14½	10½@ 2
9 to 12	41½@38	28@24½	9 to 12	17½@ 9½	5½@ [illegible]

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	40½	3½ to 4½ in.	1½
2½ to 3¼ in.	30½	3 to 3¼ in.	1
2¼ in.	24	2½ to 2¾ in.	+ 1
1¾ to 2 in.	19½	2 to 2¼ in.	+16
		1¾ to 1⅞ in.	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in.	$327	1¾ in.	$207
1⅛ in.	267	2 to 2¼ in.	177
1¼ in.	257	2½ to 3¼ in.	167
1½ in.	207	4 in.	187
		4½ to 5 in.	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiations

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond. M Ft	Three Cond. M Ft	Two Cond. Lead M Ft	Three Cond. Lead M Ft.
No. 14 solid	$104 00	$138 00	$164 00	$210 00
No. 12 solid	135 00	170 00	225 00	265 00
No. 10 solid	185 00	235 00	275 00	325 00
No. 8 stranded	285 00	375 00	520 00	500 00
No. 6 stranded	400 00	500 00	560 00	

From the above lists discounts are:

Less than coil lots	Net List
Coils to 1,000 ft	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever-Ready

	Each, Net
Less than 12	$0 45
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS, ELBOWS AND COUPLINGS—These prices are f. o. b. New York with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
Size, In.	2,500 to 5,000 Lbs.	2,500 to 5,000 Lbs.	2,500 to 5,000 Lbs.	2,500 to 5,000 Lbs.	2,500 to 5,000 Lbs.	2,500 to 5,000 Lbs.
½	97 01	103 18	24 20	25 26	2 65	8 10
¾	128.48	136 82	32 20	33 65	8 92	7 42
1	189.92	202 26	47 14	49 80	12.73	14 58
1¼	256.96	273 05	60 02	63 26	16.56	17.50
1½	307.24	327 20	80 02	84 35	22.75	23 89
2	413 36	440 24	145 63	154 63	28.10	29.52
2½	653 57	699 60	240 00	253 04	37.35	39.36
3	854.67	910 20	640 22	674 78	53.35	56.23
3½	1,060 94	1,127 74	1,433 83	1,494 60	80.03	112.46
4	1,283.15	1,362 53	1,633 90	1,722 10	106.70	140.58

Standard lengths rigid, 10 ft. Standard lengths flexible, ⅜ in., 100 ft. Standard lengths flexible, ½ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
7/32	250	$0.05½	Coils.....40% off Less coils, 25% off
¼	250	.06	
⅜	250	.09	
½	200	.12	
⅝	200	.15	
¾	150	.18	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities.

CUT-OUTS, PLUG

S. P. M. L.	$0 11	T. P. to D. P. S. B.	$0 24
D. P. M. L.	.11	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0 84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	.....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2 10	....
T. P. D. B.	1 35	3 60	...
T. P. to D. P. D. B.	.90	2.52	..

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.

No. 18 cotton twisted	$22 00
No. 16 cotton twisted	27 00
No. 18 cotton parallel	26 50
No. 16 cotton parallel	34.50
No. 18 cotton reinforced heavy	34 00
No. 16 cotton reinforced heavy	42 00
No. 18 cotton reinforced light	30 00
No. 16 cotton reinforced light	36 75
No. 18 cotton Canvasite cord	28 50
No. 16 cotton Canvasite cord	32 00

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0 25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
425-amp. to 600-amp.	10	5.50

600 Volt	Std. Pkg.	List
3 amp. to 30 amp.	100	$0 40
35 amp. to 60 amp.	100	.60
65 amp. to 100 amp.	50	1 50
110 amp. to 200 amp.	25	2 50
225 amp. to 400 amp.	25	5 50
450 amp. to 600 amp.	10	8 00

Discount	
Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4 75C
0-30 ampere, less than standard package	6 00C

LAMPS—Below are present quotations in less than standard package quantities:

Straight Side Bulbs — Mazda B				Pear-Shaped Bulbs — Mazda C			
Watts	Plain	Frosted	No. in Package	Watts	Clear	Frosted	No. in Package
10	$0 40	$0 45	100	75	$0 75	$0 80	50
15	40	45	100	100	1 10	1 25	24
25	40	45	100	150	1 55	1 70	24
40	40	45	100	200	2.10	2.30	24
50	40	45	100	300	3.15	3 40	24
60	45	.50	100				12
				500	4 60	4 90	12
				750	6.50	6.90	8
				1,000	7 50	7.95	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

		Each
Hubbell porcelain No. 5406,	standard package 250	$0.24
Hubbell composition No. 5467,	standard package 50	.32
Benjamin swivel No. 903,	standard package 250	.20
Hubbell current taps No. 5638,	standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12 00	$16 00	$13 90	$28 50
12	13 25	15 70	18 05	30 70
10	18 30	21 00	23 85	41 50
8	25.54	28 60	32 70	56.77
6	......	......	51 40	......
4	......	......	70 00	......
2	......	......	101 80	......
1	......	......	131 86	......
0	......	......	160.00	......
00	......	......	193 50	......
000	......	......	235.20	......
0000	......	......	288.60	......

Prices per 1000 ft. for Rubber-Covered Wire in Following Cities:

	Birmingham			St. Louis		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$12.23		$38 64	$14 85	...	$37.25
10	27.60		65 57	23 45	...	57.20
8	38.64		87 33	32 10	......	..
6	69.12		.....	......	55.10	
4		107.42	......	......	73.75	...
2		138.46	.....	......	103.10	. .
1		178 52	.....	......	133.30	...
0		217.09	.....	......	159.90	.
00		263 57	...	......	189.20	.
000		320 44	. .	......	225.10	. ..
0000		389.17	. .	......	269.30	

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap			⅜ In. Cap		
Key Each	Keyless Each	Pull Each	Key Each	Keyless Each	Pull Each
$0.33	$0 30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	+50%
1-5th to standard package	+20%
Standard package	—10%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	55c. lb
No. 18 B. & S. regular 1-lb. coils	56c. lb

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 60c. lb., 100 lb. lots	55c. lb
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c lb
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb
Soldering paste, 2 oz. cans Nokorode	$1.20 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3 66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10 00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+5%
$50 to $200 list value	—10%
$200 list value or over	—15%

POWER

Volume 52 New York, July 13, 1920 *Number* 2

The Executive

By Rufus T. Strohm

I met Hoke Higginson last week
A-lookin' mighty slim an' sleek.
Sez I to him: "Well, I'll allow
You've got a real job jus' now."
An' Hoke he laffed an' winked at me;
"I'm an executive," sez he.
"I wish that you'd explanify
Jus' what you mean by that," sez I.

Sez Hoke: "I'm one of them there men
That git to work at nine or ten,
When every common office clerk
Has done about a half-day's work.
I look a pile of letters through
An' maybe answer one or two,
An' then my innards git a hunch
They're due for somethin' like a lunch;
So out I go to some café
An' stow a good square meal away."

"I saunter in again at three,
To see if there's a job for me,
Although my six assistants keep
The work from pilin' in a heap.
I pause to tell the newest joke,
An' then I have a little smoke,
For though there are 'No Smoking' signs,
No true executive opines
That any sign could possibly
Be meant for such a bird as he."

"An' while I smoke I sit an' scan
The details of a little plan
That I've arranged for puttin' through
Some work that I don't have to do.
I love to set folks on the run
An' have 'em sweatin' to git done
A nasty bit of labor such
As I myself 'ud hate to touch."

"Then, when the clock is strikin' four,
You'll see me waitin' at the door,
While Jackson in the gas coupé
Chugs up to carry me away.
But let me whisper in your ear,
If things don't moderate this year
An' sort of ease the strain, by heck,
I'm gonna be a nervous wreck!"

The Flooded System for Evaporating Coils

By G. H. Crawford
Engineering Department, De La Vergne Machine Company

Much has been written on the subject of the flooded system of ammonia evaporation in refrigerating and ice-making plants. This article presents the salient features of the different systems in common use in the United States.

The objects of the flooded system are: (a) To simplify the operation of a plant by reducing the number of valves to be regulated; (b) to increase the rate of heat transfer through the evaporating surfaces; (c) to make the plant safer from priming accidents. In the older refrigerating and ice-making plants the custom was to use direct expansion. Each portion of the evaporating or low-pressure side was controlled by a separate regulating or so-called "expansion" valve. The outlet from each section or coil connected into the suction line leading to the inlet valves of the compressor. Unless the regulating (expansion) valves were perfectly set—and this was generally impossible—either too much or too little liquid ammonia was fed to the evaporator. In the former case the compressor efficiency and capacity suffered, as is evidenced by Fig. 1; if too little liquid was fed into the evaporator, the rate of heat transfer and capacity of the low-pressure side was decreased.

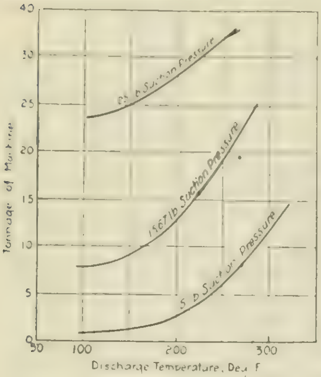


FIG. 1. EFFECT OF LIQUID IN SUCTION GAS

The flooded system has been gradually developed in its different forms to obviate the defects of the direct-expansion system. It is now used almost exclusively in medium- and large-sized ice plants and is rapidly being introduced into many other branches of the refrigerating industry. The use of direct expansion is now confined mainly to small plants and to the room coils in cold-storage establishments.

The term "flooded" is used to designate the supposed condition inside of the evaporating coils. Popularly, these coils are considered to be full of liquid ammonia. This is not exactly the case, for there is some vapor present even in the bottom coils, as is shown in Fig. 3, which is from a glass model. However, the proportion of liquid to vapor is much larger in the flooded than in the direct-expansion system. This causes a more complete and continuous wetting of the inner surface of the evaporator, which in turn accounts for the greater rate of heat transfer taking place in the flooded than in the direct expansion system. For example, tests have shown heat transfer through 1¼-in. pipe immersed in an ice freezing tank of 22 B.t.u. per hr. per sq.ft. per deg. F. temperature difference for the flooded system, while 15 B.t.u. would be a good figure for direct expansion.

The development of the flooded system has followed four general lines, as illustrated diagrammatically in Fig. 2.

In arrangement No. 1, the warm high-pressure liquid ammonia from the receiver passes directly to the expansion valve *X*. This high-pressure liquid ammonia is then "expanded" (reduced in pressure) directly into the accumulator (separator) *A* through the valve *X*. The gas formed by the pressure reduction (about 14 per cent of all the gas) passes directly to the compressor. The cold liquid formed by the pressure reduction gravitates to the bottom of the accumulator, where it helps feed the coils in the evaporator. An excess of liquid ammonia circulates in the accumulator and coils, causing the evaporator surface to be "flooded." The vapor formed by the evaporation of ammonia in the coils is separated from the excess liquid in the accumulator *A*. This vapor passes to the compressor through the suction pipe *S*, while the excess liquid drops to the bottom of the accumulator and joins with the fresh liquid from *X*.

Arrangement No. 2 is similar to arrangement No. 1 except that a liquid cooler *LC* is inserted in the body of the accumulator. This cooler utilizes the cooling effect of the vapor in the accumulator itself to reduce the temperature of the high-pressure ammonia liquid before it passes to the expansion valve. This cooling is dependent on the amount of the excess ammonia in circulation. If the feed is not regulated properly there is danger of superheating the suction gas on its way to the compressor.

Arrangement No. 3 is similar to arrangements Nos. 1 and 2. The liquid is fed directly into the coils without cooling. To prevent the vapor "flashing back" up into the accumulator, use is made of a check valve *CV* in the liquid line leading from the bottom of the accumulator. The excess liquid in the accumulator can pass down through the check valve into the coils while circulation in the opposite direction is prevented. This preventive is needed, for with the extra vapor (due to this arrangement) passing through the coils, there is danger of a backing up of liquid into the accumulator.

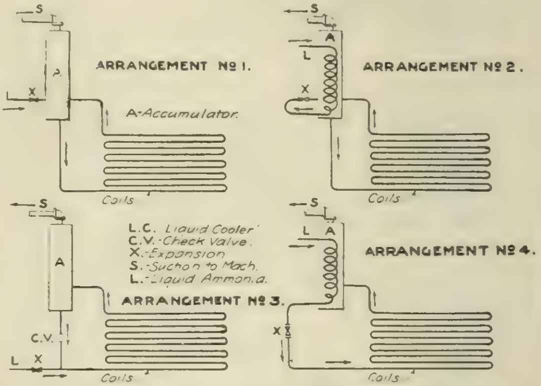


FIG. 2. DIFFERENT ARRANGEMENTS OF THE FLOODED SYSTEM OF FEEDING COOLING COILS

Arrangement No. 4 is different from the others; it really is not a gravity feed system. The liquid cooler *LC* is placed in the separator *A* as in arrangement No. 2, but the expansion valve *X* feeds directly into the coils, which are fed with more liquid than they can evaporate. The excess liquid passes through the coils and collects in the bottom of the separator *A*; there it evaporates and cools the warm high-pressure liquid in the coil of the liquid cooler *LC*. There is danger of superheating the suction gas with this arrangement unless more liquid is fed through the regulating valve than is needed in the evaporator.

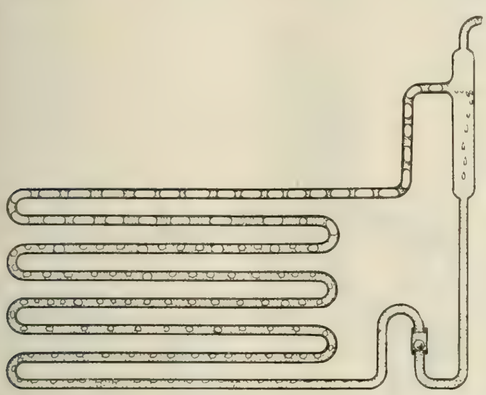


FIG. 3. ACTION OF LIQUID AND VAPOR IN A FLOODED COOLING COIL

From a paper by A. Baer, American Society Refrigerating Engineers, 1907.

Arrangement No. 4 has special application in the main suction line of complicated direct-expansion systems. Because it separates and makes economical use of the excess and otherwise waste liquid coming from the evaporators with the suction vapor, it renders unnecessary the exact opening of the regulating (expansion) valves, cools the high-pressure liquid before it passes to the regulating valves, increases plant capacity and efficiency and protects the compressor from priming.

All these layouts have the same elements of simplicity; namely, high heat transfer and safety. The first three are really gravity feed systems. Arrangements Nos. 1 and 2 are superior to No. 3 in that the coils are not burdened with the useless gas formed at the expansion valve. All of the first three get the benefit of the extra velocity in the coils because of the circulation of both fresh and excess liquid. Arrangement No. 4 has not this benefit, but is more useful than the others in special cases of complicated direct-expansion plants. In No. 1 and No. 3 the disadvantage of superheating the suction gas is eliminated.

Circumferential Cracks in Crankshafts

By John F. Whitney

In a certain power house were two cross-compound engines of about 1,800-kw. generator capacity. The crankshafts of these engines were about 16 ft. long over all, and the greatest diameter was 20 in. at the center, where the 16-ft. flywheel and the armature were secured, 18 in. at the part where the eccentrics were located and 16 in. diameter at the crank ends.

An insurance inspector, while examining the crankshaft of No. 1 engine, observed what appeared to be a minute wavy line, hardly discernible, with small lateral filaments extending outward on each side. He called the attention of the chief engineer to this unusual defect, and a magnifying glass showed a distinct crack with an apparent depth of $\frac{1}{16}$ in. It was decided to request the superintendent to look at the defect. After considerable argument as to whether the defect was a crack, it was decided to dismantle a small lathe used in the engine room, secure the bed of the lathe to the engine base, and take a thin cut about three inches long.

The crack was on the high-pressure side of the shaft, and close to the fillet on the part of the shaft that was 18 in. in diameter, increasing to 20 in. diameter. The edge of the governor wheel extended nearly over the crack, and if the latter was found not to extend any deeper into the shaft, it would be an easy matter to shim the governor pulley, and no harm would be done.

This test method was carried out, and further observation showed that there was unmistakably a serious crack. The inspector suspended the insurance policy applying to this particular engine and demanded that a new crankshaft be provided, which was strenuously objected to by the owners. The chief engineer refused to run the engine, and it was allowed to remain idle for about a month, when the owners decided to act upon representations from a welding company that the shaft could be welded. The welding people were called in, and the inspector was requested to advise with them. It was proposed to cut a slot 3 in. long, 1 in. deep and 1 in. wide on opposite sides of the shaft and to fuse, with the oxyacetylene apparatus, the molten metal into the crack, fill up the slots, and draw-file the shaft.

This seemed to appeal to the owners as an easy way out of the difficulty if the inspector could be prevailed upon to recommend a reinstatement of the insurance on the engine, but the inspector distinctly disapproved of this method of repair on such a shaft and said so. The owner would not put in a new shaft and decided to go ahead with the welding proposition.

Although the engine flywheel weighed about twenty tons and the spider of the generator probably another ten tons, no provision was made to support this weight during the welding and heating operations. Finally, when the work was completed, the crack nicely filed and emery-papered, the engine was given steam and turned over.

The crankshaft was out of true $\frac{1}{8}$ in., causing the flywheel and the generator spider to wobble about half an inch each side from the perpendicular. Conditions were worse than before, and there was no definite assurance that the weld had united the crack. Finally, a new shaft was determined upon, and after it was put in place the engine was pronounced in good condition and is now running satisfactorily.

The old shaft was sent to the shop of the engine builders, where it was proposed to cut it down and use it for a smaller engine. The inspector happened to visit the shop while the old shaft was in the lathe. The deeper the cutting tool went the worse the crack showed up, and the shaft was condemned and was ultimately returned to the company that forged it.

When the interior could be observed, it was seen that the major portion of the center of the shaft had been improperly worked in the puddling and hammer-forging process and the outlines of the scrap material of which the shaft was composed were discernible.

The Busch-Sulzer Two-Cycle Diesel Engine

Although the Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis, Mo., is the oldest designer and builder of four-cycle Diesel engines in this country, the company has recently brought out two-cycle Diesel engines for large stationary and marine work. The company will continue to make the four-cycle engines in sizes up to a maximum limit of 150 b.hp. per cylinder. Above this they will manufacture the new two-cycle engine, which has a number of interesting features, the most prominent being the system of scavenging through double ports in the cylinder wall, and a cylinder head of simplicity and safety.

The engine is of the vertical, four- or six-cylinder single-acting, cross-head type, giving one power stroke per cylinder per revolution of the crankshaft. The injection-air compressor is directly driven from an extension of the main crankshaft, and the scavenging air pump is driven in the same manner. The entire unit is designed for heavy-duty service and is arranged for direct connection or transmission as required. For the same speed and power the weight is about 30 per cent less than that of the four-cycle engines.

The bedplate is built up of sections, with transverse bridges which contain bored seats for the main bearing shells. The crankcase is oil and gas tight, and of the inclosed type, built up in sections. It is bolted to the top of the bedplate and provided with large removable covers. Hinged doors in these covers permit inspection while the engine is running. The crankcase carries the crosshead guides, and the cylinder jackets are bolted directly to its top.

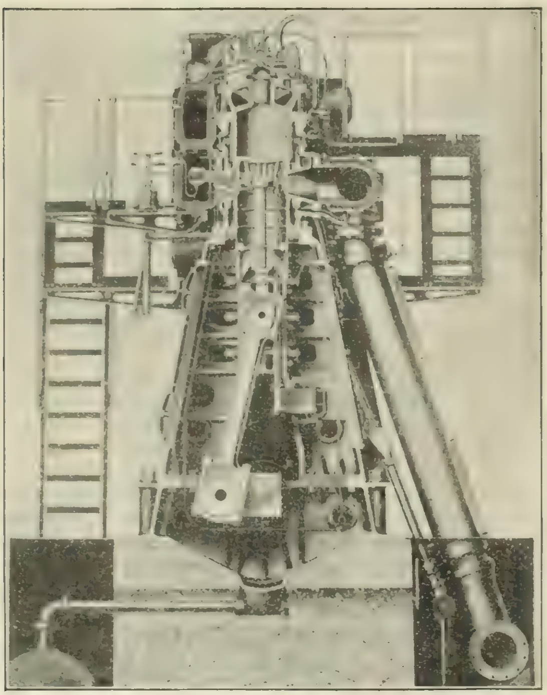


FIG. 1 BUSCH-SULZER TWO CYCLE DIESEL ENGINE

Each working cylinder consists of two main pieces, an outer jacket carrying all axial stresses and a liner which constitutes the running barrel. The lower end of the outer jacket is bolted to the crankcase. The upper end is provided with studs to hold the cylinder head. Both the jacket and the liner are provided with ports for the admission of the scavenging air and the discharge of the exhaust gases. The upper end of the liner seats on a shoulder in the jacket, making a watertight joint. The portion of the liner containing the scavenging and exhaust ports is turned to fit a bored seat in the jacket, and is provided with packing rings to make watertight and gastight joints above and below the ports. The lower end of the liner carries the oil-wiper rings and passes through the bottom flange of the cylinder jacket, where a stuffing box is provided to make a watertight joint between the outside of the liner and the lower end of the cylinder jacket. The entire construction thus allows free expansion of both parts, the space between the liner and the jacket constituting the water jacket for cooling the cylinder.

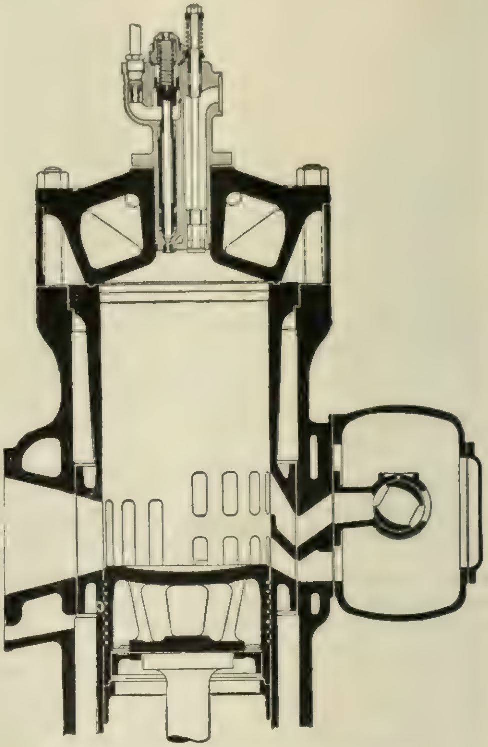


FIG. 2. CROSS-SECTION OF CYLINDER

Reference to Fig. 2 will show that the cylinder head is of simple and symmetrical design, the head containing only one central opening of relatively small diameter to receive the combined fuel valve and starting valve cage. This construction was designed to give freedom from casting and heat stresses and great resistance to all working stresses such as might be set up from high temperatures within the cylinder. On the under side the head is concave, forming in conjunction with the concave top face of the piston, a symmetrical combustion space.

The scavenging air enters and the exhaust gases are discharged through ports in the cylinder wall. In Fig. 2 the exhaust ports are shown at the left of the drawing and the scavenging ports at the right. On the scavenging side of the cylinder there are two tiers of ports. The piston uncovers the upper tier of scavenging ports before, and the lower tier after, it uncovers the exhaust ports, but the communication between the interior of the cylinder and the scavenging air supply or receiver through the upper ports is controlled by a timed rotary valve driven from the vertical shaft of the engine. This rotary valve remains closed until the exhaust ports have been uncovered long enough to reduce the pressure of the gases in the cylinder to nearly atmospheric. At this point the valve is opened while the piston uncovers the lower scavenging ports. In this way a thorough purging is effected with complete safety against a blow-back into the scavenging receiver.

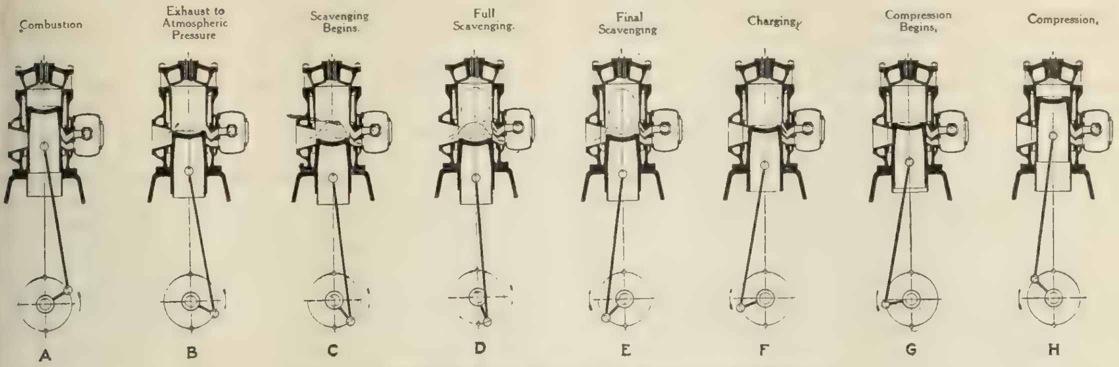


FIG. 3. SCAVENGING ACTION IN TWO-CYCLE ENGINE

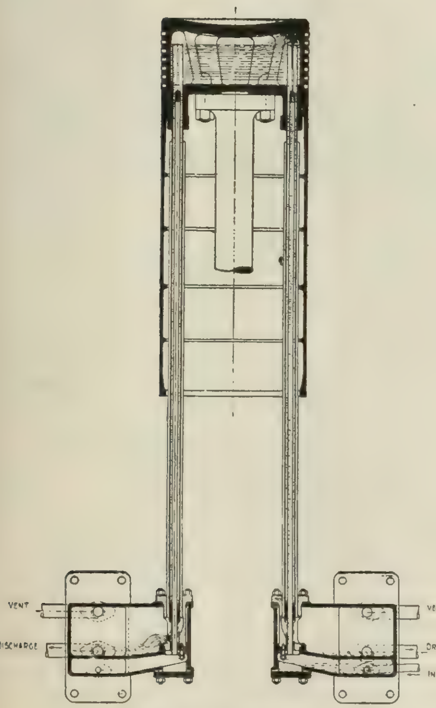


FIG. 4. PISTON

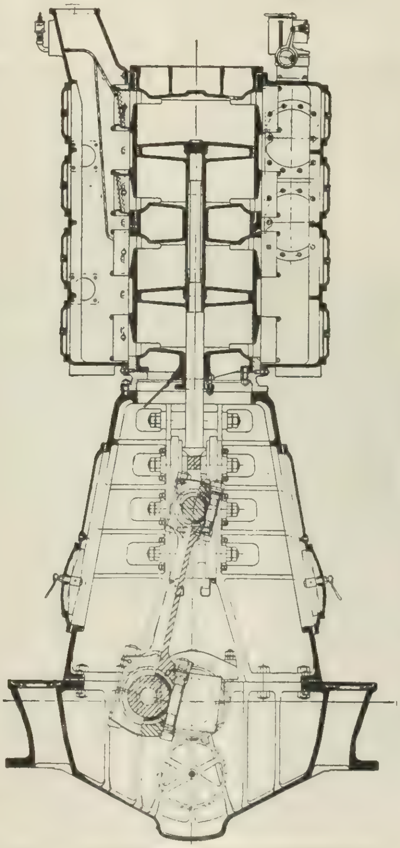


FIG. 5. SCAVENGING AIR COMPRESSOR

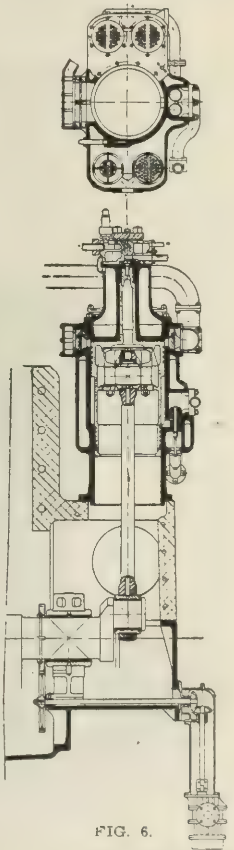


FIG. 6. AIR COMPRESSOR

Upon its return stroke the piston first covers the lower scavenging ports and then the exhaust ports. The upper scavenging ports and the valve remain open, enabling the scavenging air to fill the cylinder at full scavenging pressure before the communication is shut off by the piston. This design provides against the possibility of a blow-back of exhaust gases into the cylinder and, it is claimed, insures a clearing out of such thoroughness that substantially no burnt gases remain in the cylinder, analyses having shown that the residue does not exceed 3 per cent. This arrangement provides a simple means of surcharging the cylinder. Surcharging gives considerably more power capacity to an engine of a given size and is especially desirable in marine installations where the weight per horsepower must be kept at the lowest possible value.

The fuel valve cage, which is located in the center of the cylinder head, Fig. 2, contains both the fuel valve and the air-starting valve. The starting-valve cam is timed to partly relieve the cylinder compression on starting.

Reference to Fig. 3 will show the various stages in a complete cycle of operation in one revolution of the crank.

Extending in front and along the tops of the cylinders, the camshaft carrying the cams for operating the fuel and starting valves is inclosed in a casing. It is driven from the crankshaft at engine speed, through a pair of helical gears at the lower end of the vertical shaft and a pair of bevel gears at the upper end. This drive is located at the flywheel end of the engine and is taken off the main crankshaft on the flywheel side of the first journal, where it is least subject to torsional irregularities. A centrifugal spring-loaded governor regulates the speed by controlling the amount of fuel delivered to the cylinders and the pressure of the injection air. The governor is provided with synchronizing attachments. In addition, an overspeed governor is provided to prevent racing by cutting off the supply of fuel when the speed exceeds a predetermined limit to which the governor is adjusted.

The fuel pump is of the multiple-plunger type operated from the vertical shaft. The amount of fuel delivered is determined by the seating point of the fuel-pump suction valve which is controlled by the governor. The fuel piping is provided with visible overflow valves to free the line from any accumulated air which would interfere with starting.

Fig. 4 will show that the piston proper is short, being just long enough to accommodate the piston rings, as all guiding is performed by the crossheads. It is provided with a water jacket under the upper face. The water is injected into the cooling chamber in the piston head, and conducted away by a system of telescopic tubes arranged so as to avoid the use of stuffing boxes

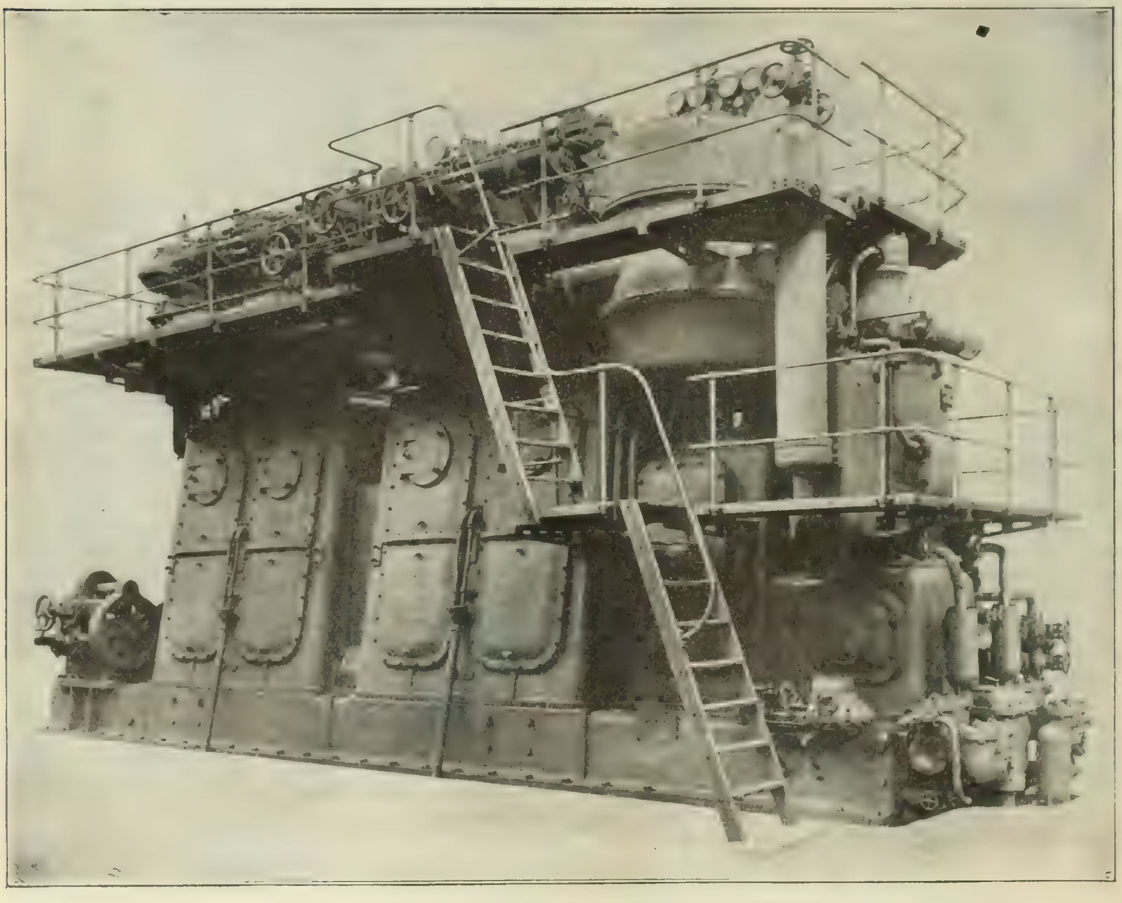


FIG. 7. BUSCH-SULZER TWO-CYCLE MARINE ENGINE

or swing joints, and at the same time preventing oil and water leakage. The injection water tube is inside the discharge water tube. The injection tube has a nozzle end and the discharge tube a restricted throat to give considerable velocity to the flow. There is sufficient overlap to the injection and discharge tubes to insure against leakage. Immediately below the piston is fitted with a skirt, the sole function of which is to cover the scavenging and exhaust ports in the cylinder wall.

For providing low-pressure scavenging and charging air for the working cylinders, a scavenging pump is mounted vertically on the crankcase at the opposite end from the flywheel, next to the forward working cylinder and in line with it. The pump is directly driven from an extension to the main crankshaft and is provided with a crosshead and guide similar to those of the working cylinders. Both suction and discharge valves are of the simple automatic shutter type mounted in cages. These valves are identical in size and design and are interchangeable. The discharge side has a valve chest with connections to the scavenging-air receiver, which in turn provides the connection to the working cylinders. This receiver extends along the front of the engine and is bolted to faces on the cylinder jackets. This provides a support for the valve gears, camshaft bearings and casings.

The air compressor, which provides compressed air for fuel injection and starting, is mounted vertically on the crankcase at the forward end of the engine in line with the working cylinders. It is also driven from an extension to the main crankshaft. The compressor is three-stage, water-jacketed and provided with intercoolers and aftercoolers to keep the air at a low temperature. Each stage of the compressor is protected against excessive pressure by a safety valve. A regulating device is provided to adjust the injection air pressure to suit operating conditions. This is accomplished by varying the opening of the suction damper valve on the low-pressure stage.

Starting of the engine is effected by compressed air from storage tanks charged by the compressor. In stationary engines only two cylinders are fitted with air starting valves, the two cylinders being sufficient to get the engine under way.

General lubrication is effected by a pressure system. After passing through the bearings the oil is collected in the bedplate and flows through a twin filter to a positive displacement pump which forces it through a cooler, from which it is again delivered to the bearings, at a pressure of 10 to 20 lb. A safety valve is provided on the oil pressure pipe and also bypass connections for the regulation of the pressure. All camshaft bearings are provided with oiling rings. The cylinders, including the cylinder of each stage of the compressor, are oiled by a multiple-feed pressure type oil pump. Where necessary, oil c are provided.

Fig. 7 is a view of the marine two-cycle engine.

A Difference in Specific Gravity

BY JOHN S. CARPENTER

"NINETY-FIVE per cent?" Exclaimed the sales manager, screwing up his face. "What do you mean Peterson, the generator efficiency?"

"I mean just what I said, Mr. Williams. The efficiency of the turbines as found by official test is 95 per cent at normal load. But you got some chance making me believe that it's the truth!" The chief erector took a bundle of papers from his pocket and threw them on the desk in a disgusted fashion. He had studied the test figures in the hope that those five pages of closely written figures would give up the secret of the bungle.

Gages had been checked by a gage tester, the head had been verified by a surveyor with a level, water quantities had been figured both by the city's consulting engineers and by the turbine company's men. Calibrated wattmeters were used, and two sets of men made each reading. The results were worked out to four places of decimals, and while nobody doubted the accuracy of the work, all denied the truth of the result.

"Usually," began the sales manager, "we kick because we think we've been short-changed, but here you claim that you've got too much and you don't know what's wrong! But give me the dope and I'll think about it a bit—also a set of drawings for this job."

"All right," replied the erector, "got a pad—three units, 500 hp. each, 30 ft. head, 150 r.p.m., vertical shaft, to run on city sewage plant located on river bank below hill. Bonus at the rate of $500 for each unit on each per cent above 88 per cent; penalty at the same rate for each per cent below 88 per cent efficiency. I'll get you a set of drawings, and you can go to it with my compliments." The chief erector folded up the contract specifications and leaned back in his chair.

"If we can make the city's engineers believe that it's the truth—95 per cent—that's just $10,500 for three units on 7 per cent excess efficiency." The sales manager laughed gleefully at the idea and added: "Say! We'll cut a little melon next dividend time."

The erector snorted as if amused. "You got to get that melon before you can cut it."

"Yes, and I'm going to write the city officials today that you have made your report and that you state that the city's consulting engineers agree fully as to the readings and the result. Is all that true?"

"True enough," declared the erector, "but you ought to have seen them look at me when I told them I would make my report."

"Ten thousand five hundred dollars," said the sales manager slowly, with a dollar's worth of cold cream on every word. "All velvet, too."

"Dream on if you like," teased the erector, "but you may find a few splinters in the velvet before you get through."

"Are the conditions there as good as up at Holyoke—is it really favorable for high efficiency?"

"Yes," the erector assured, "even a trifle better—good draft tube—nice clean tailrace."

The last thing that day the sales manager dictated a carefully throught-out letter to the chief engineer of the city plant, in which he congratulated the city on having such fine turbines, which had broken all previous records. Then he made a brief résumé of the contract terms and at the end of a neatly dotted line stated the sum for which the city was debtor to the company.

In due course of business, which means how the letter from Mr. Williams, sales manager, percolated through a maze of softly cushioned political offices, bound hand and foot with red tape, the letter finally reached the hands of O. Braithewaite Smythe, chief engineer of the municipal power plant. It was not how Chief Engineer Smythe got that position that gave wonderment to those who knew better, but rather how he held on. Brains, he told his confidants, could always be bought cheap, but diplomacy and tact, he declared, commanded super salaries.

In the meantime the city's consulting engineers had just a few words to say. They had never, they cautioned, heard of any such efficiency on so small a unit. Upon reference to records of other tests, no rational justification existed for considering that test to be absolute. There had been an error somewhere and they meant to find it. Until the plant had been retested and the error uncovered, they could not give their approval to the payment of the turbine company's claim. It is not to be wondered, then, that figuring efficiencies became fashionable at the municipal plant.

But with Sales Manager Williams it was different. He could not see the need of another test. The one already made suited him completely, absolutely. Why make another?

Another test was to be made. So there was nothing else to do than to go to it and make it. But the sales manager decided that he would be present this time.

Peterson, the chief erector, had come in from his southern job just in time to join in the festivities. The same consulting engineers were there with two more assistants. The whole party, consisting of the turbine company's men, the consulting engineers and Chief Engineer Smythe, spent a whole afternoon in consultation as to just how they would go ahead. They double-checked every reading and measurement. Every doubtful point was carefully gone over. With their data complete, the calculation of the results was in order.

The sales manager gave his chief erector a vigorous jab in ribs. "I told you so—the final figures are so close to the result of the first test that there's no fun in it!"

The consulting engineers looked at the figures somewhat dazed. The chief engineer puffed vigorously at a cigar that was cold and stale. He had a feeling that it was going to be expensive.

The sales manager, Mr. Williams, bent over and took official note of the results. "The results seem to be identical with the first test. Are you gentlemen agreed as to that?" His tone was very conciliatory.

Nobody fell over himself in the hurry to answer. There could be but one answer. Figures don't lie, they favor nobody. Williams' chest and head seemed to swell perceptibly.

Now Jerry was a very good friend of Smythe. "Will you gentlemen kindly answer me a question?" inquired Jerry, getting all red.

"What is it," asked Smythe.

"How much does a cubic foot of water weigh?"

"Sixty two point three fifty four," answered one of the highbrows.

"Now tell me how much does a cubic foot of sewage weigh?" Practically the same as water—no difference," the sales manager snapped hastily.

They all looked at each other. Pretty soon the tension was so heavy that the sales manager asked all around to have another deal at the cigars.

"Jerry has raised a material point," one of the highbrows cautiously suggested.

"If you fellows are going to split hairs," grumbled the sales manager, "I'm going home."

"Don't be a quitter, Mr. Williams," laughed Smythe, "the game's only begun."

Mr. Williams shut up like a clam; he was stung to the quick. A generous-sized pail was filled with the sewage and then hustled over to a chemist with instructions to find the specific gravity and to furnish a signed certificate.

It must be admitted that Mr. Williams was growing more and more impatient. Various opinions were being rapidly formed in the minds of those present. Jerry, who had evidently started something, was no longer looked on with contempt. It was a mixed feeling of fear and chagrin. The gentle gaze of Mr. Williams had changed from a warm gray-blue to a cold blue-gray.

The chemist came in with a paper and handed it to Mr. Smythe. Smythe arose and cleared his throat. "Gentlemen, the chemist says that the specific gravity of this stuff is just 1.07."

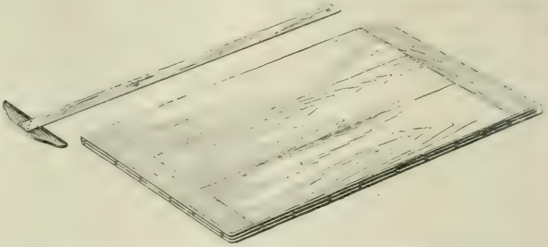
A dozen slide rules moved to the same place. "What's the verdict?" asked Smythe, anxiously.

"The corrected efficiency is 88.78 per cent," replied the spokesman, peering over the tops of his glasses.

True Edges on Drawing Board

By C. Nye

It is a difficult matter to keep the edges of a small detached drawing board true for any considerable length of time, as they frequently become dented and curve toward the courners. Owing to such an experience a brass strip, as illustrated, was applied to a new drawing board with success. No holes were drilled in advance in the edges of the board. Holes were drilled at intervals of several inches in a thin strip of brass or other metal and countersunk to accommodate the heads of small screws.



DRAWING BOARD BOUND WITH BRASS STRIP

Furnace grates should have approximately 50 per cent air space to avoid loss of combustible material into the ashpit. This loss will depend on the kind of fuel used. Study the fuel with this in mind.

Phasing-Out Rotary Converters

A Simple Method of Phasing-Out Rotary Converters Requiring No Other Equipment Than a Number of Lamps and Special Brushes—How To Interpret the Different Fluctuations of the Lamps When Phasing Out and What To Do To Correct the Connections

BY K. A. REED

PROBABLY the most commonly used method of phasing out a rotary converter that has no knife switches in the secondary leads, between the slip rings and transformers, is to bring it up from the alternating-current side with a generator. However, in many cases it is not convenient to divide the power-house and substation busses in such a manner as to secure a feeder that can be used to accommodate the generator and rotary. In such instances it is usually necessary to bring the rotary up from the direct-current side, unless it is equipped with a starting motor. In the absence of knife switches between the machine and the transformers, the question becomes more or less serious in that the phasing out has to be done on the high-tension side of the transformers. This involves connecting potential transformers across the oil-switch terminals. Fig. 1 indicates the usual method of connections used for a test of this kind.

A more simple, as well as much safer, method of phasing out rotaries has been used by the writer, which requires no equipment other than lamp banks and special brushes for the alternating-current rings. In the case of rotaries with copper-leaf brushes for the slip rings, a piece of fiber is cut to fit the alternating-current brush-holder, and is of sufficient length to permit a piece of stiff sheet copper or brass to be riveted into one end so that it will ride on the ring in about the same manner as the leaf brush. A terminal is attached to the metal part of this brush for a lamp-bank lead, as in Fig. 2. Where metal-graphite brushes are used on the alternating-current side of the rotary, a fiber brush is made to fit the box holder, as in Fig. 3. A hole is drilled in the center of this brush for the insertion of a piece of carbon to make contact with the ring. This carbon has a terminal attached for a lamp-bank lead similar to the leaf type of brush.

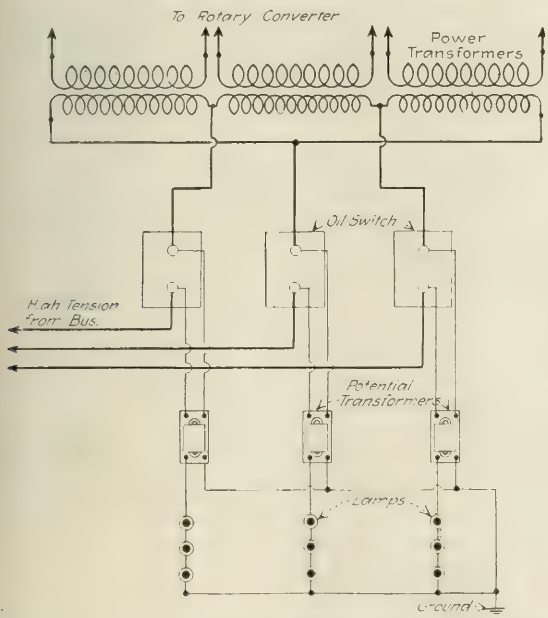
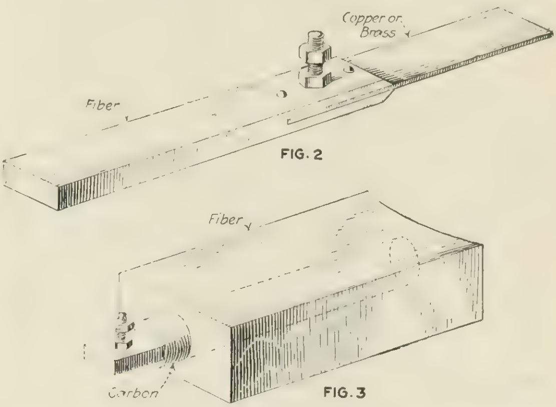


FIG. 1. POTENTIAL-TRANSFORMER AND LAMP CONNECTIONS FOR PHASING-OUT A ROTARY CONVERTER ON THE HIGH-TENSION SIDE OF THE TRANSFORMERS

If the rotary is three-phase, all alternating-current brushes are removed from their holders and the three insulated brushes substituted, one on each of the three rings. As mentioned before, three banks of lamps are provided, one lead from each bank being connected to the terminal on the metal part of the insulated brush on each ring. Leads are run from the three brush-holder stands in which the insulated brushes are placed, to the other terminals of the lamp banks, so that each bank is connected across a slip ring and its corresponding brush-holder stand, as shown in Fig. 4.



FIGS. 2 AND 3. SPECIAL BRUSHES FOR USE IN PHASING-OUT ROTARY CONVERTERS

For a six-phase diametrically connected rotary the connections are shown in Fig. 5. In this case, however, the alternating-current brushes are removed from only one ring, or secondary lead, of each phase, say rings 1, 3 and 5, as shown in the figure. Brushes on rings 2, 4 and 6 are left in their holders to complete the circuit. As a rule, phase rings are 1-4, 2-5 and 3-6, counting the inside ring as No. 1, for rotaries built by one of the leading manufacturers; while the same scheme of numbering, counting the ring nearest the pedestal as No. 1, applies to machines of another company. Care must, of course, be taken to place enough lamps in series in the banks to take care of the maximum voltage to which they may be subjected.

After making connections as outlined, they should be checked carefully to see that they are correct. For a three-phase machine such a check can, obviously, be made by inspection. With a diametrically connected, six-phase rotary, however, the connections between the transformer, or transformers, and the brush-holder stands should also be checked up, to make sure that transformer leads have not been interchanged, especially so if the secondary cables run through duct lines where they cannot be readily followed. This can be done by lifting all the alternating-current brushes and ringing or lighting out between brush-holder stands for rings 1-4, 2-5 and 3-6. The brushes should now be put down, the oil switch on the primary side of the transformers closed and the machine brought up to normal speed from the direct-current side, or by the starting motor. With the speed of the rotary kept at about normal, the lamps may fluctuate in any one of the following four ways:

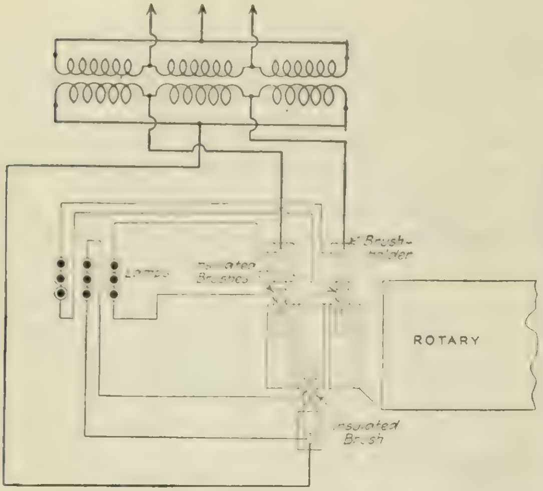


FIG. 4. CONNECTIONS FOR PHASING-OUT THREE-PHASE ROTARY CONVERTERS

(1) All the lamps burn bright or are dark at the same time. Such being the case, no changes are necessary and the rotary is in phase when the lamps are dark.

(2) The fluctuations of two of the lamp circuits are together and the third is exactly opposite. This condition indicates that the secondaries are reversed from one of the transformers, and the leads from the transformers whose lamp bank fluctuates opposite to the other two should be interchanged to correct the fault.

(3) The three lamp-circuit fluctuations follow each other at regular intervals. Such a condition gives an indication of phase rotation reversal. Interchanging any two of the three-phase primary leads to the transformers, or interchanging at the brush-holder stands, the secondary transformer leads connected to 1 and 3, and those connected to 4 and 6 should produce condition (1).

(4) All three lamp banks become bright in rapid succession and then pass through an interval when the lamps are all dim. The indication under this condition is that there is a combination of reversals of (2) and (3). If the leads connected to brush-holder stands 1 and 3 are interchanged, also those connecting to 4 and 6, and the machine started up again, it will be found that condition (2) will prevail. Then if the leads from the transformer whose lamp bank fluctuates opposite to the other two are interchanged, condition (1) will exist; if the transformers have been connected properly to the converter's slip rings.

Should the transformers for the rotary be connected double-delta the phasing out can be done in a similar manner, although it will be necessary to remove the alternating-current brushes from all the rings and use six insulated brushes, one for each ring, and six lamp banks, instead of three as in the previous cases and the fluctuations of the lamp circuits will be somewhat different owing to the fact that there are two separate deltas. Phasing out connections for six-phase double delta transformer secondaries are shown in Fig. 6. As will be noticed from the diagram, the leads from one delta are connected to the rotary terminals for rings 1, 3 and 5, and those from the other delta to rings 2, 4 and 6, and a bank of lamps is connected across each ring and its brush-holder stand. Before connecting up the lamp banks, however, the connections to the power transformers should be checked by ringing or lighting out, and this test should show that leads to brush-holder stands for rings 1, 3 and 5 are electrically connected, as well as those to stands for rings 2, 4 and 6; but that there is no connection between 1, 3, 5, and 2, 4, 6.

The rotary should now be brought up to about normal speed, in a manner similar to that described for a six-phase diametrically connected machine, and the fluctuations of the lamps noted.

(1) If the lamps are all dark and bright together, it indicates that the connections are correct and the machine is in phase when the lamps are dark.

(2) All the lamps connected to one delta fluctuate together, while those of the other delta follow each other at regular intervals; the fluctuations of one lamp circuit of the latter, however, occurring at the same time as those of the former. In other words, the three groups of lamps connecting to one delta and one group on the other delta fluctuate together, while the other two groups fluctuate in succession. To correct this condition, the transformer leads corresponding to the two lamp groups that fluctuate at intervals should be interchanged. As an example, if the lamp banks connected to rings 1, 3, 5, and 6 fluctuate together, the leads to rings 2 and 4 should be interchanged.

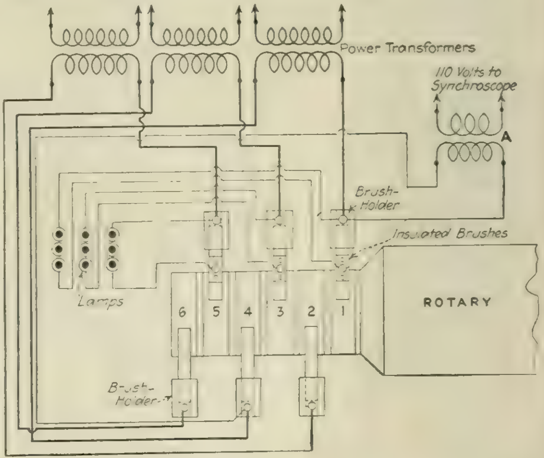


FIG. 5. CONNECTIONS FOR PHASING-OUT A SIX-PHASE DIAMETRICALLY CONNECTED ROTARY

(3) The lamps in each delta all follow each other regularly in their fluctuations, and each circuit of one delta becomes bright with a corresponding circuit of the other delta; that is, the fluctuations occur in pairs. Any two circuits, one in each delta, in which the fluctuations occur together can be selected as being correct, and the other two leads of each delta should be interchanged. For example, if the lamp banks connected to rings 1 and 6 fluctuate together, leads 3 and 5, and leads 2 and 4 should be interchanged. Interchanging any two of the three-phase primary leads to the power transformers when this condition exists will also correct the trouble. If the fluctuations of the lamps are different from those described, the phase connections should again be carefully traced out or the polarity of the transformers checked.

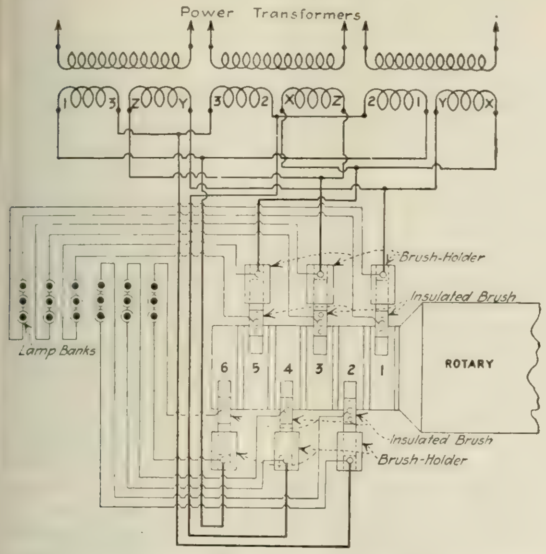


FIG. 6. CONNECTIONS FOR PHASING-OUT A SIX-PHASE DOUBLE-DELTA CONNECTED ROTARY

As a general rule synchronizing connections for the rotary are taken from the slip rings by means of a potential transformer whose secondary delivers 110 volts. The primary of this transformer is usually connected to the brush-holder stands, since that is the most accessible and convenient point. The phases across which the primary of this transformer is connected, of course, must correspond to the phases on the high-tension bus across which the bus synchronizing transformer is connected. The synchroscope-transformer connections to the rotary are shown at *A* Fig. 5. It will be noted that by removing the primary lead from the brush-holder stand for ring No. 1 and temporarily connecting it to the terminal of the insulated brush on this ring, the synchronoscope will still be connected across rings 1 and 4. Therefore, the rotation of the synchronoscope, position of the pointer when the machine is in synchronism as indicated by the lamps, etc., can be checked while the rotary is being phased out.

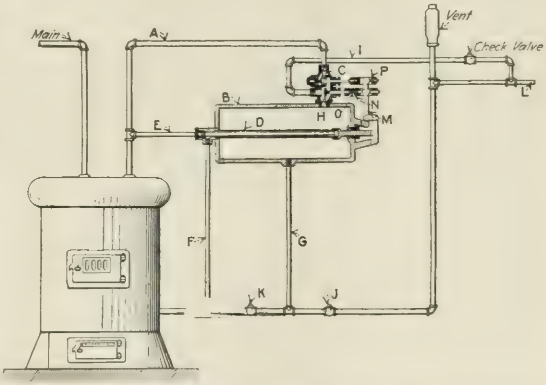
This method of phasing out has advantages over starting up a rotary from a generator, aside from eliminating the inconvenience of sectionalizing high-tension busses in the power house and substation, starting up a separate machine, etc., in that when incorrect connections exist their nature is disclosed at once by the fluctuations of the lamps, and the remedy is obvious. On the other hand, if the rotary is out of phase when starting from the power-house generator, it is more or less a "cut and try" proposition to locate and correct the wrong connections.

Kelly Thermo Return Controller

A device especially designed to return water to the boiler against any back pressure and keep the return lines dry has been perfected by the Kelly Controller Co., 175 West Jackson Boulevard, Chicago. It differs from the ordinary return trap in that it is thermostatically controlled, the operating mechanism being visible and accessible. The illustration shows the system applied to a low-pressure house-heating boiler. A steam line *A* from the boiler connects with the controller chamber *B* through a valve *C* and with the thermostat *D* through pipe *E*. The return to the boiler from the thermostat is through pipe *F*.

Return water flows to the controller chamber through pipe line *G* and is vented through the valve *H* and the pipe *I*. Check valves *J* and *K* prevent a back flow of water from the boiler.

In the sectional view, the return controller is in its normal position, with the thermostat *D* expanded by heat. When the return water has accumulated in sufficient quantity to cover the thermostat in the chamber *B*, the differential in temperature between the return water and the steam causes the thermostat to contract, thereby closing the valve *H* and opening the valve *C*. This action permits steam at boiler pressure to enter *B* and thus allows the water to return to the boiler by gravity. As soon as the water recedes, the thermostat expands to its normal position, closing the valve *C* and opening the valve *H*, thereby allowing the pressure in *B* and in the return line *L* to equalize and the water to collect as before in the controller chamber.



CONNECTIONS OF THE THERMO RETURN CONTROLLER

Contraction of the thermostat *D* causes the lever *M* to move against the plunger *N*, closing the valve *H* while the spring *P* holds the valve *C* closed. Further movement of the lever opens the valve *C* and compresses the spring *O*. As the thermostat returns to its normal position, the lever closes the valve *C*, while the spring *O* holds the valve *H* closed. The final movement of the lever opens the valve *H* and compresses the spring *P*. It is thus apparent that the valves *C* and *H* are never open at the same time.

CO_2 Exploration To Detect Air Leakage

By A. E. GRUNERT

Air leakage through boiler settings is a factor increasing in importance with the size of the boiler. With the larger boilers the old orthodox methods of CO_2 sampling will not suffice if correct diagnoses are desired. A method of exploration for detecting air leakage and giving the CO_2 conditions throughout the setting is presented. Its use in cases cited so reduced air infiltration that final over-all efficiencies of 81 to 83 per cent were obtained.

RECENT experiments and investigations by one of the largest utility companies of the country, on boilers and economizers of large capacity, have shown that the question of air leakage and infiltration is an important factor. This is primarily because the large heating surface involved means larger and more complicated casings, increased mean gas travel with the leakage possibilities increasing in proportion, and more complicated furnace and setting designs requiring many sealed joints. There is probably no heat loss less understood or more ignored in the average boiler room than that of air leakage and infiltration. In most cases about the only check made on boiler-setting conditions is periodic CO_2 observations on the escaping gases. If the usual conditions are indicated, in many cases no further interest is taken and as a result the engineer is no wiser than he was before as to the reducible heat loss incidental to air leakage. Again, in the use of a boiler heat balance based on test or observed data, the various losses are shown under such general headings that the separation of the possible reducible losses from those more or less fixed cannot be accurately or intelligently made without additional data. For instance, the loss due to stack gases is generally considered as a total quantity. This loss can be considered as the sum of three components: (1) The loss due to gases resulting from the theoretical combustion of the fuel, which cannot be reduced; (2) the loss due to excess air drawn through the fuel bed, which is only partly reducible within limits; and (3) the loss due to that part of the total excess air due to leakage and infiltration, which is almost entirely reducible and is here considered.

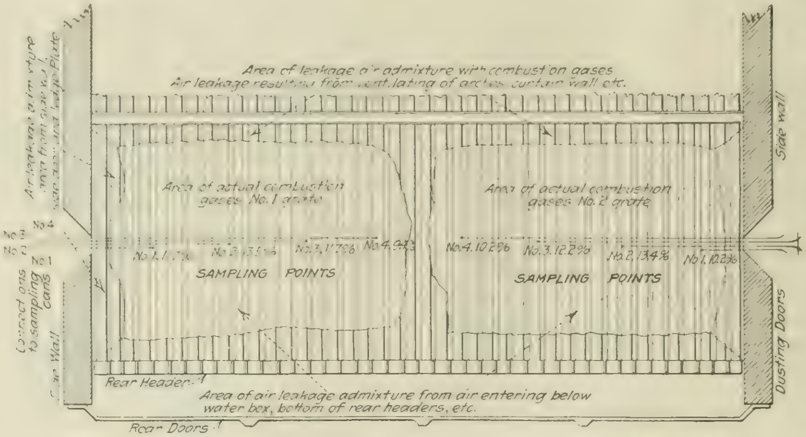

Area of leakage air admixture with combustion gases
Air leakage resulting from ventilating of arches curtain wall etc.
Air leakage air admixture and from side wall and leakage plate
Side wall
Area of actual combustion gases No. 1 grate
Area of actual combustion gases No. 2 grate
No. 4
No. 3
No. 2
No. 1
No. 1, 11.7%
No. 2, 13.5%
No. 3, 11.7%
No. 4, 9.4%
No. 4, 10.2%
No. 3, 12.2%
No. 2, 13.4%
No. 1, 10.2%
SAMPLING POINTS
SAMPLING POINTS
Connections to sampling cans
Wall
Dusting Doors
Rear Header
Area of air leakage admixture from air entering below water box, bottom of rear headers, etc.
Rear Doors

FIG. 1. PLAN OF FIRST BOILER PASS SHOWING NORMAL AND LEAN AREAS AND POSITIONS

Of this determination the principle is on the basis of the air dilution of the actual gases of combustion with additional air, as indicated by the reduction in the mean CO_2 percentage. By actual gases of combustion is meant only that portion that results from the air actually drawn through the fuel bed. The difference between the mean CO_2 of this portion of the flue gas and the mean CO_2 of the total escaping gases determines the amount of air dilution, with the actual combustion gases, that enters the setting in the form of leakage and infiltration.

The problem, then, resolves itself into some method of obtaining the mean CO_2 of these two conditions. In practice the actual determinations cannot be made a matter of precision measurement, but as the possible errors are present in both cases in practically the same degree, the results considered relatively are an accurate indication of the heat loss under consideration. That portion of the total stack loss is in this manner separated from the remainder, and as a consequence the engineer has something tangible to go by in improving his conditions. In Fig. 2 is shown a plan of the first pass of the boiler at the second row of tubes. The installation under consideration is a water-tube, cross-drum three-pass type boiler having 14,403 sq.ft. of heating surface. Each boiler is equipped with two chain-grate stokers having a combined grate area of 332 sq.ft. An economizer having 9,218 sq.ft. of heating surface is a part of the boiler installation. Exhaustive exploration sampling showed that the admixture of furnace leakage air affected the composition of the actual combustion gases in certain more or less definite areas in the first pass.

These areas are indicated on the sketch by the shading. The remaining portion is area traversed by the actual combustion gases, which at that point of the setting are undiluted with the leakage air, the distance thus far traversed being too limited for a uniform admixture. It is evident, then that if a number of simultaneous samples are drawn over a suitable length of time from this undiluted area, the composite CO_2 of the actual combustion gases can be obtained. The relative positions of the sampling tanks are shown on the chart.

As the gases travel through the boiler passes, their composition becomes more uniform, except for such lanes as are effected by additional leakage air. The mixing action of the converging uptake results in a fairly uniform mixture of the total gases at the neck of the uptake. Simultaneously with those on the first pass, gas samples from four points are drawn at this place. In passing through the economizer, the gases become still more uniformly mixed and at the economizer exit are practically uniform.

Fig. 1 is a diagrammatical representation of the first pass, the smallest section of the uptake and the economizer exit. The curves shown indicate the variation of CO_2 across each area as designated. These curves shown were obtained by a series of tests on a number of boilers operating under steady steaming conditions at the capacities ordinarily obtained. The gas samples were all drawn simultaneously on each test by means of apparatus described later. The CO_2 curves have a general fixed character, the composite of which are those shown.

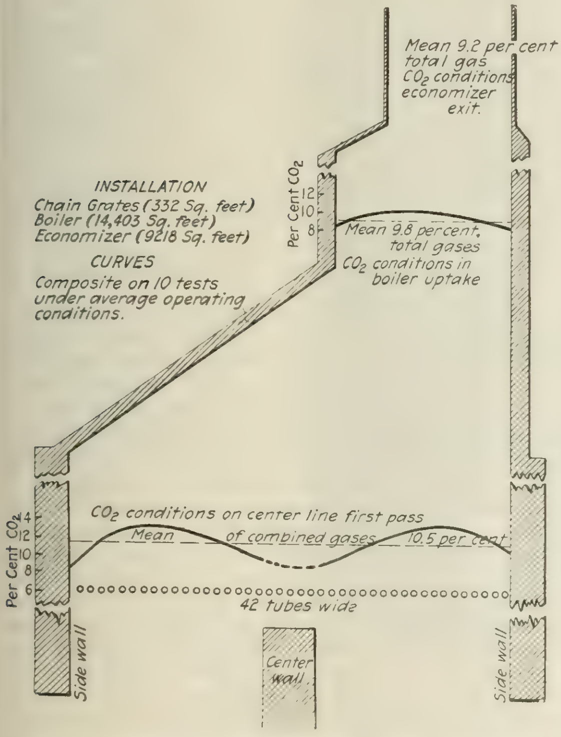

Mean 9.2 per cent total gas CO₂ conditions economizer exit.
INSTALLATION
Chain Grates (332 Sq. feet)
Boiler (14,403 Sq. feet)
Economizer (9218 Sq. feet)
CURVES
Composite on 10 tests under average operating conditions.
Per Cent CO₂
12
10
8
Mean 9.8 percent total gases CO₂ conditions in boiler uptake
CO₂ conditions on center line first pass
Mean of combined gases 10.5 per cent
Per Cent CO₂
14
12
10
8
6
42 tubes wide
Side wall
Center wall
Side wall

FIG. 2. GRAPHICAL REPRESENTATION OF AVERAGE CO_2 CONDITIONS FROM FURNACE TO ECONOMIZER EXIT

Having established these curves, the mean CO_2 is then readily obtained. The following table represents the air-leakage conditions of the boilers under consideration:

Mean CO_2 actual combustion gases, per cent	10.5
Gas per pound of coal, actual combustion gases, lb	11.6
Mean CO_2 total gas in uptake, per cent	9.8
Gas per pound of coal, total gas in uptake, lb	12.3
Air leakage per pound of coal for boiler, lb	0.7
Mean CO_2 total gas at economizer exit, per cent	9.2
Gas per pound of coal at economizer exit, lb	13.0
Air leakage per pound of coal for economizer, lb	0.7
Total over-all air leakage per pound of coal, lb	1.4
Thermal loss due to air leakage, per cent	1.37

These figures are representative of as good conditions as can ordinarily be obtained. Unusual precautions were taken to make the settings tight and minimize air leakage.

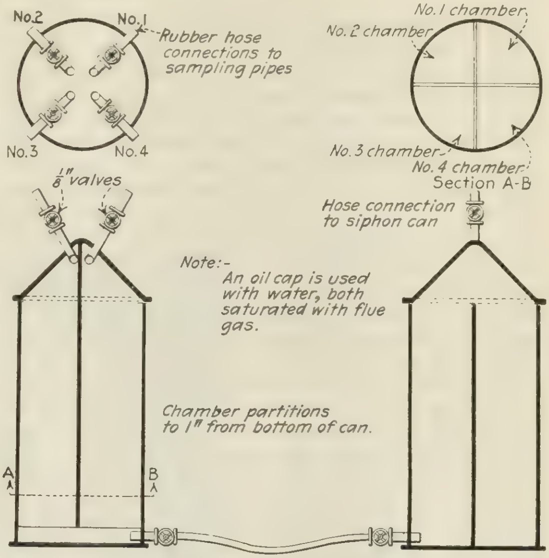

No.2
No.1
Rubber hose connections to sampling pipes
No.3
No.4
1/8" valves
No. 1 chamber
No. 2 chamber
No. 3 chamber
No. 4 chamber
Section A-B
Hose connection to siphon can
Note:- An oil cap is used with water, both saturated with flue gas.
Chamber partitions to 1" from bottom of can.
A
B

FIG. 3. QUARTERED SAMPLING CAN AND SIPHON FOR DRAWING SIMULTANEOUS FLUE-GAS SAMPLES

A reliable and practical method of determining air leakage of boiler settings and economizers furnishes the engineer with tangible data that will indicate correctly the condition of the apparatus. The usual practice of sticking a single open-end sampling pipe in the flue and drawing a few samples of gas for CO_2 determination is alone not much of an indication of the probable thermal loss resulting from air leakage. That a fairly high CO_2 can be obtained in this manner does not necessarily mean that there does not exist in spite of this a preventable faulty condition.

A leakage determination as it was applied to a certain particular boiler may illustrate more fully how deceptive the single sampling method may be. On evaporative tests this boiler showed lower efficiencies than expected. A series of leakage determinations were made to establish the true condition of the boiler setting. By means of exploration sampling, the sources of leakage were located. The whole setting was thoroughly overhauled and every possible precaution taken to reduce air leakage to a minimum. Subsequent air-leakage checks were then made to determine the degree of improvement. The following table indicates the conditions before and after overhauling:

	Before	After
Mean CO_2 actual combustion gases, per cent	11.9	10.7
Mean CO_2 total gases in uptake, per cent	6.2	10.1
Mean CO_2 total gases in economizer uptake, per cent	5.9	10.0
Pound of gas per pound of coal, actual combustion gases, lb	10.3	11.4
Pound of gas per pound of coal, total gases uptake, lb.	19.0	11.9
Pound of gas per pound of coal, total gases at economizer exit, lb	20.0	12.1
Total leakage over-all per pound coal, lb	9.7	0.7
Over-all thermal loss due to leakage, per cent	4.47	0.35

It will be noticed that the composite CO_2 of the uptake gases before overhauling was 6.2 per cent. It was possible during this time to draw samples from the center of the flue showing a CO_2 of 9 to 10 per cent, which, if it had been considered alone, would have been quite deceptive and misleading in sizing up the condition of the boiler. After the air leakage had been reduced to an almost negligible minimum, the composition of the gases in the uptake became more uniform. The lower CO_2 of the combustion gases after overhauling was due to inferior coal conditions. On the basis of these observations the reduction in the thermal loss due to air leakage is seen to be over 4 per cent. This corresponding increase in efficiency was subsequently actually verified by evaporative boiler tests.

Fig. 3 shows in detail one set of sampling cans for drawing simultaneous samples from four different points. For boiler settings of the size under consideration it is advisable to use two sets for the first pass, one set for the uptake and a hand Orsat at the economizer exit. The aspiration of the gas into the four separate chambers of the gas can permits of separate analyses afterward. This obviously eliminates the errors of a perforated pipe. A few precautions are necessary in the use of this apparatus. The air in the sampling pipe should be exhausted before drawing, preferably by means of a rubber-bulb pump before connecting the hose to the can nipples. The water used should be saturated with flue gas to prevent errors caused by CO_2 absorption in the containers. A saturated oil cap on the water has proved quite satisfactory. After the samples have been drawn, a slight pressure is put on the gas can by raising the water can. This not only permits of easy scavenging of the Orsat apparatus, but if there are slight valve leaks the sample will leak out instead of air leaking in. Otherwise the use of this apparatus is similar to that of any aspirating outfit.

KEEP CAPACITY STEADY WHILE SAMPLING

In making leakage determinations, it is advisable to operate the boiler at some fixed capacity. The quantity of air entering through the boiler setting is within certain limitations a fixed quantity. Consequently, this same quantity of air means a higher percentage at low capacity and a smaller percentage at high capacity.

Locating air leaks is not always an easy matter. It is frequently necessary to resort to some complete exploration method to determine the areas of lean mixture, and from these the source of leakage usually will be found near-by. A great many of the recent large boiler installations have been steel incased. This seems to be good practice as far as it goes, but alone it will not prevent excessive leakage. Steel casings should not be a camouflage for improper design and workmanship on the inside. The original design should be such that the tightness of the setting will not depend wholly on the casing. A straight "brick to iron" joint is seldom tight or, if it is, will not long remain so. The construction should be such that a seal at all joints is provided for expansion and contraction. At points where the heat is not excessive, close-fitting sheet-iron seals will suffice. Such cases are the joints at the top and bottom of the tube headers. Generally speaking, the design of the boiler setting should be such that it would be possible to remove the casing entirely and still have little air leakage.

There are innumerable places where air can enter in behind the casing sheets, and unless provision is made to stop it, the conditions indicated in the previous table (before overhauling) will usually obtain. Efforts toward the prevention of air leakage in this manner form a profitable investment in several large installations. The gain in steaming efficiency has been established by evaporation tests, the final over-all efficiencies obtained being from 81 to 83 per cent.

Some engineers are inclined to do too much theorizing in interpreting CO_2 analyses. Unless the circumstances under which the sampling is done are known, wild and erroneous conclusions are to be expected. In the larger steam-generating units now being operated, the old orthodox methods will not suffice if correct diagnoses are desired. The foregoing is therefore offered as a method whereby boiler operation can be improved in this respect.

A Pioneer Diesel Engine

To purchasers of Diesel engines the paramount question is that of the probable life of the machine. Many engineers, recalling the long life of the Corliss steam engine, have ventured to apply an amortization charge of less than 5 per cent; others, of a more cautious nature, have placed this charge at 20 per cent. It is evident that the proper value lies somewhere between these extremes. Unfortunately, it is impossible to cite examples of Diesels in operation for more than fifteen years. The history of the Diesel engine in America dates from 1900; from this date to about 1905-1906 there were many of the American Diesel Engine Co.'s units installed. Most of these engines were discarded owing either to faulty workmanship in the engine or to unskilled attendants, the principal fault seemingly being due to the splash system of lubrication. Occasionally, one of these old engines is encountered, plugging along, carrying a fair load with little or no trouble.

The Fulton Foundry and Machine Co., Brooklyn, has a 75-hp. American Diesel, installed in 1905, which is still in service. The early history of this installation was not particularly a happy one. Like many others, the purchasers found that the splash lubricating system was productive of much trouble. The oil gummed the piston rings with the consequent cylinder wear; the carbon from the interior of the pistons settled in the crankshaft bearings, causing the damaging of the shaft. After several years of discouraging experiences, the owners installed a pressure-feed lubrication system. The shaft was drilled with diagonal passages to the crankpins, and oil lines were run to the bottom of each main bearing. The connecting rods were also drilled, the oil for the piston pins being supplied from the crankpins. A filter was installed on the drain line from the crankcase. A pump that is geared to the engine shaft maintains a pressure of 30 lb. on the inlet lines.

The owners state that there has been no perceptible cylinder wear during the last five years. No new rings, valves or bearings have been required. The crankshaft bearings and crankpin bearings are taken up about every six months. The engine runs ten hours a day, carrying 40 hp. The fuel consumption averages 30 gallons per day. The lubricating oil added to the system never exceeds one gallon per day. The engine to all appearances is in excellent condition, and it should give fifteen more years of service. The fuel consumption is a little high for a Diesel, but in view of the crudeness of design possessed by these early engines, better economy can hardly be expected under such low load conditions.

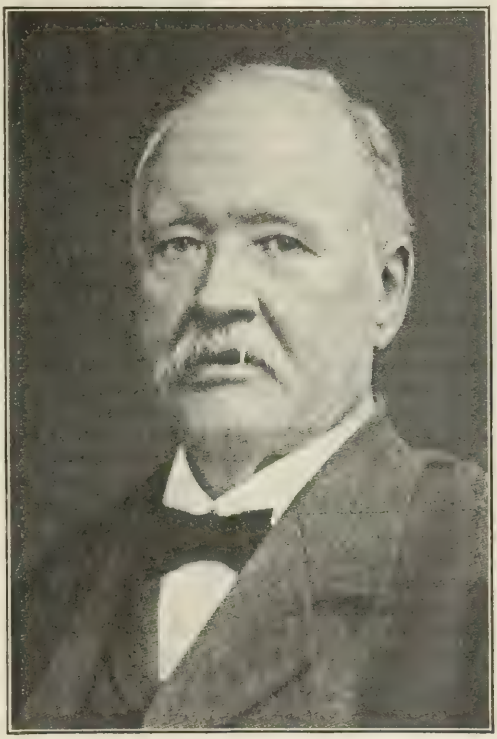
The World's Energy Supply

The author, Svante Arrhenius, eminent Swedish Scientist of the Nobel Institute, Stockholm, presented a paper of which the following is an abstract, to the Franklin Institute when that institution recently presented him with the Franklin Medal.

SINCE the days of Watt the physical well-being of mankind has become more and more dependent on fossil fuels. The life of today would be impossible without the enormous supply of coal necessary to industrial establishments, for railways and steamships, in the metallurgical arts and for the heating and lighting of houses. The demand for fossil coal has increased rapidly, about doubling every ten years during the last century, and is now some 1,200 millions of metric tons per year. It is clear to those who have studied the subject that our coal fields will be exhausted after a certain time. When this calamity will happen, and the probability of the discovery of substitute sources of energy, are questions of vital importance.

One of these questions was answered by the Geological Congress in Canada in 1913. The quantity of fossil coal down to a depth of 1,800 meters would suffice for 6,000 years at the present rate of consumption, if it were all recoverable; but a great deal of this coal occurs in beds too thin for profitable working, a considerable part is lost as dust or left in the mines as pillars, and further, the consumption of coal will probably increase in the future just as it has in the past. It is therefore necessary to reduce the indicated time considerably, probably to one-fourth, or about 1,500 years. Of the different countries the United States, in the matter of coal, has the best position as it has in the matter of other natural resources. The coal treasures there will probably suffice for about two thousand years. The worst situation among the great coal-producing countries is that of England, where the coals will be exhausted within a little less than two hundred years. Germany will be able to meet its demands during a little more than a thousand years.

This period of some few hundreds or thousands of years is short compared with the time estimate made at the Geological Congress referred to, and only about one per cent of the period of man's existence, which probably lies between the thousandth and ten-thousandth part of the time during which life has existed on our earth. It is quite clear that we must soon ration our coal and substitute as far as possible for fossil fuel other sources of energy. The world's yearly production of mineral oils repesents not quite 3 per cent of the energy contained in the yearly production of coal. Petroleum ought, therefore, to be reserved for better purposes; for example, the production of light and lubricants. Furthermore, the recent failure of many oil fields indicates that we must economize this valuable material in view of increased consumption. Still much less is the hope that sources of natural gas may deliver more than a small fraction of the fuel value of the oil fields. Even peat, although an important fuel, can by no means compete with coal. Thus, for instance, in the United States the available peat is less than one-half of one per cent of the estimated coal. Probably the relative value of the European peat bogs is about the same as compared with the European coal fields.


SVANTE ARRHENIUS

It is often said that for coal should be substituted water power. According to an estimate of Engler, the energy which might be economically taken from waterfalls amounts to about 60 per cent of the energy of the present output of coal. But even this figure seems too high, for many of the waterfalls are located in inaccessible parts of the world, where no industry is likely to be developed for a long time. So it seems wise to reduce the figure of Engler about 50 per cent. If this is done, it is evident that there is little hope that white coal will be able to substitute for black, except in a small degree. For heating purposes water power will probably not be used, because used directly for the production of mechanical or electrical energy it is at least three times as valuable as the equivalent quantity of heat. Further, the well-situated waterfalls are already developed in greatest part, at least, in Europe. Thus, for instance, in Switzerland nearly all the waterfalls that have a commercial value are developed, and in a little less degree the same is true in all the other industrial countries of Europe.

During the unhappy situation created by the World War, when there was a great scarcity of fuel, and even now, when fuel is extremely expensive, waterfalls were and rapidly are being put to use. Within a short time, therefore, this source of energy will be taken into the service of man, not sensibly diminishing the demand for coal. An estimate of the power of the waterfalls has been made by Kroehn and by Kaplan and is of much interest. Although the figures are only approximate, I give them here, with some later corrections. The power is given in millions of horsepower and horsepower per inhabitant.

THE WORLD'S ENERGY IN WATERPOWER

Continent	Horsepower in Millions		Horsepower per Inhabitant
Asia	236		0.27
Africa	160		1.14
North America	160		1.17
South America	94		5.25
Europe	65		0.13
Australia	30		3.75
Total	745	Average	0.45

Country	Horsepower in Millions	Horsepower per Inhabitant
Canada	26	4
United States	100	1
Iceland	2	22
Norway	13	5.2
Sweden	6.7	1.2
Finland	2.6	0.8
Balkan countries	10	0.6
Switzerland	1.5	0.4
Spain	5.2	0.26
Italy	5.5	0.15
France	6.0	0.15
Austria-Hungary	6.2	0.12
Germany	1.43	0.02
Great Britain	1.0	0.02
Russia	3.0	0.02

These figures are not reliable. Thus Leighton gives for the United States 200 millions, and van Hise says: "Others regard this estimate as too high, and say 100 million horsepower is nearer to truth." I think this latter figure is more to be depended on. Van Hise is of the opinion that even it will meet the needs of a population of 250,000,000. Since his estimate made in 1910, the demands for power have greatly increased, and probably only about one-half of the energy given in the table is available at present without excessive initial expenditures. We may, therefore, assume 0.5 hp. per inhabitant as adequate to present needs. In Asia the demand is still so small that even this power per inhabitant is more than sufficient. Especially fortunate are those countries, such as South American republics and Australia, where water power per unit of population is well beyond this figure and may be developed at a moderate cost. The United States is among the great powers well endowed in this regard, as in most other natural sources of wealth, such as metal, ores and coal.

ICELAND FIRST IN WATER POWER IN EUROPE

In Europe, Iceland ranks first in water power, because of its small population, and the old Saga Island may yet know a new and flourishing era. Then come the Scandinavian countries, the first being Norway, which has already greatly profited through its cheap power and is destined to be one of the leading industrial countries of the future. Sweden and Finland possess enough power for their needs. Their waterfalls are not high, and in general are far from established lines of communication, especially from those of the ocean. Denmark has scarcely any water power, as also Holland. Among the other countries of Europe the Balkan States have more power than their industrial needs require. Switzerland may also be regarded as having a nearly sufficient supply of water power, which is the more fortunate, as this highly industrial country does not own any coal deposits. The same is true of the new Austria, which has lost its old coal districts, but has retained by far the greater part of the waterfalls of old Austria, so that it now probably ranks with Switzerland in this respect. Spain is also a relatively well-situated state, but up to the present it has not made much use of its resources. In general, the waterfalls in the Alps, Spain, Italy and the Balkans are high and of great value. For the industries of France and Italy water power is of the greatest importance, although it must be regarded as insufficient for nations so highly developed. At the end of the list come the three great powers of Great Britain, Germany and Russia, with only a fiftieth horsepower per inhabitant. Russia is an agricultural country, with a small demand for power, and agriculture will probably remain its chief industry because of its small power resources, both in coal and water. England and Germany, now the most highly developed industrial countries in the world, will undoubtedly also in the future have agriculture for their chief industry. Probably a great part of these countries will again be covered by forests, as they were in the time of Tacitus.

POWER OF THE TIDE

It is often asserted that the power of tidal waves should be utilized. Of course this is possible, but doing so on a large scale would involve an initial investment not justified by prices likely ever to be obtained for power. The energy of the tidal wave is so widely distributed along the shores of the oceans that it is impossible to commercially collect a sensible part of it. It is quite in contrast to the energy of fossil fuel and waterfalls.

SOLAR ENERGY

All available energy on the earth has its origin in solar radiation. Of this energy a small part, 0.12 per cent, is accumulated in vegetation, which, however, is great as compared with the energy of the coal burned in the industries. A detailed calculation made by Professor Schroeder, of Kiel, shows that about 22 times as much energy is yearly accumulated in plants as is represented by the coal consumed in the same time. Of this energy in vegetation 67 per cent is taken up by the forests, 24 per cent in cultivated plants, 7 per cent in the grass of the steppes and 2 per cent on desert lands.

The energy collected by forests may be used for heating purposes and exceeds every year that of the coals burnt by about 14 times. But, unhappily, the greater part of this energy is collected in tropical areas, and the highly cultivated countries are so nearly deforested that their production of wood is not nearly sufficient as fuel for their industries. Further, the wood produced in civilized countries is needed for the production of paper, pulp and lumber. In forest lands the refuse from the woods may be sufficient for domestic purposes, and during the war even the industrial needs of certain countries for combustibles were met by wood, where the importation of coal was hindered by the blockade. The costs, however, were very high, due to the expensive transport from the forests to the industrial centers. The transport of wood from the immense forests in the tropics to industrial countries seems impossible on economic grounds. The forest lands possess, therefore, an advantageous position in this regard. Before other industrialized countries will be able to substitute wood for coal, an economic solution of the transportation problem is necessary, which at present seems fraught with exceedingly great difficulties.

The other sources of energy, greatly dispersed in form, remain to be considered—those of the winds and of sunshine. They are extremely great and exceed that of simultaneously burnt coal from 5,000 to 70,000 times respectively. The energy of the winds is taken up by windmills, which have been in use in Europe since the eleventh century. The great objection to wind as a source of power is its variability and the high installation costs per unit of power continuously deliverable. It has been proposed to store the energy of the wind by means of accumulators, charged from windmills, and to use these accumulators during times of calm. But even in windy countries, such as Denmark, this method is extremely uneconomical as compared with coal or wood at their present prices. Windmills are widely used for pumping water, both in the New and the Old World.

Solar Engines to Renew Civilization on Ancient Sites

The radiation of the sun may be concentrated by means of mirrors on a boiler, and this in turn connected to a steam engine. The best-known of these solar engines was constructed by John Ericsson, and described in *Nature* in 1888. It was an improvement of an earlier machine constructed in 1860. In his experiments in New York John Ericsson obtained an effect of one horsepower with a mirror of ten square meters (15,500 sq.in.) opening. Later, his experiments were taken up on a commercial scale by Shuman, of Philadelphia, who installed a solar engine, with mirror of 1,200 square meters (12,915.6 sq.ft.) in all, at Meads, ten kilometers south of Cairo, in Egypt. The machine was of the Ericsson type, with some small modifications, and auxiliary apparatus. Shuman did not obtain more than half the effect of that obtained by Ericsson, namely, one horsepower per twenty square meters (215 sq.ft.) mirror opening. After an inspection of Shuman's plant, Mr. Ackerman thought it possible to introduce improvements which would give as good results as those obtained by Ericsson.

After improvements the solar engine seems likely to play an important rôle in the opening up for cultivation of great arid districts in tropical countries, as Ericsson maintained with great energy it would do. In these parts of the world are great deserts, such as Sahara, the Arabian Desert, the Syrian Desert, and those in Mesopotamia, which have in historical times been the seat of flourishing culture, but are now the homes of wandering tribes. The decay of these regions resulted from the destruction of their aqueducts and irrigation plants, which the present wandering population is unable to restore. With the aid of the solar machine it would be possible to re-establish the old agriculture and horticulture of these districts, and industrial works founded on its use might also be looked forward to.

It is not only in the deserts that the sun is shining nearly continuously during the greatest part of the year, but extensive provinces in Spain, Greece and North America possess such a climate that they would profit by the introduction of the solar engine. In other parts of the world, where the sky is covered for the greatest part of the year, as in the Congo or the Amazonas, or which lie nearer to the poles, as the temperate regions, the solar machine will be of little use.

It seems probable that when fossil fuel has been consumed, civilization and culture will return to its birthplace about the Mediterranean and in Mesopotamia in the Old World, and to Central America and the land of the Incas in the new.

According to some calculations made by me, an increase of the carbonic acid in the atmosphere will give the whole earth a more uniform and warmer climate. Therefore, we may suppose that the burning of coal will cause our climate to approach to that of the tertiary age. Furthermore, vegetation is highly stimulated through absorption of carbonic acid in the soil, augmented through an increase of the carbonic acid in the air. It is, therefore, probable, as I have tried to show in my book, "Worlds in the Making," that the total consumption of the available coal by the industries will, in a high degree, favor agriculture and the growing of forests in the temperate regions now the chief seat of culture. These regions will then know not only harmful, but some useful consequences as the result of the present waste of our fuel resources.

Kelly Boiler-Control Specialties

A number of power-plant specialties for boiler control have been perfected and are being placed on the market by the Kelly Controller Co., 175 West Jackson Boulevard, Chicago. Each specialty is designed to combine several functions in one device, and in every case the operation is effected automatically by the steam pressure or the buoyancy of a float.

Fig. 1 shows an automatic feed-water controller for intermittent or continuous feed combined with a safety water column having high and low-water alarms controlling from the water end; the device also acts as a pump governor.

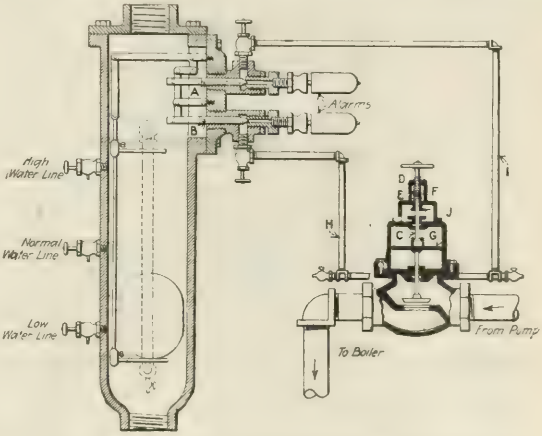


FIG. 1. AUTOMATIC CONTROLLER AND SAFETY WATER COLUMN

The water column houses a float which operates the high and low water alarms and indirectly controls the position of the feed-water valve. On the lever system in the water column, stops are set at the high- and low-water lines. When the water rises to the high-water line, the float comes in contact with the upper stop and opens the needle valve *A*, a slot in the stem of valve *B* allowing it to remain closed. In a similar way the float at the low-water line opens valve *B*, while valve *A* remains closed.

The valves *A* and *B* control the openings to the alarms. Referring to the sectional view of the feed-water valve, the stem *C* is threaded and screws into a square nut *E* which slides in the yoke *E*. The nut is held in normal position by the spring *F*. The position of the valve stem

C determines the flow of water to the boiler. The spring *F* is of sufficient power to overcome the differential in pressure between the boiler and the pump pressures and to hold in suspension the combined weight of the valve disk, piston, stem, nut and the handwheel. The tension of the spring is adjusted through the nut *J*. Steam is admitted to the bonnet of the feed-water valve, above the piston, through the passages of valve *B* in the water column and the piping connection *H*, and below the piston through the passages in the valve *A* and the pipe line *I*. The action of the combination is self-evident.

When desired the feed-water valve may be opened or closed by means of a hand wheel or by the petcocks on the pipe lines *H* and *I*.

Controllng Supply and Discharge

Should it be desired to provide a means for removing a surplus of water from the boiler, this may be done by placing another valve in parallel with the feed-water valve, but the steam connections above and below the piston are reversed and the discharge valve is slightly different in construction. When high water occurs, the steam pressure is reduced simultaneously under the piston in the water-feed valve and above the piston in the water-discharge valve. This action shuts off the water supply to the boiler and opens the discharge valve, allowing the excess water to flow out. As soon as the water level gets back to normal and the pressures on both sides of the two pistons equalize, the discharge valve closes and the feed valve opens, allowing the flow to the boiler to continue as usual. When low water occurs, the water discharge valve does not operate, as the valve is already closed and the reduction of pressure under the piston does not affect it.

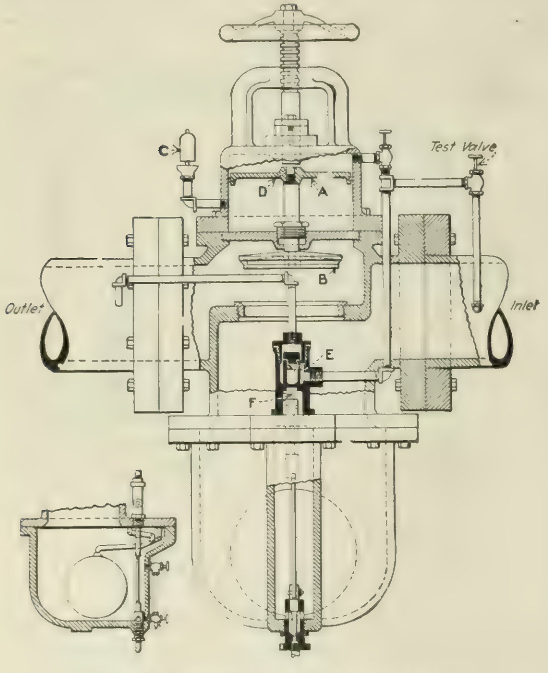


FIG. 2. QUINTUPLE-DUTY VALVE

A valve combining five separate functions in one device, is shown in Fig. 2. This valve automatically protects the boiler, mains and engine by closing when a rupture occurs either in the boiler or the mains, or when the boiler primes. Enumerating the five functions, the device may act as a non-return or check valve, as a main protection, as a steam trap as an engine protection, and as an equalizing valve.

Should the boiler pressure become lower than the header or steam main pressure, owing to a rupture or any cause, the weight of the plunger *A* and the disc *B* will close the valve slowly against the cushioning action under plunger *A*, the opening *D* allowing the air to escape.

Should a break occur in the main or header, the pressure lowers on the top side of the auxiliary valve *E*. As boiler pressure is under this valve, it will open, allowing steam pressure to be applied to the upper side of plunger *A*, which will close the main valve. The piping connection on the inlet side is provided merely for testing out the operation of the valve.

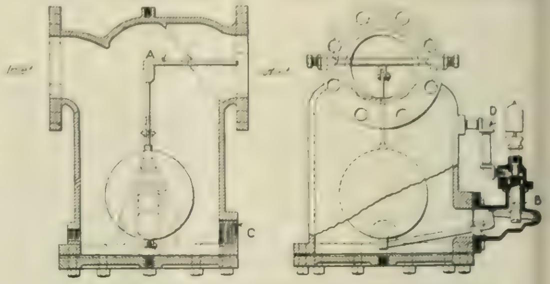


FIG. 3. HIGH-PRESSURE CONTROLLER FOR SINGLE BOILER

Should the water accumulate in the trap chamber from condensation, priming or any cause, the float will rise and open the valve at the bottom of the trap chamber, allowing the water to escape. If the priming is greater than the steam-trap capacity, the float will continue to rise and by means of pin *F* will eventually open the auxiliary valve *E*, allowing steam pressure to be applied to the upper side of plunger *A*, which forces it down, closing the main valve and sounding the alarm.

The fifth function is that of an equalizing valve. From the foregoing it will be apparent that the quintuple duty valve will equalize the pressure and load between boilers and automatically cut in and out the boilers without attention. The absence of springs and complicated adjustments and the general simplicity of the valve should appeal to the operator.

Fig. 3 shows a high-pressure controller designed primarily for single boilers when the devices shown in Fig 1 cannot be used. The controller acts primarily as steam separator. It is inserted in the steam-supply lin from the boiler. The float in the casing is connecte from its upper spud to the butterfly valve *A* and fro the lower spud to the valve *B* through a series of levers When the quantity of water separated from the stea becomes greater than can be carried away through th bleeder opening *C*, the float rises and pulls the stem downward. This allows steam supplied through th pipe *D* to blow the alarm. If the quantity of separate water continues to increase, the float continues to ris and closes the butterfly valve *A*, thus preventing wate from entering the steam mains. If the valve is in th steam lead to an engine, it will shut off the steam a well as the water and thus doubly guard the engin against a charge of water.

Electric Development in California

"There is no system of interconnected electrical companies in the world which will compare in magnitude with the electrical energy situated in California," recently declared H. G. Butler, state power administrator. Nearly one hundred plants will be tributary to it and consumers who use over 10,000,000 kw.-hr. daily during the summer will be supplied from it. The output of the plants in 1919 was 3,300,000,000 kw.-hr.

There will be carried out to Floriston a projected interconnection between the Southern Sierra Power Co. and the Truckee General Electric Co., the California companies, both north and south, being at present nearly all interconnected. With all California companies interconnected, Mr. Butler says, it will be possible to follow a transmission line from Oregon to Mexico, or from Oregon down the San Joaquin Valley to Los Angeles, from there to San Bernardino, north to Mono Lake, nearly due east to Stockton. The projected Southern Sierras-Truckee connection will extend this territory to a point opposite Lake Spaulding and thirty miles east over the Divide.

PRESENT POWER AND WATER SITUATION

Referring to the present power and water situation, Mr. Butler says: "No definite plans for this year have been made. The plans to be made will depend on conditions when it becomes necessary to use stored water. All that has been done so far is to prepare to secure as much power as possible, to attempt to keep the rice load within bounds and to urge farmers, through associations and organizations, to plan and do their irrigating at night. Stored water will be used to equalize the shortage over the seven months during which the shortage will prevail. This method of using stored water also works best for irrigation as the water will be withdrawn when needed for crops. The shortage, based on the estimated demand, will be 114,000,000 kw.-hr. for seven months, or about 10 per cent. The estimated demand is from 5 to 9 per cent greater than for the corresponding months last year."

SITUATION MORE SERIOUS IN THE NORTH THAN IN THE SOUTH

Referring to the shortage in the north, after declaring that the situation in the south was not so serious, Mr. Butler said: "In the north this is the third consecutive dry year. It is difficult to estimate the stream flow, which is important. Indications are that the Pacific Gas and Electric Co. will have 10,000,000 kw.-hr. more than last year, but will not fill its upper reservoirs. Lake Almanor, of the Great Western Power Co., will be only 40 per cent full. Steam is a very uncertain factor. To carry out the programs as much as 77,000,000 kw.-hr. per month must be generated. The best the plants have ever done before was 64,000,000 kw.-hr. in August of last year.

"The precipitation in the Southern District has been nearer normal than in the north and the supply of energy is proportionally greater. The San Joaquin Light and Power Co. has been face to face with a shortage since 1918 and has not taken on an extensive load, and the Southern California Edison Co. also has been careful on new business. The watersheds of the hydro plants are higher than those in the north and it is more difficult to estimate what the water supply will be, but I believe it is safe to say that if the agricultural and other load can be shifted from day to night and no extensive new load is taken on, and the resources are carefully husbanded, it may be unnecessary to place restrictions on the use of power in the south."

Pointing out that there are eleven large construction projects under way, with a capacity of 208,000 kw., Mr. Butler, making reference to the future of the state, said: "All but 10,000 kw. of this, or 198,000 kw., will be available before low water next season, and there are other plants in contemplation which could be completed by that time. Of this 76,500 kw. is in the northern district, and the interconnection between north and south is too light to permit of an interchange of power sufficient to make the new plants of the south available for the north. Still, with a normal supply of water there should be no water shortage next year. And the more distant future is safe if the power companies definitely realize —and I believe they do—that they must think in terms of hundreds of thousand of kilowatts and tens of millions of dollars. But even then it will be a severe drain to finance and build the power plants necessary to make our water sources available to the manufacturers of the East, who will seek them in increasing numbers as the fuels become more and more exhausted and more and more expensive. The Goodyear Rubber Co., in my opinion, is only the advance guard of those manufacturers, and that company alone, when it reaches full completion, will take 100,000,000 kw-hr. per year, or 3½ per cent of the total 1919 output of practically all the plants on the Pacific Slope, between Oregon and Mexico."

PROJECTS NOW UNDER WAY

Following is a list of projects under way, with their locations, type, probable date of completion and estimated capacity:

City of Los Angeles, San Francisquito Creek, July 1, 1920, hydro, 20,000 kw.

San Joaquin Light and Power Corporation, Bakersfield, June, 1920, steam, 12,500 kw.

San Joaquin Light and Power Corporation, San Joaquin (Kerckhoff), Oct. 1, 1920, hydro, 30,000 kw.

Southern California Edison Co., Big Creek (new unit), Nov. 1, 1920, hydro, 16,500 kw.

Southern California Edison Co., Kern River No. 3, Nov. 1, 1920, hydro, 30,000 kw.

Pacific Gas and Electric Co., Oakland, Nov. 1, 1920, steam, 12,500 kw.

Pacific Gas and Electric Co., Pitt River, Jan. 1, 1921, hydro, 24,000 kw.

Los Angeles Gas and Electric Corporation, Jan. 1, 1921, steam, 10,000 kw.

Southern States Power Co., Adams plant, Jan. 1, 1921, hydro, 2,500 kw.

Great Western Power Co., Feather River (Caribou), March, 1921, hydro, 40,000 kw.

Southern Sierras Power Co., October, 1921, hydro, 10,000 kw.

The principal heat losses of a boiler plant are due to dirty boilers, inside and out; leaky settings by air infiltration; leaky valves and poor management of firing. Air leaks reduce efficiency. The brickwork of boiler settings develops cracks and gaps through which air is admitted to the furnace, which lowers the temperature of the gases of combustion. A careful study of the settings should be made, and a remedy applied such as plastic fireproof mixture, covered and painted

Recent Advances in Surface-Ignition Oil Engines

Those engineers who have operated surface-ignition, or hot-bulb engines, are well aware of the difficulties encountered in operating this type of engine on a low load. In engines employing water injection the hot ignition surface is designed with the intention that at no load, with the water injection cut out, the bulb will contain sufficient heat to vaporize and ignite the fuel charge. At heavy loads the water injection, by its cooling effect, maintains the bulb at a temperature low enough to prevent pre-ignition. Unfortunately, this involves more or less attention from the engineer. Furthermore, if the low or no-load period extends over a considerable time, the bulb will cool off, requiring relighting of the starting torch. This lack of flexibility is one of the disadvantages possessed by this type of oil engine.

To overcome this defect, the Bessemer Gas Engine Co. has adopted a decidedly novel design of vaporizing or hot ignition surface. It is well known that a vessel, partly filled with a liquid and placed over a flame, will attain a temperature sufficiently high to boil the liquid. Further addition of heat will merely increase the rate of evaporation without any further rise in the temperature of the vessel. The side of the vessel exposed to the flame reaches a temperature somewhat greater than the boiling point of the liquid; the temperature difference is dependent on the shape and composition of the vessel as well as other factors. Taking advantage of these facts, the Bessemer company makes use of the cylinder head and vaporizer appearing in Fig. 1.

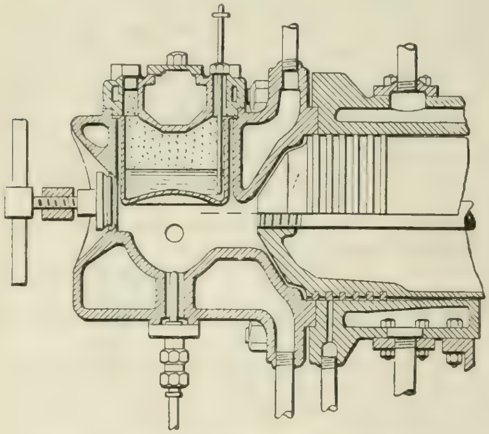


FIG. 1. BESSEMER MERCURY VAPORIZER

In the top of the cylinder head is placed a steel pot partly filled with mercury and held in place by a water-cooled cap. To start the engine, a plug is removed from the end of the head and a torch flame directed onto the bottom of the pot or vaporizer. When the vaporizer has become sufficiently heated, the plug is replaced and the engine started. The vaporizer is hot enough to give the initial explosion, after which the heat of combustion maintains the vaporizer temperature.

Even at no load the heat absorbed by the thin steel vaporizer raises the temperature of the mercury to its boiling point of 675-690 deg. F. Part of the mercury evaporates and, as it leaves the surface of the boiling liquid, strikes the water-cooled top. The vapor is chilled and, liquifying, trickles down into the bottom of the vaporizer. This continued evaporation and condensation process serves to maintain the vaporizer at a uniform temperature regardless of load changes. This enables the water injection to be discontinued.

A quick-starting ignition plug employing the same principle has been recently patented by the Bessemer company. This appears in Fig. 2. The plug is essentially a hollow tube carrying a charge of mercury and provided with a water-cooled jacket. Into this tube is placed an electric heating element. To start the engine, the current is turned into the coil, which heats the mercury and the tube. The coil should have no tendency to burn out as is so prevalent with starting coils, since the mercury should keep the entire tube at approximately 675 deg. F.

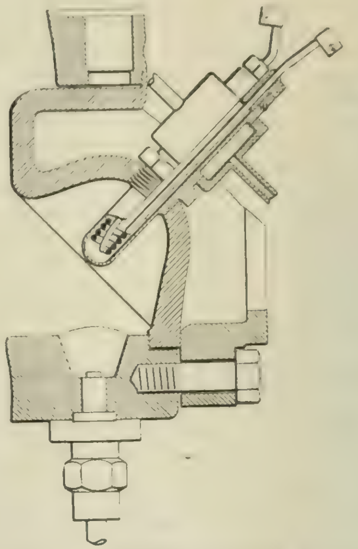


FIG. 2. BESSEMER IGNITION TUBE

To get the most efficient transfer of heat in a heating system, the radiating surfaces should be properly designed so as to create a circulation of the heating elements and to dispose of the water and air, which are enemies to heat transfer.

The exhaust is one of the principal factors of the engine room. After the steam has been delivered to the engine, care should be taken to see that it is utilized to the best advantage. Where all the steam is needed, the rate of steam consumption of the engine itself is not of particular consequence; that is, a simple slide-valve engine using steam at the rate of forty or fifty pounds per horsepower-hour may be the best type of engine to use. As the demand for exhaust steam decreases, the importance of economy in the engine increases. If there are periods when the exhaust is not used, the economy of the engine during these periods is of the greatest importance. For such work the most economical generating unit should be selected and of a size that will be economically loaded with the amount of power produced.

EDITORIALS

Welding in Steam Boilers and Other Pressure Vessels

THE Boiler Code of the American Society of Mechanical Engineers allows the use of forged welding for boiler joints, assuming as the ultimate tensile strength of a joint which has been properly welded by the forging process, 28,500 pounds per square inch, with steel plates having a range in tensile strength of 45,000 to 55,000 pounds per sqquare inch. Autogenous welding is allowed only where the stress is carried by other construction, and the safety of the structure is not dependent upon the strength of the weld.

In view of the progress which is being made in the art, and the consistently excellent work that is being done by some of the welding companies, it is suggested that the next revision of the Code may be a little more liberal to autogenous welding, and perhaps permit its use in door frames, flanges of water legs and other places where the factor of safety would be large in proportion to any stress upon the joint, or induced in other members by its failure.

There is likely to be a strenuous effort on the part of the welding interests for a more generous treatment of autogenous welding in the Code for Unfired Pressure Vessels, now in process of formulation. The Code in its tentative form divides unfired pressure vessels into two classes.

Class A:

Vessels for containing liquids above the atmospheric boiling point, inflammable substances, or any gas, and limited in size to those over 6 in. in dia., more than 1.5 cu.ft. in volume, and carrying over 15 lb. per sq.in.

Class B:

Vessels for containing liquids, the temperatures of which are under control so as to be below atmospheric boiling point, and limited in size to those over 9 in. in dia., more than 4 cu.ft. in volume, and carrying over 30 lb. per sq.in., but not to exceed 100 lb. pressure per sq.in. For pressures over 100 lb. per sq.in. the rules for Class A vessels apply.

The ultimate strength of a joint which has been properly welded by the forging process is to be taken at 65 per cent of the tensile strength of the plate. The ultimate strength of a joint which has been properly welded by the autogenous process may be used in Class B pressure vessels only, and shall be taken at 50 per cent of the tensile strength of the plate.

This, the welding people claim, would disqualify autogenous welding for many uses for which it is now successfully applied. On the other hand, it is urged that the autogenous weld is simply a line of cast metal interjected into a ductile surface, and subject to all of the uncertainty of cast material; that while a large proportion of welded joints show excellent holding power, often superior to that of the plate itself, the proportion which fails is still large enough to be guarded against; that the integrity of the metal surrounding the weld is apt to be impaired in the process of welding, and that no practicable method of determining whether the weld is sound short of a test to destruction has been evolved.

The Boiler Code Committee should go as far in permitting the applications of the development of this comparatively new art as it can consistently with public safety, and on the other hand the autogenous welding people will make a mistake which will seriously retard their own progress and development if they are successful in urging uses which result in serious accidents.

Turbo-Alternator Failures

IN THIS issue is published a paper, along with a discussion, on "Classification of Large Turbo-Generator Failures," by Philip Torchio, which was presented before the annual convention of the American Institute of Electrical Engineers. Mr. Torchio classifies fifty-five failures occurring in turbo-alternators ranging in size from five thousand to thirty thousand kilowatts. This classification is a valuable piece of engineering literature. However, its value would have been enhanced if more details had been given regarding the size and speed of the units, the kind of insulation on the coils, the length of time the machine had been in service, the system of protection against overloads or failures, etc. Nevertheless, the paper has served a very important purpose in that it brought out some very constructive discussion on this exceedingly important phase of power-plant operation.

Even taking the figures (fifty-five) given by Mr. Torchio, which date back twelve to sixteen years, and weighing them in accordance with operating conditions, they are not so formidable as it first might seem. First, for a number of years it was general practice not to provide turbo-alternators with automatic protection against overloads or breakdowns in the machine. Although the machine does not require protection against external overloads, it is now generally recognized that protection is necessary when failures occur in the windings. Not that the protective device will minimize breakdowns, but it will reduce the effects of the failure to a very small fraction of what it would be otherwise.

Second, it is only quite recently that the necessity of grounding the neutral of the generators has become generally recognized. As pointed out by Mr. Newbury in his discussion, in four cases where breakdown had been caused by surges, the cause of the trouble entirely disappeared when the neutral was grounded.

Third, during the war period many turbo-generators were operated under the most unfavorable conditions, and undoubtedly this led to many of the failures during this period.

Fourth, there is no doubt that interconnecting power systems without first providing adequate protection has contributed its quota of generator failures. When these facts are taken into consideration, the record of turbo-alternators has not been one to cause alarm.

The causes of past alternator failures are now generally recognized both by the operating companies and by the manufacturers, and very decided steps have been taken to remedy the causes; consequently, it is evident that in the future generator failures will be considerably reduced. To absolutely insure against failure is a well-recognized impossibility, no matter what the restrictions may be, but the manufacturer must produce a machine that will give the maximum degree of reliability consistent with the present state of electrical development. More than this the operating engineers should not insist upon.

Exploring for CO_2

THE tendency in recent years has been toward greater and greater capacity in one boiler, both by considerably more heating surface than formerly furnished and by high rates of combustion. Large boilers mean large furnaces, the design of which not only increases the volume of gas, but sometimes materially lengthens the path the gases must travel in their rise from the fuel bed to the flue.

As the efficiency and completeness of combustion depend much upon how thoroughly the gases from the fuel and the air admitted for combustion are mixed, furnace volume and character of the gas paths or passages are well worthy of investigation.

How well do the gases and air mix in a particular part of the furnace? How does the mixing done here influence the mixing farther on, and thereby promote or fail to promote high furnace efficiency?

These are questions which one large public utility attempted to answer by exploring the settings for CO_2. The results of the investigations are told in the article beginning on page 54 of this issue. This is but another of the refinements already introduced and to be introduced in boiler operation. The trend is one of basic economic importance owing to the seriousness of fuel availability and price.

Proceedings of the Third International Congress of Refrigeration

THE third International Congress of Refrigeration was held in Chicago in September, 1913. The proceedings, English edition, of this congress, have just been distributed, delayed by the war which later swept over Europe and soon engulfed the United States. Though late, the proceedings, which form three large volumes, two of which are finished, comprise literature of great value to the industry.

Refrigeration is an industry that embraces a far greater number of sciences and subjects than the average person—layman, engineer or bacteriologist—has in his mind when thinking about his particular part in it. Happily, this is as it should be, for it is not to be expected that the engineer should know as much about the combined action or native enzymes and bacterial flora on milk at various temperatures, or of the histology of various frozen fish, as he does or should about heat transfer and the myriad of details that lie wholly in the field of refrigerating engineering. And yet the success of cold storage, one of the most important factors in our highly specialized civilization, depends upon how well the laws and practices of building construction, transportation, engineering and bacteriology are merged and functioned. Fortunately, the tendency is toward decentralization—the industry does not expect the engineer to be the encyclopedia he once was held to be. It is up to the bacteriologists, the plant and animal-industry scientists, to furnish information about the retardation of decomposition of stored products. The questions of temperatures for sharp freezing, and holding, of odor absorption, shrinkage, handling of produce, etc., etc., are for the warehouseman to answer. The engineer should be through when he has designed, built, chilled the house and keeps it cold and ventilated. Doing these, together with his responsibility for the power plant and refrigeration-producing machinery, gives him enough to keep him busy to effect and to keep abreast of the progress in this division of the art. Going through the proceedings referred to convinces one of this.

What Shall Be the Horsepower Standard?

THERE is a growing feeling in engineering circles, particularly marine circles, that some standard should be adopted for the horsepower. Today we have the steam reciprocating engine, the capacity of which is well expressed in indicated horsepower, and the steam turbine, which so far no one has been able to simply and conveniently measure in terms of indicated horsepower. The turbo-generator set is invariably expressed in terms of the generator's electrical capacity with no reference to horsepower capacity of the turbine. Brake horsepower is the measure of the capacity of the internal-combustion engine, a growing number of which find use on land and sea. With electrically driven ships the power of the vessel is in most cases expressed in terms of the electrical energy that is available for the motors.

Our contemporary, *Shipbuilding and Shipping Record*, believes that if one expression is to be adopted for all types of prime movers, the shaft horsepower should be agreed upon. This seems all right for marine practice; but what would it mean to builder and user if applied to land prime movers? Would such rating be worth what it would cost to state it for each type of prime mover?

There is reported a temporary increase in accidents on power systems due to the scorn of personal danger evinced by returned soldiers employed in this work. The former doughboy does not want to forget that even if he could put terror into the heart of the enemy by proving himself a bad actor, he cannot do any such thing with moving machinery, electric circuits or other sources of accidents. The latter have never been made to retreat.

During the war the Fuel Administration turned the searchlight on inefficient plants. It is a pity that a similar campaign is not now in effect to ferret out coal and steam wastes and compel the elimination or immediate improvement of these plants. Such methods would put a premium on efficient plants and likewise on higher grades of men to own them.

The selection of O. B. Merrill as the executive secretary of the Federal Water-Power Commission will meet with general approval. Nowhere could there be found a man who is better qualified for this work by experience and breadth of view.

CORRESPONDENCE

Faulty Connections the Cause of Trouble

When making cable connections to motors, switchboards or other electrical apparatus, it is of the utmost importance to see to it that the contact surfaces are clean and that the screws or nuts are pulled up tight. Lack of attention to these details is a common cause of trouble, as the following examples will show:

A 50-hp. three-phase 550-volt motor, driving rolls for crushing crude rubber, began to give trouble in a peculiar way. The machine would operate normally until a particularly tough piece of rubber was inserted between the rolls, then out would go a fuse. In the plant was an exactly similar machine, doing harder work without any difficulty. The gearing was examined and found to be free, as the machine made a considerable number of revolutions after the power was shut off. The motor and compensator were carefully gone over and no faults found. Finally, pulling on the cables where they connected to the fuse blocks revealed the fact that one of them was slightly loose, and on removal the contact surfaces of the lug and fuse were found to be blackened, showing signs of the arcing which had taken place. It was apparent that when the machine was subjected to a heavy load, the poor connection caused the motor to take an unbalanced current from the line. Being unable to maintain its normal speed under these conditions, it slowed down and the inrush of current blew out the fuses.

In another instance a 250-volt 100-kw. direct-current generator, directly driven by a high-speed vertical compound engine, failed to take its proportion of the load when operating in parallel with other machines. Cutting out all the shunt resistance made but little difference, so the operator concluded that, either the engine was running slow or else a field coil had become short-circuited. A thorough testing and examination of the generator revealed the fact that one of the connections joining the bottom series-field coils was hot to the touch. This connection was in a very inaccessible position, and probably for this reason the bolts had not been pulled up tight in the first place. After cleaning and tightening up this connection, the series field functioned all right and the machine held the load easily.

The appearance of many marble switchboards is marred by large cracks caused by connections that have become overheated, either owing to the nuts on connections not being tight, or else the switches not being kept clean. In stations operating gas engines the conditions are sometimes such that it is necessary to keep the switch contacts lubricated with vaseline in order to keep the surfaces clean and to prevent the formation of an oxide film caused by the gas in the atmosphere. This, in some cases, is so bad that the commutator of a machine shut down will turn black in a few hours. I have in mind a switchboard equipment that was practically ruined by the effects of gas. The contacts were allowed to become so badly coated with oxide and the switches so overheated in consequence, that the clips became too soft to be serviceable. After this the vaseline remedy was applied with good results.

Toronto, Ont., Canada. H. WILSON.

Better Pay for the Engineer

For some time past I have been investigating the engineer in his plant, and some of the discoveries I have made have been rather startling. I have found expert mechanics, with a good technical education, acting as chief engineers in plants of over 1,000 hp., and who are getting only about $2,000 per year. I have found other men, who were fair mechanics, but who knew very little of the technical end of steam engineering, holding down the position of chief engineer, with salaries of around $1,800 per year. Ask them what their factor of evaporation was, what efficiency they were obtaining, what percentage of CO_2 they were carrying in their stack gases, and they could not answer.

Now, if the first man were to ask for more pay, he would be told that an engineer could be hired for less money than he was getting.

As a result the first man, who has spent years of his time and a good portion of his wage for an education, is compelled to work for the same money that the second man receives, as they both hold the same kind of license.

The first man should be considered a professional man, as he has spent as much time and money to get his education as is required of any other professional men, but he is compensated by receiving the wage of a laborer. The second man remarks, "Why should I spend time and money for an education when I can make as much without it?"

The remedy for this condition, in my opinion, would be to establish a national license law, divided in classes, as chief, first, second and third, and these into Classes A, B, C and D, the last division being the size of the plant. The examinations for licenses would be divided in the same way.

In this way the first man could command the salary he was worth, and the second man would have something to work for, making better conditions all around

Philadelphia, Pa. GEORGE H. SMITH.

Reinforced Handhole Patch

On a certain boiler the handhole plates were allowed to leak continuously, which resulted in the metal around the holes so wasting away that the flange thickness of the heads was greatly reduced and the boiler was ordered removed from service. It was decided to repair the boiler by cutting out the defective parts and putting on a patch, flanged as shown by Figs. 1 and 2.

It was necessary to remove two 3-in. tubes and enough of each head to allow the gasket and the flange of the handhole plate to come flush against the patch. The tube holes were tapped and a special steel threaded bushing with a thin flange-head was screwed through from the inside and faced up smooth with the outside of the head. The patch covered both of these bushings, and a stay rod was run through them with a nut on the inside and a machine nut and a copper washer on the outside, the rods serving as through stay for the unsupported area created by the removal of the tubes. The patch was riveted to the flange and to the boiler head and the joint calked.

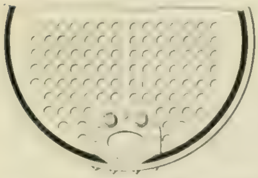


FIG. 1. PATCH ON FRONT HEAD

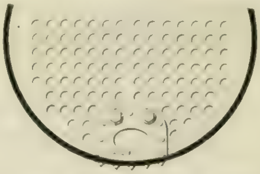


FIG. 2. PATCH ON REAR HEAD

The edge of the front patch flanged was scarfed on the under side to fit the flange of the boiler head, which was scarfed on the top side, taking in one rivet hole on each edge, leaving the remainder of the patch edge chamfered for calking. Figs. 1 and 2 show the patch in position on the front and rear head after riveting. The heads on this boiler were made with the flanges turned in, and the patches were put on the outside of the heads.

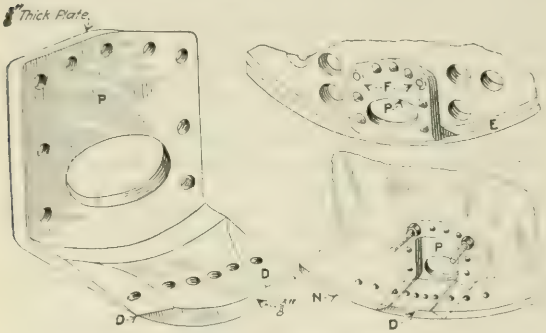


FIG. 3 DETAILS OF REAR HEAD PATCH

Attention is called to the patch (shown in Fig. 3) that was put on the rear head. The edges *DD* are scarfed on the top side of the flange or just opposite to the patch shown in Fig. 1. The boiler-head flange is scarfed on the under side to allow the flange of the patch to fit in under the edges between it and the shell sheet, as shown, where *E* is the calking-edge end of the shell sheet. The dotted lines *FF* represent the plugged tube holes.

A thoroughly skilled workman did the work, and the boiler has been in service for some years. These repairs saved the boilers from the scrap heap and saved the owner a large bill of expense.

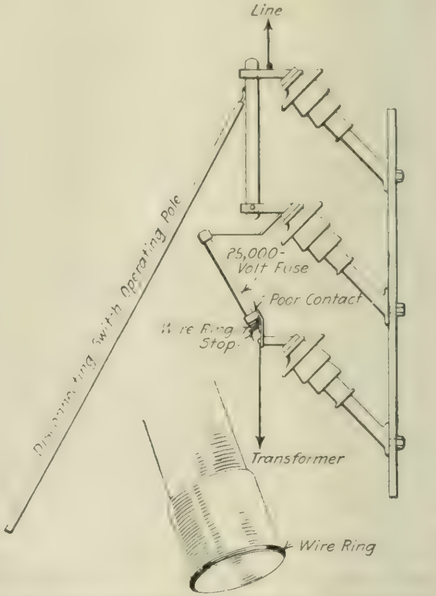
R. A. CULTRA.

Cambridge, Mass.

Loose Fuse Caused Voltage To Be Unbalanced

Recently I rewound a 200-hp. 2,300-volt three-phase motor and had put it into service driving a 16-in. centrifugal pump, but upon comparing phases I found that the current per phase was 39, 44 and 30 amperes respectively, with voltmeters indicating 2,400, 2,450 and 2,400 volts.

I shut down the motor, and the voltmeter showed all phases equal. Since the motor and pump were badly needed it was started up and run for a week until I had time to trace the trouble. Finally, I was able to shut down and inspection showed the oil circuit-breaker on the motor circuit, the transformer switch and the pole-top 25,000-volt switch to be in good condition. There remained only the transformers and the disconnecting switches and fuses. In the last-named I found the trouble. Our combined disconnect switches and fuse blocks were mounted upright, and a 20-ft. stick was used to open and close the switches. The sudden shock of closing had worked one fuse up until it was making a poor contact between the clip and the fuse ferrule. As the full-load current at 25,000 volts was only about five amperes, there was no excessive heating at the fuse or clip.



COMBINED HIGH-TENSION SWITCH AND FUSE

To prevent a repetition of the trouble a small brass wire ring was soldered to the extreme lower end of the fuse ferrule. The ring was placed so as to slide between switches and fuses. In the last-named I found the trouble. Our combined disconnect switches and fuse blocks were the fuse clip and the lower stop, as in the figure.

Pittsburgh, Pa.

M. A. ANDERSON.

Cleaning Water Jackets of Gas Engines

Under "Inquiries of General Interest," in *Power* of June 1, you state, in reply to query of R. M., that muriatic acid will remove scale from a gas-engine water jacket if the scale is of lime formation. I have had some very severe and trying experiences with deposits in a twin tandem double-acting gas engine. I tried many boiler compounds and solutions suggested by commercial chemists. The muriatic-acid solution was strongly recommended, and, in consequence, it was given a thorough test, using various proportions and periods for reaction. It would remove a coating of from one to two thousandths of an inch in thickness at an application. However, no great amount of scale was removed, and in no way was the acid solution any more successful than the boiler compound.

We resorted to hammers and chisels, which was very expensive and slow; especially was this true where twelve cylinders 22 in. by 33 in. had to be scaled.

After much experimenting we succeeded in developing an instrument which enabled one man to scale a jacket in five hours. The apparatus was, in effect, a gas blowtorch. A piece of $\frac{3}{32}$-in. copper tubing was fitted with a $\frac{3}{4}$-in. tee. To the two open ends of the tee, lines were run from the air starting tank and from the gas-supply line, both lines being equipped with regulating valves. When the gas was turned on and ignited and the gas and air valves properly adjusted, the flame issuing from the tip of the copper tube was at a white heat. When the flame was directed against the scale, the latter became very hot and, in expanding, dropped off. Since it required only a few seconds for the scale to become heated, the cylinder walls were not injured.

L. S. Henley.

National Park, N. J.

Obtaining a Fluctuating Record

When a graphic meter is used to record a very steady circuit and then is changed to record a fluctuating load, the pen takes considerably more ink and it is sometimes necessary to change the adjustment of the pen in order to get a good record. In order to see if the ink would flow properly on a fluctuating load, the scheme shown in Fig. 1 was used. The regular external register of the graphic instrument was omitted and a carbon lamp substituted, the bulb being carefully broken off leaving the filament intact. The voltage was then adjusted by the transformer, shown to the right, until the instrument stood at its normal point and the outfit was set in an open window. The filament of a carbon lamp has an extremely high negative temperature coefficient, therefore, the breeze that came in cooled it off, thus increasing its resistance and causing a considerable change in the reading of the instrument. The section of the chart, Fig. 2, shows both the normal variation of the circuit and the variation with the filament in series.

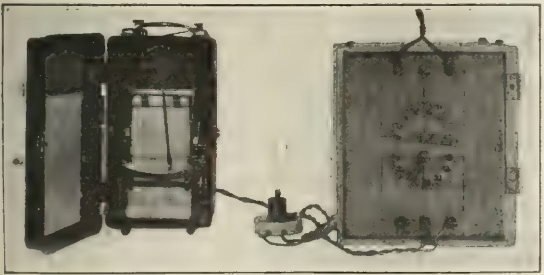


FIG. 1. GRAPHIC METER WITH LAMP CONNECTED IN SERIES

If it is desired to test an ammeter or a wattmeter in this manner, the series coil should be excited from the low-voltage side of a phantom load testing transformer, and the filament connected in series with the primary of the testing transformer.

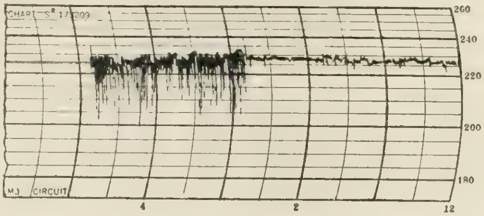


FIG. 2. CHART SHOWING READINGS OF METER WITH AND WITHOUT THE LAMP

Orange, N. J. **Victor H. Todd.**

Prolonging the Life of Condenser Tubes

In the June 15 issue of *Power*, page 976, I note the contention of C. Harold Berry regarding the article which appeared in the April 13 issue on "Prolonging the Life of Condenser Tubes."

Mr. Berry points out that if two electrodes are immersed in a suitable electrolyte there will be no galvanic action if the electrodes are not electrically connected outside the solution. Farther on he says that the tubes are metallically connected through the ferrules.

If the tubes are properly centralized where fabric packings are used, there is no metallic contact between the tube, tube sheet or ferrule. There is a slight clearance through the tube sheet and also a clearance in the ferrule, and even though the tube was not properly centralized, the metallic contact between the tube and the ferrule would be imperfect owing to the fact that a film of oxide is soon formed which results in the connection having a high resistance, and should this metallic contact through the ferrule occur, it is likely that it would be limited to only one end of the tube, and then we would have exactly the condition to which Mr. Berry refers in the second paragraph of his article.

I maintain that in order to overcome this electrolytic decomposition of condenser tubes it is essential to establish a good metallic contact at both ends of the tube. One end is not sufficient, as with one end bonded or metallically connected, there would be established a condition that would facilitate electrolytic decomposition. I agree with Mr. Berry that if we immerse an electrode and a cathode in a suitable electrolyte, galvanic action will occur as soon as outside connection is established; but on the other hand, if we so connect this anode and cathode in such a manner that the current will not flow through the electrolyte then galvanic action will not occur.

Julian N. Walton.

New York City.

Operating Alternators in Parallel Belted from the Same Shaft

We have an engine connected through a rope drive to a countershaft running at 200 r.p.m. To this countershaft is belted a 75-kw. 550-volt three-phase 50-cycle 900-r.p.m. alternator. It is the intention to install a 120-kw. alternator operating at 900 r.p.m. and belt this to the present countershaft. The countershaft, therefore, would be common to both alternators. The question before us is, will these machines operate satisfactorily in parallel and keep in synchronism? We have not been able to find an installation where this condition actually exists nor can we get any definite information as to how satisfactory the operation would be if arranged in this way. One engineer says the scheme is impractical and knows of a case where it was abandoned and one large alternator substituted for the two. Another feels that the arrangement should work fairly satisfactorily. From another source the opinion is expressed that the scheme is impractical with belted machines, but if a chain drive was substituted they would be mechanically interlocked and would keep in step. From a fourth source of information the engineer, while not knowing of an actual installation of this sort, believes the machines should operate satisfactorily.

The foregoing makes it evident that there is a diversity of opinion on this problem. It does not seem advisable for us to use a chain drive or at this time substitute one large machine for the two, or to install what we would like, from an engineering point of view—direct-driven alternators.

We have an existing equipment which must be made use of if possible. A suggestion has been made that the electric load of the factory be divided so that each machine will run independently of the other on the separate electrical distributing systems. If there is no other recourse, we may have to use this method. We would like to know of an installation where the two alternators are belted from the same lineshaft and run in synchronism, as we consider that it would be well worth our while to visit such a plant and interview the operator. MATHEW KING.

New York City.

[The operation of two alternators in parallel, when driven by belts from the same lineshaft, is apparently highly impractical. Even if the two machines were identically alike, which they are not in this case, it would be impractical. To put the alternators into service, it would be necessary to get the rotors of the two machines into the same relative positions with the stator windings and tie the stators together in the correct phase relation, then to bring the two machines up to speed and voltage simultaneously. If the rotor poles had absolutely the same relative position to those of the stator, then the load should divide proportionally between the machines. This is the crux of the whole problem. Owing to the slight differences there may be in the pulleys and belts, the two machines will not tend to run at the same speed, consequently the load will shift to the machine that has a tendency to run faster, and there is no way that this can be controlled. Direct-current machines have been operated successfully in parallel when driven from the same lineshaft. But in this case the division of the load between the two machines is only a question of voltage control, which can be taken care of through the shunt-field rheostats and the equalizer connections between the two machines. In alternators the division of load is controlled by the position of the rotor poles relative to those of the stator, the machine whose rotor has the leading position taking a larger portion of the load. If the alternators are connected through gear or chain drives, they can be adjusted to take their proper portion of the load and, after once so adjusted, must remain in that position. If any *Power* readers have had experience in attempting to operate two alternators in parallel driven through belts from the same lineshaft, it would be interesting to know just what results were obtained.—EDITOR.]

Small Wear of Engine Cylinder in Sixteen Years' Running

In September, 1904, we started a new 24 x 42-in. simple non-condensing engine. We calipered it recently for the purpose of finding how much it had worn out of true and got the following measurements: Crank end, $24\frac{3}{64}$ in. in vertical, $24\frac{1}{32}$ in. in horizontal; middle, $24\frac{3}{64}$ in. in vertical, 24 in. in horizontal; head end, $24\frac{3}{64}$ in. in vertical, 24 in. horizontal.

We consider this an excellent showing for 16 years of running, 10 hours per day and 6 days per week, especially with the bad start it had. In wearing it in, when new, we ran the engine about five hours light, regulating the speed with the throttle, the governor being out of action because of the low speed. The erecting engineer then ordered the speed increased until the governor came into action. We had run this way for a few minutes, when the bull ring stuck and the engine came to a sudden stop. On removing the head, the cylinder was found to be badly scoured and thoroughly casehardened.

We spent several hours smoothing down the rough places, and once a year since we take out the bull and the packing rings and with emery cloth grind away all ridges on the rings and round off all sharp edges with a file, replacing the parts in exactly their original position. This treatment has kept the cylinder in good condition and comparatively smooth all these years. We have speculated as to whether the cylinder would not have been worn worse if it had not gone through the casehardening process.

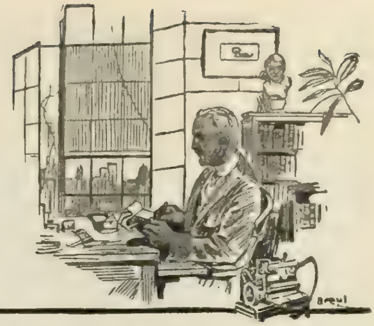
We diagnosed the original trouble as being due to a close fit of the bull ring, but as long as we regulated the speed by the throttle, the vapor, at low pressure, followed the piston and distributed the oil and carried the excess heat away. When the governor was operated, the steam at boiler pressure was admitted for perhaps one inch of the stroke before cutoff took place. This steam probably was so small in quantity and was soon expanded to such an extent that there was nothing to distribute the lubricant or carry away heat and the rubbing surfaces became very hot.

After 20 years' experience with gas engines, I am convinced that if steam-engine builders would put three rings on their pistons and dowel them so that the joints would stay in the bottom of the cylinders, their engines would show higher efficiency.

Many steam-engine pistons leak badly from their first revolution on. In a gas engine this will not do. They have to be tight and usually stay so for an indefinite period. B. O. BENEFIEL.

Anderson, Ind.

INQUIRIES OF GENERAL INTEREST



Cleaning Leather Belts of Oil—How can machine oil be removed from leather belts without injury to the material?
H. C. R.

Remove all gum or glaze from the surfaces by scraping them with a broad putty knife or similar scraper with rounded corners so they will not cut or scar the belt surface and then, with the belt stretched out on a floor or bench, clean first one side of the belt and then the other by a spreading of dry sawdust swept off with a clean stiff broom. Then place the belt in a warm place for a few days, packed in clean, fine sawdust, powdered chalk or fuller's earth for absorption of the oil by capillary action.

Treatment of Hot Bearings—What is a good treatment for a hot main bearing that must be kept running?
R. D. B.

One of the best remedies for a hotbox or main bearing is to loosen up the bearing all around, then give it a generous supply of cylinder oil through the oil holes, or feed the bearing with a mixture of about one measure of graphite and ten of heavy engine oil. If heating does not disappear, at first opportunity clean the bearing and try to run it down smooth with a light load while the bearing is kept flooded with a very thin mixture of flowers of sulphur in clean water.

Oiliness and Viscosity of Lubricant—What is the difference between oiliness and viscosity of a lubricating oil, and how do these respective properties aid lubrication?
A. D. B.

A lubricant is said to be oily when it is in nature of a limpid greasy liquid that readily spreads and attaches itself to the bearing surfaces without chemically combining with their material, and keeps the surfaces separated with reduction of the friction without gumming or cutting of the surfaces. Viscosity, or "body," of a lubricating oil is the measure of its fluidity and therefore an index of the cohesiveness of its particles. It is advantageous to lubrication if no greater than necessary to give strength of cohesiveness and adhesiveness required to hold the oil together in a film of sufficient thickness to prevent engagement of the irregularities of the opposing lubricated surfaces and to prevent the lubricant being pressed from between the surfaces.

Wear and Breakage of Chain Drive of Ventilation Fan—Trouble is experienced with wear and frequent breakage with a chain drive used for transmission of power from a motor to a 16-ft. diameter ventilating fan of a mine. The pitch of the chain is 2 in., the sprocket wheel on the fanshaft is about 5 ft. 5 in. pitch diameter with 102 teeth, the pinion on the motor has 19 teeth and the chain has 124 links. What may be the cause of the breakdowns?
V. J. S.

It is likely that the distance between centers and form of teeth are not adapted to the pitch of the links and relative sizes of the wheels, causing delivery of the slack side of the chain out of mesh with the sprocket on the fanshaft. The data given indicate that the center-to-center distance of the sprockets is about 50 inches. To insure good operation, the distance should not be less than about 40 times the pitch or 80 inches, and it is better to have the slack side of the chain at the bottom.

Relative Amount of Steam for Instroke and Outstroke—Is more steam required by an engine on the instroke or outstroke?
F. S. B.

No more power is required to be developed by one stroke than the other. With the same percentage of cylinder clearance, same point of cutoff and same compression in each end of the cylinder, there will be less steam required and a development of less power during the instroke on account of the presence of the connecting rod and its reduction of the piston area. This reduction generally amounts to no more than 2 to 3 per cent and, in ordinary operation of horizontal engines, may be neglected. In the case of a vertical engine more steam should be admitted on the upstroke to compensate for lifting the weight of the piston and reciprocating parts during the upstroke and the assistance which their weight renders to the downstroke.

Cylinder Ratios of Compound Engines—Is it considered practical to construct and operate compound engines with a cylinder ratio as high as 6 to 1?
J. P. O.

In a cross-compound engine it is desirable to have the load divided equally between the cylinders and then make the cylinder ratio such as to sustain the least drop of pressure between the cylinders and the least loss from range of temperatures in the cylinders. For present-day boiler pressures of 100 to 200 lb., this can be accomplished with cylinder ratios betwen 4½ and 5 with variation of load between one-half and full load. Ratios between 6 and 7 have been used on special engines with good economy when operated with loads and steam pressures appropriate for the ratio. These engines were marine and water-works engines carrying uniform loads. For stationary cross-compound engines with variable loads, the smaller cylinder ratios have given better results.

Air in Cooling Water of Jet Condenser—Our cooling water supplied to barometric condensers is furnished by two 8-in. centrifugal pumps which take their suction from a canal through a 14-in. suction line, 430 ft. long. The pumps are set so their suction flanges are about 6 in. below the summer water line in the canal. In summer when the canal water is about 6 ft. above the intake, there is no trouble to obtain 28 in. vacuum. During the winter season, when the water in the canal is lowered so the top of the suction pipe is only 12 to 15 in. below the water surface, but without any eddy formation at the intake, we can seldom get better than 22 in. vacuum. Would this be due to more air contained by the colder water of winter?
V. T.

It is possible, though hardly probable, that the winter water contains more air in suspension, but with a submergence of only 15 in. of the 14-in. suction pipe and higher suction lift, direct leakage of air at the intake is likely to occur unobserved and there also would be more air leakage at joints, causing lower vacuum to be obtained by the condensers.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Purchase and Erection of Engineering Equipment*

BY A. S. LOIZEAUX

IN THE purchase and erection of engineering equipment certain well-defined steps are generally necessary, which may be outlined as follows: Determination of work to be done by the equipment; choice of general character of equipment to do the required work; specifications to cover construction and performance of the various parts of the structure and equipment; contracts to cover price, terms of payment, time and point of delivery, erection and initial operation; following up manufacture, delivery and erection, inspection of material and equipment and necessary testing to insure that all terms of contract are fulfilled.

The engineer's object in choosing methods and equipment to accomplish desired results should be to get maximum reliability and efficiency with an ultimate minimum cost for fixed charges and operation. This object can generally be achieved by the employment of the best equipment obtainable, of ample capacity and simple and rugged construction. This kind of installation will not be the cheapest to buy or install, but will figure the cheapest in total cost over a period of years of operation. The engineer should realize that the final judgment of his work is not a theoretical or technical matter. His work will be judged by the same hard, practical tests that all other work is judged by. Does it work? Does it pay? Does it stand the test of time?

To illustrate in a practical way the steps mentioned in the purchase and erection of engineering equipment, we will take the problem of unloading coal from barges at a water-front and transferring this coal to the bunkers of a boiler house about 300 ft. distant from the water-front and 70 ft. above the water.

Determination of Work To Be Done by the Equipment

The engineer's first step is the determination of work to be done by the equipment.

The power-plant design in the case which we have taken as an example contemplated an ultimate development calling for a maximum power-house output of about 120,000 kw. If 2.5 lb. of coal are burned per kilowatt-hour, this output would require a maximum use of coal of 300,000 lb. per hour, or 150 short tons per hour. A load factor of 80 per cent would indicate a maximum requirement of 2,880 tons per 24-hour day. It is, of course, desirable to unload coal in daylight in a working day of eight hours, making the capacity of coaling equipment large enough to supply maximum ultimate coal in an eight-hour working day. This condition to supply 2,880 tons per day of eight hours would require an outfit of 360 tons capacity per hour.

It is evident that there is much latitude allowed to the judgment of the engineer in the determination of the first point; that is, the capacity that he shall require of the equipment. One device working eight hours for maximum coaling must be 360 tons per hour capacity, an equipment working twelve hours would be 240 tons capacity, and an equipment working twenty-four hours would be 120 tons capacity.

It must also be remembered that it is not good engineering practice to rely on one equipment of this character for the entire supply of a station. The final judgment as to the best capacity applied to this problem was to provide two duplicate coaling equipments, only one to be installed at first, each equipment to have a maximum capacity of 300 tons per hour, or be able to supply maximum coal requirements in a ten-hour working day. This gives reliability even under breakdown conditions, as each tower can supply the plant with coal.

In choosing permanent coaling equipment for the new house, the gantry type was eliminated because of its slow operation. The low-type unloader with cars and skip hoist was eliminated because of its complication.

A low-type unloader with inclined conveyor and belt distribution over bunkers was proposed by a firm manufacturing coal-handling machinery, but it was rejected because of multiplicity of parts. The equipment finally determined on was a high-speed coaling tower located on the water-front, with a structural-steel boom overhanging the water. A bucket grabs coal from the barges and lifts it into a receiving hopper 105 ft. above the water. From this hopper the coal passes through a two-roll crusher and into another hopper directly above a cable railroad. The cable railroad is on the level of the top of the coal bunkers in the boiler house to be served. The cars are circulated in an endless route from the coaling tower over a bridge to the boiler house, their load of coal is dumped in the proper bunkers without stopping, and the cars return to the coaling tower to be loaded.

This equipment is perhaps as simple as possible. All the elevating is done in one lift when the coal is picked up from the barge. Gravity then causes the coal to flow through hoppers and crushers to the cars. Horizontal transportation is done entirely by cars which are most reliable and efficient for that purpose.

An inspection trip was made by the engineer in charge of the coaling problem to view the actual performance of similar towers, both steam-driven and electric-driven, and to determine what were the valuable and the undesirable features of each. It should be here remarked that it is most important for an engineer to actually see the operation of equipment similar to what he expects to purchase, because some important features will at once appeal to the eye which may be overlooked in a specification or description. It is also desirable to question men in charge of actual operation, as they sometimes give information not available from other sources.

Specifications To Cover Construction and Performance

Having chosen the general character of coaling apparatus, it is necessary to specify the construction and performance required of its several important component parts.

No engineering student should imagine that an engineer can sit down and evolve complete specifications for highly developed equipment. This method has been sometimes attempted, probably more in European than in American practice, and the results cannot well avoid being inferior. The proper method, and one almost universally followed, is to call upon manufacturing and constructing concerns for their proposed specifications for equipment and construction to accomplish the desired purpose.

Selection of Bidders

To obtain best results it is, of course, necessary to invite the most reliable and capable firms to bid. If the engineer is in doubt who is best fitted to do certain work or supply certain equipment, he can get such information from several convenient sources.

The advertisements of technical and trade journals are constantly revised lists of bidders. The engineering-society journals carry announcements and advertisements of capable firms. Directories sometimes give a full list of manufacturers and outline their products. From these and other sources of information the engineer can quickly get, if he does not already know, the names of proper parties to confer with on the prospective work.

For competition it is, of course, necessary to have two or more bidders. It may be advisable to have as many as ive if there are that many entirely competent parties. Beware, however, of inviting the irresponsible or incapable bidder. He will make promises he cannot fulfill or quote a low price that will not see him through the contract, and then abandon the work. The character of a contractor is important. One will haggle at every doubtful point and seek extras at every turn. Another will fulfill his contract without question and give his client the benefit of the doubt.

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*Abstract of one of the J. E. Aldred Lectures, Johns Hopkins University, Baltimore, Md.

A good rule in the selection of bidders is to invite only those whom you are willing to have do the work, and treat them all impartially, awarding the contract to the one offering the best proposition, all things considered, which does not always mean the proposition of lowest price.

CAISSON FOUNDATIONS

In the case of the coaling tower under consideration the two most experienced foundation concerns in the country were turned to, with the result that one company built the caissons for the first tower and the other company the caissons for the second. By turning to the engineering and construction firms best fitted in this country for this work, we have not only secured permanent structures, but were ourselves relieved from the serious responsibility of providing foundations that might fail under adverse conditions.

STRUCTURAL-STEEL TOWER AND BRIDGE

The steel structure for tower and bridge was roughly designed by the owner's designers; that is, the general size and character of the structure was determined and loading given. The result is called a setting plan. This drawing or setting plan was then submitted to the structural-steel firms for competitive bids, it being specified that the successful bidder should completely check the design and be responsible for its strength and detail in all of the parts. The price in such cases is given on a tonnage basis, so that moderate changes in design or size of members will not affect the contract.

A personal conference with capable engineers of a manufacturer will accomplish more than weeks of corresponding. It is also highly desirable to have the contracting engineer familiar with conditions on the site.

Engineers of manufacturers are ready and anxious to explain the design and merits of their apparatus, and by giving each bidder an attentive hearing the purchasing engineer can gain valuable knowledge of the apparatus offered with minimum expenditure of time and effort.

The engineer in charge should remember to inquire for possible improvements beyond what the manufacturer's specifications may contain.

In drawing up specifications for automatic equipment it should be remembered that labor is in general the most expensive item in operation, and where it is possible to eliminate a single laborer at a wage of $3.50 per day, or say $1,000 per year, an investment as high as $5,000, or even $10,000, may be justified. Interest and depreciation on the investment should pay the laborer's wage, and operation will in general be more reliable and rapid than with the laborer. It will often be found that the value of more rapid operation is greater than the saving in operating wages.

CONTRACTS TO COVER PRICE, TERMS OF PAYMENT, TIME, ETC.

After specifications have been evolved, it is necessary to enter into contracts for the different parts of the work to cover price, terms of payment, place and time of delivery, provisions for erection, initial operation and tests of equipment.

Contract forms are nearly always provided by manufacturers with clauses protecting them from numerous possible contingencies. The owner's engineer should scan these carefully and eliminate or modify any that may be unsatisfactory or unfair.

A valuable method to compare all important competitive bids is that of tabulation. In tabulating bids parallel columns are provided, headed by different makes of apparatus available. The character of apparatus, with all its important features, method of control, operating characteristics, capacities, speeds, sizes, weights, materials, etc., are tabulated in these parallel columns. This method of analysis enables differences to be quickly and accurately located. It discloses which is the best proposal and enables the best to be improved by requiring changes in the specifications submitted to provide for any superior features that may appear in any of the other specifications. By this means of comparison and selection remarkable results are sometimes obtained in procuring apparatus of high reliability and general efficiency.

PRICE AND TERMS OF PAYMENT

Price is a matter of competition with due regard to difference in material and equipment furnished. It is well to have inquiries for prices contain the statement that the owner reserves the right to reject any or all bids submitted. The experience and reputation of the contracting firm must be considered and price difference allowed in favor of a concern of ample responsibility to meet emergencies that may arise or bear losses that may occur. In terms of payment it is customary to allow 40 or 50 per cent on submission of bills of lading proving shipment. Contractors will usually call for two additional payments, one at 30 days and one at 60 days after shipment. These terms are in general not satisfactory to the owner except in the case of standard equipment. It is necessary for the protection of the owner's interest, when equipment is at all special, to provide a final payment of 25 per cent or more after complete erection and satisfactory operation of the apparatus. This safeguards the owner from carelessness on the manufacturer's or contractor's part in not putting equipment in final and satisfactory operating shape and provides the owner with a whip to require the full performance of the terms of the specifications and contract.

Point of delivery should be carefully specified, as many troublesome delays are due to lack of full information as to this matter.

Erection is best placed with the same concern that provides structure or equipment as before noted. If for good reasons it must be given to separate concerns, it is necessary to carefully specify how and where the material is to be delivered, who shall unload it and move it to the permanent site. It is necessary to state what responsibility shall be taken by the erector and what by the manufacturer or owner. Insurance is generally necessary to cover accident during erection, and it should be stated that defects of erection shall be made good without loss to the owner.

It is necessary to specify conditions governing overtime in erection. These additional expenses can be placed on the manufacturer if delivery is late, but only when so specified.

Extra work must be mentioned, giving the terms and rates at which such work shall be done.

Actual operation is the final test of all equipment, and considerable periods of time should elapse whenever possible before final payments are made, as it is possible for radical defects to develop after a short period of successful operation. The owner's engineer must be careful not to commit himself in word or writing as to his final acceptance of equipment until it has been in full capacity operation for a considerable period.

CONTRACTS ON BASIS OF COST

There are some situations when it is desirable to enter into a contract on the basis of the cost of the work to the contractor. Such a situation exists when the cost is doubtful, by reason of unknown conditions of soil for foundations, unknown conditions of stream flow or weather, or the like, which may greatly influence the cost. The risk in such cases belongs to the owner, not to the contractor. The contractor could not take this risk unless he included a high figure for contingencies in his bid or gambled on his chances of good luck in construction. A contract based on cost must define cost carefully, stating particularly what percentage is to be charged for overhead costs or whether the overhead is to be included in a percentage to cover profit as well.

In contracts for field work the cost of "plant" must be explicitly stated. It is generally to the owner's interest to agree on a flat sum to cover all plant rental, specifying, however, the main items of plant that may be required. This makes it to the contractor's interest to finish the job promptly, to use his plant elsewhere.

After paying all costs, including overhead, it is common to allow the contractor a net profit of 5, 10 or 15 per cent, depending on conditions and the magnitude of the work. Another method, however, which has an important advantage, is to give the contractor a fixed fee for his services over and above his costs, including overhead. This also tends to expedite the work, as the contractor cannot increase his fee by delays or increased costs.

FOLLOWING UP MANUFACTURE, DELIVERY AND ERECTION

After contracts have been signed embodying all specifications, it might be supposed by the engineering student that the engineer's work was finished, but such is far from the practical fact. To obtain what we have specified at the right time usually requires a large amount of effort in following up the various manufacturers and construction men.

In all important equipment where time has a large financial value, it is wise and often necessary to have a follow-up system, keeping track of the progress of manufacture, especially of the heavier parts such as large forgings and castings, to insure that delivery will not be greatly delayed. It is the customer who follows his work the closest and inquires most persistently and explicitly of the manufacturer that gets the best service from the factory. A trip to the factory to see the exact status is often necessary and profitable.

An effective means of securing results in deliveries and erection is the formation of a tabulated schedule specifying all the important parts of a completed job at the side of the tabulation and making spaces showing time intervals at the top of the tabulation. The desired progress of the work can then be chartered from the beginning of manufacture or field work to the completion of the job.

The foreman in charge of erection decidedly influences the speed and quality of the work. When an unusually capable foreman is known, his services may be called for by the owner with good results. A foreman should have support in getting labor and material, and in some cases where time is valuable, he may be given a bonus for completion earlier than the normal time for erection.

Completion is often specified in number of working days rather than by definite date. This is justified for outdoor construction, especially in winter, when the contractor is prevented by the weather from making progress on certain days.

OPERATION OF EQUIPMENT

Operation is not only a test of whether specification has been met, but is also a gage of the engineer's success in obtaining desirable features that are not or cannot be included in specification. For instance, such qualities as quietness of operation, freedom from vibration, rigidity of structure, convenience and ease of control are not generally subject to specifications in any exact terms, yet they indicate the degree of skill with which the design has been made and carried out.

In companies having a purchasing department the engineer works through such department in most of his official acts, such as the invitation to bid or the awarding of a contract. Engineering interviews are a part of the engineer's duties to arrive at correct decisions, the final results of his work in the form of specifications and orders or contracts being sent through the purchasing department and company's officials to maintain uniform records and secure proper approval of important purchases.

The purchase of electrical machines has been simplified by the issuance some years ago of the Standardization Rules of the American Institute of Electrical Engineers. These rules specify standard temperatures, ratings and methods of testing for electrical machines, to which most manufacturers now conform, so that their guarantees are generally directly comparable.

A successful engineer is one who applies common sense to every step of his work, devising means to get results desired by the simplest and most direct methods. The engineer's educated judgment will enable him to choose the best design and equipment of various alternatives submitted, but he needs great diligence and determination to drive an undertaking through from its inception to a successful and timely completion.

Anthracite Coal Monopoly

Charging that the anthracite industry, made up of seven distinct railway systems, is knitted closely into a single monopoly by inter-stock ownership, by interlocking directorates, by informal conferences and in general by the engrossing control of the great Wall Street banking combine which centers about J. P. Morgan & Company and the National City Bank, W. Jett Lauck, consulting economist for the United Mines Workers of America, laid before the Anthracite Coal Commission a survey which, he stated, had been made to discover the degree of inter-relationship and combination to control the production, transportation and market which prevails in the anthracite industry. Mr. Lauck declared that this survey pointed to the fact that the anthracite industry is today dominated by seven different railroads, each of which controls the production, transportation and sale to local dealers of a certain proportion of the total anthracite consumed.

This domination has resulted from a consistent effort to render secure for all time an adequate proportion of anthracite traffic.

Before the end of 1919, the railroad companies, either operating directly or through their coal companies, had come into the ownership of over 90 per cent of the unmined coal.

The majority of the anthracite roads came to be represented in the mining of anthracite by separately incorporated coal companies either created by the railroads or acquired through stock purchase. Until the period of reorganization the entire stock of these coal companies was held by the separate railroads; and such high rates were established for the transportation of anthracite that it became impossible for a coal company to operate at a profit.

The combination of excessive transportation rates with the consequent coal company losses has furnished apparent justification for high prices and low wages. It has amounted to a process of writing the losses of coal companies into the cost of transportation, thus justifying high traffic rates; and then the writing of these high transportation costs into the price of anthracite charged to the local dealer, thus justifying the high prices to the consumer.

The resulting high rates have enabled the anthracite railroads to pay dividends far above those of the other railroads in the country.

The process just described, from which these high profits have resulted, is such that it is well concealed from the public and difficult to reach; for these methods have enabled the anthracite corporations to show margins between the cost of producing anthracite and the price at which it is sold at the mine, between the cost of transporting anthracite and the rate charged by the railroad, and between the total cost of the anthracite before it is delivered to the dealer and the price at which it is delivered to him, which are to all outward appearances no more than average.

It is, therefore, unjustifiable to claim on the basis of such margins as are exhibited (particularly in the production end of the business) that the anthracite industry cannot pay higher wages without increasing the cost to the consumer.

The conclusions drawn from this study seem to be that as the result of the combination that has been achieved, we must look for anthracite profits not in the coffers of the coal companies, but in (a) the profits of anthracite railroads; (b) the profits of sales companies; (c) the profits of those who control the banking combine which has engineered the anthracite combination.

An Engineering Analysis of the Labor Problem*

By CALVERT TOWNLEY,
President American Institute of Electrical Engineers

CALVERT TOWNLEY

ONE of the most important problems which the American people now have to solve is that of the relations between the employer and the employee classes, generally referred to as capital and labor. A large measure of our national success will depend upon this solution, and as engineers are even more directly affected by and therefore more intimately connected with, industrial prosperity than are the other professions, it is more obviously their duty to assist in the solution of the problem as much as they can. Although this subject has been voluminously discussed by numberless people, there is one angle from which, so far as I know, it has not been treated; namely, from the standpoint of what is instead of what ought to be, that is to say, from the engineering standpoint, one of fact, human nature and of economic laws as contrasted with the laws enacted by man.

To begin with, the first law of nature is self preservation. It is manifested in its highest form as patriotism, in its lowest as sordid greed. Between these two extremes appear all forms of selfishness, many of them by no means blameworthy, others under control or not infrequently dormant, but nevertheless certain to manifest themselves when circumstances compel. For example, selfishness is the actuating motive in barter. It leads the seller to try to sell at the highest price and the buyer to try to buy at the lowest. Barter and trade are at the foundation of industry and, having been always recognized as essential to prosperity, have been encouraged and protected. The ideal condition for barter is where both parties are absolutely free agents and neither therefore under duress. Too great power, if continued long enough, will always be abused, and just as such power in government becomes tyranny, similarly, too great advantage in barter begets commercial robbery. These statements sound like platitudes, and I should hesitate to repeat them were it not for the fact that they not only bear directly on the present situation between labor, capital and the public but seem to be so frequently forgotten or ignored. Please remember that I am not blaming or praising anyone. I am trying to recite cold facts and to call things by their right names.

How Labor Unions Came Into Existence

In the time-honored barter between employer and employee the employer formerly held the strategic position. As business concerns grew larger, this advantage naturally increased and just as naturally the employers' power was abused. By and by the resulting oppression became sufficiently acute to provoke general resistance, and the labor union came into being. Workmen banded together to eliminate competition among themselves. The effect was generally beneficial because it corrected an evil, and the general public, while not particularly interested, looked on approvingly. But early in their history the unions made a serious although not a surprising blunder. They set up a system of contracts between employer and employee and, because they could escape doing so, provided no means by which the workmen could be penalized for violation, except by the union itself. This flagrant flouting of a fundamental did not for a time have any serious effect, but the blunder once made was never thereafter corrected and it is probable that even today it would be difficult to find a labor leader who could be made to see the seriousness of this mistake, much less to endeavor to rectify it. The World War created an entirely new condition—an imperative demand for men came up almost over night. The effect on the price of labor was axiomatic—it rose. The unions, being the vehicles through which the demands of many classes of workmen could most readily be expressed, at once became active. Wages and prices rose to hitherto unheard of figures. Labor had too much power; their demands had to be met whether or no, and of course they abused their power. Then the unions made another mistake. They credited too much of their successes to their organization and failed to appreciate the part played by the law of supply and demand, also they understimated the power of resistance which would be engendered by oppression. In their turn they became the oppressors—insistent—arrogant. Where their principal weapon—the strike—was not effective as against the employer class in one industry, they enlisted the workmen in other industries and who had no grievance, in sympathetic strikes.

We hear that a new order of things has come to pass; that the "rights" of labor must now be respected; that the workman will hereafter have a greater share of the products of his toil; that he must share in the management of industry and have a recognized place in government and the like. To my mind the facts warrant none of these assumptions. There is no new order—economic laws are the same as they have always been. They are as ruthless and as inexorable as are the laws of physics. Neither has human nature changed. The unions are in the saddle but, to use a hunting expression, they are riding for a fall. Please let me remind you again that I am not blaming the unions—or anyone else. I am trying to confine myself to statements of fact and to logical opinions based thereon according to the precept and training of the engineer.

Situation Confronting the Nation

The individual workman cares no more for his fellow as a class than does the employer. It follows therefore that a union must continue to succeed or it will disintegrate and disappear. The history of the last thirty years has recorded many once powerful unions even the names of which are now almost forgotten. The "Knights of Labor" and "The Amalgamated Associations of Iron and Steel Workers" are two examples which illustrate this point. The strength of organization contending against the mob is very great, and it is probably true that so small a proportion as 10 per cent or even five would prevail under these conditions. That, in fact, is the situation confronting the nation today. This small organized percentage, supported by the operation of the law of supply and demand, has prevailed, but looking into the future it seems clear that there is only needed a sufficient incentive to induce the unorganized 95 per cent or even a small part of them, to get together in opposition to the 5 per cent in order that the latter may be overwhelmed. This incentive has been or will be furnished by union oppression. I say "has been or will be" because the abuse of too great power always grows. Therefore if the unions shall still continue to gain their ends even in the face of their present insolence and ruthless disregard of others, their arrogance and self-confidence born of such success, will inevitably lead them on to acts of greater and yet greater oppression until they force their opponents to combine against them for defense or even for self-preservation. Already there are indications that the people will not much longer submit to domination by the unions. The Governor of Massachusetts defied them, was shortly thereafter reelected by an abnormally large majority and has now been nominated on the Republican National ticket for Vice President, which latter distinction it is safe to say he owes almost entirely to this incident. The State of Kansas has enacted a law to curb union interference with the peace and comfort of her citizens, and her Governor has become a popular national figure in consequence. The temper of much of the daily press has changed, and where formerly there was much said about the so-called "living wage" and criticism of "capitalistic greed," there now appear articles about "the vicious cycle of mounting wages and costs," "loafing on the job" and the "need to teach the people thrift and economy." Whether or not an aroused public does curb union domination, the present high wage era will not be radically affected. That is a condition controlled not by the unions at all, but by the much discussed law of supply and demand.

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*Abstract from an address delivered at Annual Convention, A. I. E. E., White Sulphur Springs, W. Va., June 29, 1920.

Lest I may be misunderstood, I might here state that because I have been confining myself to a discussion of the relations between the employer and the employee and have had much to say about the employee's abnormally high wages, I do not want to be understood as giving that condition as the only cause of the prevailing high prices.

SELFISHNESS A UNIVERSAL TRAIT

Advantage has very generally been taken of the opportunity to increase profits by those who had wares to market, which is only another way of saying again that selfishness is a universal trait of which no class or classes have a monopoly. Government reports of falling exports indicate that the expected lessening of the foreign market for our high-priced products is approaching, and it is not at all unlikely that this may be followed by heavy increases in our imports which will displace American-made goods. This result may come about both because foreign nations are getting into their stride of production again and because the high prices prevailing here have naturally created an attractive market. A combination of these and other conditions will reduce the demand for our products and consequently for the workmen to produce them. The immigration authorities of the Port of New York report their facilities overtaxed to handle the large numbers coming to our shores and say that even those numbers would be far larger if there were only more ships to carry the people who want to come. It is natural to suppose that as the heavy burdens of after-war taxation are brought home to the foreign people, an increasing percentage will seek to escape them by coming here to live and also that the gradual restoration of transatlantic shipping to its normal schedules will afford the greater facilities thus demanded. This augmentation of population—largely workmen of course—will swell our supply and likewise tend to correct any shortage that may exist.

LABOR DOMINATION AND HIGH PRICES TEMPORARY

If my analysis of the facts is correct it is clear that the present domination by organized labor is temporary and also that the era of high prices will pass. Therefore, no material permanent change in either our social order or in our industrial structure is to be anticipated. In the contest between brains and brawn, waged since the world began, brains have always won and brains always will. Free play for the natural forces of trade may be counted upon to exercise a beneficial influence, and they should be hampered and interfered with by government restrictions as little as possible. We cannot, of course, determine from history or from any fact at hand, how long a time it will take for conditions to become normal again, but what we need now is clear thinking, courage and patience. I know that we can rely on the engineer for clear thinking, and I haven't the slightest doubt about his courage, but I am not so sure about his patience. You should be leaders of thought in your several circles. You can help to allay much of the present anxiety about the so-called unrest and the apprehension as to the future, therefore, I feel warranted in asking you to give your close consideration to the subject matter of what I have said this morning.

A.I.E.E. Annual Convention at White Sulphur Springs

ARTHUR W. BERRESFORD

FROM June 29 to July 2 the American Institute of Electrical Engineers held its 36th annual convention at The Greenbrier, White Sulphur Springs, W. Va. The convention opened Tuesday morning with President Calvert Townley presiding. After a few brief remarks on the work of the institute, Mr. Townley delivered his presidential address, in which he gave a very comprehensive analysis of the present strained relations between capital, labor and the public. An abstract of the address is published elsewhere in this issue.

After delivering his address President Townley introduced President-elect A. W. Berresford, who was greeted with a very enthusiastic applause. Mr. Berresford said that he greatly appreciated the great honor that had been bestowed upon him by the members of the American Institute of Electrical Engineers in electing him as their president and was going to do his best to make good the trust placed in him. He paid high tribute to the great work accomplished for the Institute by President Townley during his period of administration.

The reports of the various technical committees were presented at the Tuesday morning session. For some time past there has been considerable controversy over the term "Instantaneous Relay," as a result of which the Committee on Protective Devices appointed a subcommittee to consider a name that more properly described this device. A number of other terms were suggested, of which "quick-acting" appeared to have the preference. On account of the wide diversity of opinion among the members of the committee on the subject, no definite recommendation has been made, and it was agreed that the chairman of the subcommittee would summarize the various opinions on the subject and submit them for publication in the A. I. E. E. *Journal*.

According to the subcommittee on reactors there is still some difference of opinion as to the proper place to insert current-limiting reactors to obtain the best results, but in general the best protection for the service is obtained by installing the reactors in individual feeders, and this is the practice followed by most companies, provided there is the necessary space available. Although some engineers prefer to sectionalize the system by inserting reactors in the busbars, attention is called to the chances of the different sections getting out of synchronism, which become very much of an operating menace.

The subcommittee on resistors for use with potential-transformer fuses reports that a number of operating companies in and around New York City have adopted the standard practice of installing protective resistance in series with potential transformer fuses which are connected to the high-tension busses for the purpose of limiting current and preventing damage to apparatus.

In its report the Committee on Instruments and Measurements says that the various companies manufacturing watthour meter and demand devices practically all report the completion of experimental models, finished designs or actual production of devices to measure kva.-hr. and demand devices for measuring the demands of kva. and kw. and power factor.

In the opinion of the Committee on Transmission and Distribution, 60 cycles is becoming firmly established as the standard frequency for the United States, and its virtually exclusive use for general power supply can be predicted for the near future. The practice of using a grounded neutral connection for the higher voltages is considered to have clearly demonstrated its superiority and is rapidly supplanting the isolated delta connection. In the large low-voltage systems preference for the grounded neutral is evident. The report further states that it is becoming clearly recognized that interconnection of power-supply systems is not to be merely an occasional expedient, but the normal condition, and probably will continue until, eventually, an interconnected system of nation-wide proportions will result. In lieu of this tendency it is important that present work be so planned that it will fit into such development with a minimum of waste.

In the committee's report of the Iron and Steel Industry it is stated that the present total generating capacity required by the industry is approximately 1,000,000 kw. and each new development in the art of steel making opens up new fields for electrical application.

The Industrial and Domestic Power Committee reports an increasing use of the synchronous motors. As a power-factor corrective of industrial loads they continue not only desirable, but a growing necessity to meet a continual problem. In this connection, the use of static condensers has continued as a power-factor corrective.

WEDNESDAY MORNING SESSION

At the Wednesday morning session nine papers were presented. Of these, one on the "Classification of Large Steam Turbo-Generator Failures," by Philip Torchio, with the discussion, appears in this issue. Other papers were: "Ventilation and Temperature Problems in Large Turbo-Generators," by B. G. Lamme; "Temperatures in Large Alternating-Current Generators," by W. J. Foster; "Some Practical Experiences with Embedded Temperature Detectors in Large Generators," by F. D. Newbury and C. J. Fechheimer; and "Eddy-Current Losses in Armature Conductors," by R. E. Gilman.

R. D. Newbury, in discussing Mr. Foster's paper, pointed out that the resistance method of measuring the temperature in the winding was much more accurate than temperature coils located between the generator coils.

It was brought out that there was no method in use that gives the true copper temperature. The resistance temperature-measurement method does not even give the average temperature of the copper in the slot, since the machine has to be shut down, which allows the coils to cool off before the measurement can be made, also the end windings operate at a lower temperature than the coils in the slots.

In discussing Mr. Gillman's paper, F. D. Newbury was of the opinion that it was absolutely impossible to avoid a 100 deg. C. temperature rise on account of certain limitations of design, especially the elimination of eddy currents in the core and copper.

THURSDAY EVENING SESSION

One of the most important meetings of the convention was held Thursday evening, at which was presented the preliminary report of the special joint committee appointed by the A. I. E. E. and the N. E. L. A. on the determination of power factor in polyphase circuits. In addition to the report there were also presented and discussed ten papers dealing with different aspects of the problem. Two definitions covering two different forms of power factor in polyphase circuits were arrived at by the committee, together with some suggestions as to the proper qualifying terms to be applied to each definition. These definitions are:

1. Power factor in a polyphase circuit is the ratio of the total watts to the (arithmetical) sum of the volt-amperes in the several phases, each measured to a non-inductive neutral point. This definition may be otherwise expressed as the weighted mean of the individual power factor in the phases (weighted according to volt-amperes in each phase).
2. Power factor in a polyphase circuit is the ratio of the total watts to the vector sum of the volt-amperes in the several phases.

After considerable discussion covering various aspects of the problem a motion was passed that it was the consensus of opinion at the meeting that polyphase power factor be defined as the ratio derived from the active power and reactive power. The joint committee was instructed to devise a definition on the basis of the discussion at the meeting, to be acted upon later.

FRIDAY MORNING SESSION

At the Friday morning session exciter systems was the subject discussed and six papers were presented: "Considerations Which Determine the Selection and General Design of an Exciter System," by J. T. Barron and Alex E. Bauhan; "Factors in Excitation Systems of Large Central-Station Steam Plants," by J. W. Parker and A. A. Meyer; "Exciters and Systems of Excitation," by H. R. Summerhayes; "The Application of Direct-Current Generators to Exciter Service," by C. A. Boddie and F. L. Moon; "Exciter Practice in the Northwest," by J. D. Ross; and "Generator Excitation Practice in the Hydro-Electric Plants of the Southern California Edison Company," by H. H. Cox and H. Michener. Abstracts of these papers will appear in later issues.

This year's convention proved to be one of the most successful held by the institute from both an engineering and an entertainment viewpoint. Five technical sessions were held, at which a total of 39 papers and technical reports were presented. The convention closed Friday afternoon with a member and guest registration of 325.

Fuel Oil Famine Endangers City Light

Declaring that many Seattle industries and most of the 63,000 consumers of city light will be without electric current at the end of forty days unless additional fuel oil for the Lake Union steam-power plant is obtained, Superintendent J. D. Ross has asked the United States Shipping Board to furnish a tanker to carry fuel oil to Seattle.

The supply of oil on hand now, Mr. Ross said, will not last longer than forty days, and if an accident should occur at the steam plant during that time, the city would be virtually without electric current, so far as the municipal power system is concerned.

Heavy rains are fast taking the little snow left on the mountains, and depleting the amount of power furnished by the Cedar Falls power plant. Lack of hydro-electric power will throw such a burden on the auxiliary steam plant during the months of August, September, October and a part of November that a minimum of 20,000 bbl. of oil a month will be required to turn the wheels of the Lake Union plant equipment.

Hydro-electric development at Seton Lake is now beginning to assume definite form. Plans are to be prepared in Vancouver this year providing for the installation of a large up-to-date plant, the total capacity of which will be 175,000 hp., and which when completed will cost in the neighborhood of $12,000,000. To begin with, a plant of 40,000 hp. will be erected, and this is expected to be finished in two years. It will be the largest hydro-electric power plant, when completed, in the province. The output of the present B. C. Electric Railway plant at Lake Buntzen is 47,700 hp. and that of the Western Power Company of Canada at Stave Lake is less than that.

Proposal that the City Council of Seattle, Wash., appoint a commission to investigate fully the recommendations of Superintendent of Lighting J. D. Ross for developing hydro-electric power possibilities of the Cedar River plant was made by Mayor Hugh M. Caldwell in a letter to the council June 10. The mayor suggested that a commission consisting of three members of the council who are not already committed to some plan or another, three members of the Board of Public Works similarly unembarassed and three engineers not connected with the city, be named to investigate the tunnel project proposed by Superintendent Ross, so that development of additional power may be carried out without further delay.

Classification of Large Turbo-Generator Failures*

By PHILIP TORCHIO,
Chief Electrical Engineer, New York Edison Co.

The experience with this class of electrical apparatus is in a measure less satisfactory than could be desired. The design difficulties are undoubtedly greater than encountered in the design of low-speed generators as used in hydro-electric plants, but the exacting service requirements of large steam-power undertakings demand the maximum of reliability from its generators. To meet these requirements, designing engineers must ultimately produce apparatus more dependable. At the same time users must install and operate their generators under conditions that will be most favorable to their maintenance.

For the only object of reviewing past failures to aid us to avoid repetitions in the future, I have accepted the invitation of the Machinery Committee to give a summary of typical generator failures of which I have a record or report from different installations in this country.

The size of generators investigated ranged from 5,000 to 30,000 kw., the larger units being of more recent manufacture, while the smaller date back from twelve to sixteen years.

The total failures, several occurring on the same unit, amounted to 55, of which 33 occurred in armatures, 16 in fields, 4 in armatures and fields, and 2 in terminals.

The classification of all these generator troubles is as follows:

Armature failures due to:		
Mechanical damages	3	
Heating of windings	17	
Heating of iron	2	
Loose laminations	1	
Moisture in cooling air	3	
Corona shield breaking	2	
Heating at end turn clamping	1	
Overload damaging end turns	2	
Causes undiscovered	2	33
Field failures due to:		
Open-circuited connections	3	
Grounding	7	
Grounding caused by bus short circuit	4	
Loosening of damper windings	2	16
Armature and field failures due to:		
Moisture	1	
Undiscovered	3	4
Terminal failures due to:		
Moisture	2	2

From the above analysis given, it appears that at least 50 per cent of armature failures are due to heating, damaging the insulation. To avoid similar troubles, designing engineers should use insulating materials of proved dependability, maintain low copper temperatures by proper subdivision of copper and transposition of strands in windings and provide liberal ventilation throughout the machine. The operating copper temperatures should be limited at or closely to 100 deg C. Too great range of operating temperatures is bound to cause generator failures.

It may be appropriate here to emphasize a broad general principle to which perhaps we have not given full consideration in the past, and that is that insulated electrical apparatus subjected to too wide operating temperature ranges may be seriously impaired by mechanical bulging and damages to the insulation and the incasing structure, without inherent deterioration of the insulation itself. We found that the insulation, while excellent to withstand the maximum temperatures, was mechanically damaged by the expansion and contraction of the copper which it surrounded. For instance, mica insulation installed in hydro-electric generator armatures, which have only a small fraction of length of a turbo-generator armature and are operated at a practically steady continuous load, last indefinitely at high temperatures, while mica insulation, under the same or lower temperature conditions, in steam turbo-generators operated at partial loads for several hours, then loaded to a maximum and later shut down every twenty-four hours, will fail.

To weed out cracks or latent defects due to defective workmanship at factory or in installation, the test voltage for windings should be raised to three times full voltage plus 1,000.

The large number of field failures on generators of older design using fibrous insulation were practically eliminated in more recent designs by the use of mica and asbestos tape insulation.

Experience seems to indicate that a solid forged field has greater resistance to field stresses under bus short-circuits than laminated field structures or even structures made up of end plates and several central plates a few inches in thickness.

The loosening of damper windings seems to have been satisfactorily overcome, from the experience of the last few years.

From the standpoint of the users it appears important that great care be exercised in the supply of cooling air to prevent moisture of condensation depositing on windings.

DISCUSSION ON GENERATOR FAILURES

W. J. Foster pointed out that it was almost impossible, in the design of large turbo-alternators, to limit the operating copper temperatures to 100 deg. C., as recommended by Mr. Torchio. Mr. Foster emphasized the serious effect of low power factor on the operation of these machines and said that in almost every case the temperature rise was from 50 to 60 per cent lower at 100 per cent power factor than at 80 per cent. F. D. Newbury gave an analysis of all the failures of large turbo-generators, 15,000-kva. capacity and above, put in operation by the Westinghouse Electric and Manufacturing Co. The machines have mica-insulated coils and were designed for a temperature rise of 50 deg. C., but in some cases this rise in spots was as high as 100 deg. C. For the seven years since the first of these machines were put into operation, there have been 22 failures, 11 of which the operating companies have accepted the responsibility for without any question, in 8 of the failures the manufacturing company accepted the responsibility, and the operating company raised a question as to responsibility in 3 cases. In 4 breakdowns, the cause was fire outside of the generator. In 4 other cases breakdown was caused by surges on the system; in these cases the cause of the trouble entirely disappeared when the neutral was grounded. Mr. Newbury classified the machines into high-voltage and low-voltage units, those generating 11,000 volts and above, being classed as high voltage, and those generating less than 11,000 volts as low-voltage equipment. Although twice as many machines have been wound for the high voltages (11,000 and above), breakdowns were equally divided between the high-voltage and low-voltage classifications; that is, 11 failures occurred in machines generating 11,000 volts and above and 11 in machines generating less than 11,000 volts. All these machines have open slot cores which allows the windings to be thoroughly insulated.

R. B. Williamson emphasized the importance of power factor on the operating temperatures of the machine. In regard to Mr. Torchio's recommendation that the test voltage for windings should be raised to three times full voltage plus 1,000, Mr. Williamson said that for the lower-voltage machines it would not be difficult to meet these requirements, but it would be very difficult to insulate a 13,200-volt machine to stand a test of three times this voltage plus 1,000.

W. F. Dawson took exception to the impression that only an all-mica insulation would stand up in a turbo-alternator. From his experience with the smaller-sized units, which covered at least 2,000 machines, 90 per cent did not have mica insulation and the failures have been very few. All machines below 4,000 volts were insulated with treated fabric, where above 4,000 volts mica insulation was used.

J. Lyman emphasized the vital importance that we have generators that will give reliable service. He pointed out that where high temperatures were allowed, breakdowns might occur from expansion and contraction of the windings. He was of the opinion that although it may be impossible to attain what Mr. Torchio has recommended, every effort should be made to make alternators as safe as possible.

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*Paper presented at the 36th Annual Convention of the American Institute of Electrical Engineers, White Sulphur Springs, W. Va., June 29-July 2, 1920.

A. S. Loizeaux was of the opinion that there is considerable evidence that the lack of rigid bracing of the end windings is responsible for failures. He said that if current transformers were installed in the air ducts leading to the generator, they should be removed, as it had been proved that their failures in the air ducts had been the cause of generator fires. He strongly recommended the proper spacing and rigid bracing of the generator leads.

During the discussion it was brought out that the large number of turbo-generator failures being experienced in Continental Europe and England was due to the use of pulled windings in semi-closed slots. The use of semi-closed slots in the core and pulled-in windings is very handy from a manufacturing standpoint, but it is impossible to properly insulate the windings for high voltage.

Philip Torchio expressed the opinion that large generating units are of such importance that the last 10 or 15 per cent capacity makes no difference to the customer, and that low power factor is a handicap to the progress of power development.

Creamery Boiler Explodes at Owosso, Mich.

The death of one fireman and a property damage amounting to $7,000 were the results of a boiler explosion in the plant of the Detroit Creamery Co., of Owosso, Mich. The plant contained two marine dry-back boilers, each 90 in. in diameter by 13 ft. 3 in. long, having an internal furnace, as well as seventy-eight 3½-in. tubes. In a timber structure at the end of the main factory building the boilers were installed, new, in 1913, and there is no record of their having exhibited unusual behavior or signs of distress at any time during the seven years of service.

It appears that the plant was operated pretty much according to the usual routine, until about 5:30 p.m. on June 17, or just a few minutes before the day's run would have been completed, when the explosion occurred. The furnace of boiler No. 2 failed by collapsing its entire length and by rupturing the first girth seam. About 50 per cent of the rivets sheared, and for the balance of the rupture the metal in the sheet pulled out. The rupture extended about 39 in. around the top of the seam, and the upper part of the front course was pushed down and forward until it almost overlapped the rivets in the head seam. The furnace was 47 in. in diameter by 12 ft. 10 in. long, being constructed of five 30-in. sections of ⅜-in. plating. It was of the type technically known as a plain furnace, and was secured to the heads at each end. The girth seams and longitudinal seams of the furnace were of the single-riveted lap-joint type.

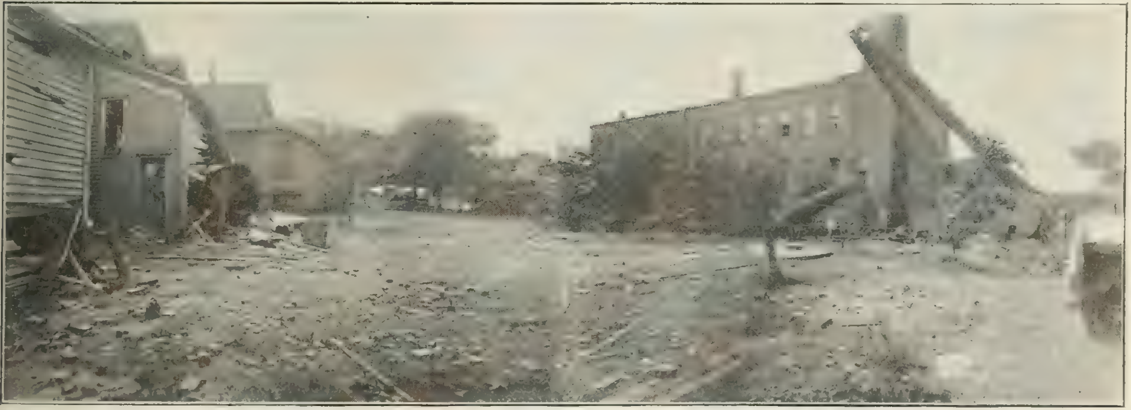

FIG. 1. RESULT OF EXPLOSION AT OWOSSO, MICH.

Only one man was in the plant at the time of the explosion, a fireman who had been employed two days before. Apparently, he had been standing in front of the boiler and, when the steam came rushing out of the furnace door, was blown across the river against the wall of an old packing plant some five hundred feet away. The boiler shell intact was blown sixty feet in the opposite direction against the rear of a residence, crushing the woodshed and moving the house fully a foot on its foundation. Two other residences and an automobile standing near-by were damaged. The boiler house was demolished, the steel stacks toppled over onto the factory building, and the second boiler was moved a few feet from its foundation. It is of interest to state that both boiler shells were uninjured and only require new flues and furnaces to be ready for service.

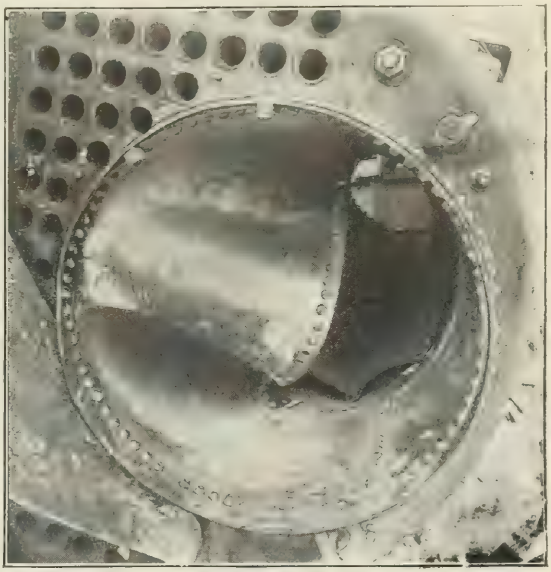

FIG. 2. CLOSE-UP VIEW OF FURNACE THAT FAILED

While an emergency fireman, who was in the plant but a few minutes before the accident, was of the opinion that the boiler contained a sufficient amount of water, several who have examined the boiler since the accident are convinced that the condition of the furnace sheet and the rear boiler head indicated considerable overheating, which may have been the primary cause of the accident. This opinion is somewhat confirmed by the fact that boiler No. 1 which was in service in connection with No. 2 when the accident occurred, had been damaged by overheating. This might have taken place after the accident, however, as the fuel was not removed from the grates for about thirty minutes after the explosion.

The back head of boiler No. 2 had the reddish appearance invariably caused by low water. The ends of the tubes, which had been loosened and were projecting through the back head, gave the same indication. At the rupture the metal in the sheets had been blistered, and where the rivets pulled through the metal had been drawn down and had the bluish appearance indicative of overheating. In cases of this kind a line indicating the water level is usually visible. As there was no indication of such a line, it was the opinion of expert observers that the boiler had been nearly empty and that the firemen had just started to pump water into it. There was testimony to the effect that the boiler was being filled at the time of the accident.

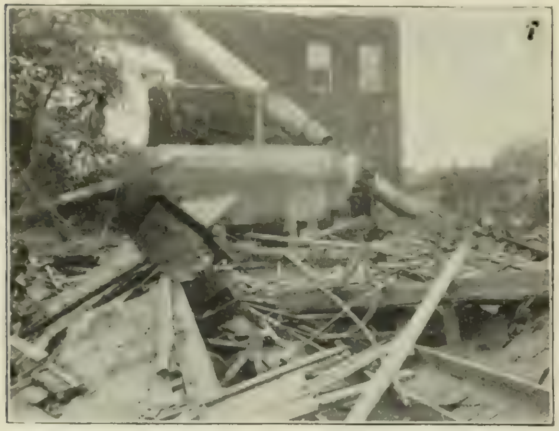

FIG. 2. BOILER NO. 1 AMONG THE RUINS

The first girth seam, being the hottest part of the furnace, would be affected first by low water. With the metal softened by excessive temperature, the joint ruptured and the furnace collapsed both ways from this point.

At the time these boilers were constructed, plain furnaces were in common use, and the length of each section was used as the base for the calculation to determine the safe working pressure. On account of the inherent defects in plain furnace construction, the A. S. M. E. Code now provides that the distance from head to head shall be used as the base for determining the safe working pressure, and limits the diameter of an unstayed furnace of this kind to 38 in. No credit is given to the stiffening of the furnace by the double layers of metal at the girth seams.

It is thus evident that a plain unstayed furnace 47 in. in diameter would not be allowed by the Code today. Even with furnaces of this type nine inches less in diameter, which are allowable, the new method of using the furnace length as the base, so reduces the allowable pressure that furnaces of the corrugated or ring joint type would have the preference. In the present case, supposing a 38-in. furnace, the allowable pressure by the Code ruling would have been less than 30 lb., as compared to a pressure of 85 lb. which the boilers were carrying at the time of the accident, or to 95 lb., at which the safety valves were set. Upon this basis it is easy to see that the factor of safety for a 47-in. furnace must have been unusually low and no doubt this was a contributing factor in the results.

Personals

R. K. Tiffany, project manager of the United States Reclamation Service, has resigned to open an office as consulting engineer at Spokane, Wash

Prof. O. H. Leland, of the College of Civil Engineering at Cornell University, has accepted a position with the J. G. White Engineering Corp., New York City.

Comfort A. Adams, dean of the Engineering School of Harvard University, has resigned to become chairman of the National Research Council, with headquarters in New York.

A. C. Irwin, structural engineer for the Portland Cement Association of Chicago, has resigned as chairman of the national qualification committee of the American Association of Engineers.

Charles F. Kettering, president of the Delco Light Co., Dayton, Ohio, was elected president of the Engineering Club of Dayton at the recent annual election. Mr. Kettering is a fellow of the American Institute of Electrical Engineers.

Doctor F. H. Newell, head of the department of Civil Engineering at the University of Illinois and past president of the American Association of Engineers, has been appointed director of field forces of the A. A. E. during the summer months.

Society Affairs

The Pacific Coast Section of the National Electric Light Association will hold its annual convention at Portland, Ore., July 21-23.

The Stoker Manufacturers' Association, at a recent meeting held at Lakewood, N. J., appointed the following officers and executive committee: Sanford Riley, president; M. Alpern, vice president; A. G. Pratt, treasurer; S. A. Armstrong, and H. A. Hatton, J. G. Worker, secretary.

The Michigan Section of the National Electric Light Association will hold its annual convention at Ottawa Beach, headquarters at the Hotel Ottawa, August 24-26.

The Carson City Chapter of the A. A. E. has changed its name to the Nevada Chapter and the jurisdiction of the chapter has been made to include the entire state except the student chapters.

The Pittsburgh Chapter of the American Association of Engineers is raising a fund for the assistance of a graduate electrical engineer who is partially paralyzed. G. H. Chapp, chairman of the Chapter fellowship committee, is in charge of the fund.

The United Engineering Society, at a meeting of the Trustees, June 24, elected Irving E. Moultrop, of 39 Boylston St., Boston, as a trustee of the American Society of Mechanical Engineers, a member of Engineering Foundation Board to fill the vacancy caused by the death of E. Gybbon Spilsbury, May 28, 1920.

The American Association of Engineers, Oregon Chapter, upon the invitation of W. B. Dennis, chairman of the Oregon Bureau of Mines and Geology Commission, has appointed a committee to assist in making a study of the geology of Crater Lake National Park and later of publishing a report of this district designed for the special use of the tourist. The committee consists of R. E. Kremers, assistant city engineer of Portland, and Joseph O. Barr, consulting engineer, Portland.

The American Association of Engineers has appointed the following engineers on the committee of uniform fees and practice of consulting engineers; Farley Gannett, of Harrisburg, Pa.; A. N. Johnson, consulting highway engineer of the Portland Cement Association, Chicago; C. J. Tilden, professor of engineering mechanics in Yale University; Edwin Duryea, of San Francisco; Langdon Pearso, sanitary engineer of the Sanitary District of Chicago; Wilbur J. Watson, chief engineer, Watson Engineering Co., Cleveland, Ohio; John W. Cunningham, of Portland, Oregon; L. E. Ayres, of Ann Arbor, Mich.; and George W. Fuller, of New York City. W. L. Bonham, consulting engineer, of Kansas City, is chairman of the committee.

Miscellaneous News

"The Ontario Government proposes to raise by bond issues $17,527,000 for the development of hydro-electric power during the present fiscal year," says *The Practical Engineer.* Development of the Port Arthur and Thunder Bay systems will cost $2,500,000 and $10,500,000 will be expended for the Chippewa plant.

The Penn Central Light and Power Co. is planning improvements that will cost approximately $900,000. The plant at Williamsburg, Pa., will be doubled in size and the power increase will be 11,000 kw. A new substation is to be erected at Spangler, with a power line extending to the Patton Clay Works. The improvements also take in the plants at Huntington, Mt. Union and Lewiston.

Business Items

General Electric Co., Schenectady, N. Y., has purchased a twenty-acre tract of land in Philadelphia, Pa., to be used as a site for a new plant, of which the plans for the initial units are already under way. Construction work will start in the fall. It is estimated that the entire plant with equipment will cost $5,000,000.

Trade Catalogs

The Link Belt Co., Chicago, Ill., has ready for distribution a new 23-page booklet entitled "Link-Belt Traveling Water Screens." It contains written descriptions and line drawings of company's newest developments in water screens. A copy will be sent on request.

The Griscom-Russell Co., of New York, manufacturer of oil separators, has ready for distribution a new 11-page catalog describing its line of separators. Line drawings and photographs are used to show the details of mechanism. A copy of the booklet will be sent on request.

Is Bituminous So Scarce?

It is understood generally that the coal shortage is most ute in the bituminous field. Last week we gave conderable attention to this feature. This week we publish a tter from Chicago giving some interesting and exclusive formation.

Chicago, July 6, 1920.

It has been asserted by coal producers, coal dealers, and e Fuel and Railroad administrations that coal cannot be ined unless facilities are provided for its immediate emoval from the mines; that practically no mines can perate more than 72 hours without the output being emoved. At the same time we hear on every hand rumors f a coal shortage, particularly bituminous. Public utilities, unicipalities, factories and small consumers all have the ame difficulty in obtaining sufficient supplies. Dealers state hat plenty of coal is "blocked out" in the mines and plenty f labor available to dig it, but that the atrocious transortation situation is holding up production.

Public utilities, municipalities, factories and individual onsumers all have the same difficulty—despite the fact that roduction has been speeded up in order to overcome the lackness in the latter part of 1919. Some interesting gures:

It is interesting to compare certain figures of production in the bituminous field for the first 146 working days of the last four years:

	1917	1918	1919	1920
Tons ..	257,783,000	265,547,000	201,000,000	241,291,000

The year 1920 is thus 40,291,000 tons ahead of 1919 according to the weekly reports of the U. S. Geological Survey for the week ending June 19, 1920. And this year's production is only 9.1 per cent behind 1918, which was by 5 per cent the greatest year from the oint of coal production in the history of the country. The 1920 production, moreover, is exactly the same as the production of 1916.

The question therefore arises: If production is higher than last year and it is being moved, and if last year's supply was reasonably adequate, what is the reason for a shortage this year if production is 20 per cent higher than in 1919? Another question: If this 10,000,000 tons of coal per week has not gone to the general consumer where has it gone?

Not abroad; at least not more than 1,000,000 tons a week, that being the combined coal dock facilities of the Atlantic Coast. Furthermore, exports have been held down by embargoes. It is asserted that industrial consumption is greater than ever before. This would hardly seem possible, however, in view of the war-time production that has been curtailed.

PROPOSED WORK

Me., Portland—The New England Cold torage Co., 329 Commercial and York Sts., s having plans prepared for a 4 story, 75 100 ft. cold storage building. About 175,000. Haven & Crosby, 40 Court St., oston, Consult. Engrs.

Mass., Boston—The Schoolhouse Comn. eceived bids for the installation of a heating ystem in the Louisa M. Alcott School, from J. Hurley, 104 B'way, $13,394; J. L. earn, $15,300; F. W. Zemier, 321 La range St., $15,494.

Mass., Foxboro—Warren A. Merrill reeived bids for the installation of central lant steam mains at the Foxboro State Hospital from the Power Heating & Venilating Co., 66 Travers St., Boston, $13,055; . J. Hurley Co., 104 B'way, Boston, $15,-60; Hobart & Farrell, $15,528.

N. Y., Albion—Monsignor John S. Reilly, res. of the Bd. of Mgrs., will soon award he contract for remodeling the heating sysem, etc., at the Western House of Refuge ere.

N. Y., Buffalo—The Amer. Car & Fdry. o., 370 Babcock St., plans to construct a story, 50 x 100 ft. boiler house. About 30,000. John N. Cowper Co., Inc., Fidelity ldg., Engr.

N. Y., Buffalo—G. Elias & Brother, Inc., 65 Elk St., is in the market for a 75-100-25 hp., 220 volt, a.c., 3 phase, 25 cycle enerator.

N. Y., Ogdensburg — The State Hospital omn., Capitol, Albany, will soon award he contract for additions and alterations, o the Central Heating Plant at the St. awrence Hospital here.

N. Y., Marcy—The State Hospital Comn. will receive bids for a pump house, and umping equipment, etc., in connection with he water supply and sewerage system at he Utica State Hospital here. About 400,000.

N. Y., New York—J. McE. Bowman & o., c/o Warren & Wetmore, Archts. and Engrs., 10 East 47th St., is having plans repared for a hotel addition, including a team heating system, on 42nd St. About 2,000,000.

N. Y., New York—M. H. Cardo, Archt. and Engr., 160 West 45th St., will soon award the contract for a 4 story loft building, including a steam heating system, at 0-44 Bethune St., for the Wilson Paper Stock Co. About $250,000.

N. Y., Ossining—Chas. D. Rattigan, Supt. of State Prisons, Capitol, Albany, will soon receive bids for a 2 story, 120 x 160 ft. building for capital crime convicts and deendencies at the Sing Sing Prison, here. Heating, plumbing and electric contracts will be sub-let. About $300,000.

N. J., Butler—The Borough Council will soon award the contract for an addition to the electric light plant.

N. J., Trenton—The Bd. of Comrs. will receive bids until July 16, for new pumping equipment, including a centrifugal pump, motor and turbine driven generator.

Del., Lewes—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C. will receive bids until July 23 for removing two boilers, furnishing and installing one 40 hp. vertical tubular, high pressure boiler at the U. S. Quarantine Station, Deleware Breakwater, here.

Del., Newark—Eban B. Frazer, Pres., and the Town Council will soon award the contract for furnishing one 700 g.p.m. horizontal centrifugal pump, direct connected to electric motor, one 700 g.p.m. horizontal centrifugal pump direct connected to electric motor and 85 hp. gas engine.

Md., Baltimore—J. A. Dempwolf, Archt., c/o York Safe & Lock Co., York, Pa., will soon award the contract for a 1 and 2 story, 123 x 400 ft. safe factory, including a steam heating system, on Wilkens Ave. and St. Catherine St., for the Miller Safe Co., Fremont Ave. and Briscoe St. About $1,000,000.

Md., Laurel—C. L. Reeder, Engr., Park Ave. and Saratoga St., Baltimore, has been commissioned to prepare plans and specifications for the construction of a municipal electric distributing plant. About $25,000.

Md., Sparrows Point — The Bethlehem Steel Co. is having plans prepared for a 2 story, 48 x 140 ft. hospital, including a boiler power plant, etc. About $150,000. J. E. Sperry, 409 Calvert Bldg., Baltimore. Archt. C. L. Reeder, Park Ave. and Saratoga St., Baltimore, Engr.

D. C., Washington—Louis Brownlow and Charles W. Kutz, Comrs., will receive bids until July 30, for a superstructure, at the Rock Creek Pumping Station, 27th and K Sts., N. W.

D. C., Washington—The Construction Division, War Dept., received bids for furnishing and installing power plant equipment at the Walter Reed Hospital here, from the Carroll Electric Co., 714 12th St., N. W.

Va., Richmond—The Barnes Safe & Lock Co., 13th and Main Sts., is in the market for one 5 hp. motor, etc.

N. C., Charlotte—The Charlotte Spinning Mill Co. is having plans prepared for a 3 story, 100 x 300 ft. spinning mill and boiler house. About $300,000. Watson Eng. Co., Hippodrome Bldg., Archt. and Engr.

Ga., Atlanta—The E. L. Nash Co., 810 Candler Bldg., is in the market for one 25 hp. upright boiler, etc.

O., Akron—The Goodrich Co., South Main St., plans to build several buildings including a water softening plant and power house on Rubber and Falor Sts. About $1,000,000.

O., East Cleveland (Cleveland P. O.)—The East Cleveland School Bd. is having plans prepared for a 1 story, 48 x 66 ft. heating plant at the Prospect School. Two 300 hp. boilers, stokers, etc., will be installed in same. About $75,000. W. H. Nichles, 1900 Euclid Ave., Cleveland, Archt.

O., Warren—The Bd. Educ. will soon award the contract for a 2 story, 120 x 150 ft. high school, including a steam heating system. About $350,000. R. J. Keich, Warren, Archt

Mich., Buchanan—The city plans to construct extensions to the waterworks system, including the installation of 2 new pumps. Burd & Giffels, Kelsey Bldg., Grand Rapids, Engrs.

Mich., Detroit — The Bd. of Educ., 50 B'way, plans to construct 5 schools. Steam heating systems will be installed in same. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Archts.

Mich., Detroit—The city plans to purchase and install automatic stokers for present boilers, move 2 boilers from present location and reinstall same, build tunnel and install steam lines from Municipal Courts building to Receiving Hospital. About $25,-000. Esselstyn, Murphy & Hanford, Marquette Bldg., Engrs., John Scott & Co., Dime Bank Bldg., Archts.

Mich., Detroit — The Harper Hospital, Martin Pl., will soon award the contract for an 84 x 106 ft. heating plant and is in the market for stokers for boilers, pumps, etc. Albert Kahn, Marquette Bldg., Engr.

Mich., Durand—The city engaged R. A. Murdoch, Engr., Free Press Bldg., Detroit, to prepare plans for improving the waterworks system and pumping equipment, constructing electric driven pumping unit and laying water main extensions, etc. About $50,000.

Mich., Grand Rapids—The Amer. Can Co., 120 Bway., New York City, will soon award the contract for a factory including a steam heating system, on 6th St. About $1,000,000. M. M. Loony, Archt. and Engr.

Mich., Grand Rapids — The East Side Water Power Co. is having plans prepared for rebuilding dam and canal head gates along the Grand River here. About $10,000. Burd & Giffels, Kelsey Bldg., Engrs.

Mich., Grand Rapids—The Portland Hotel, Monroe St. N. W., is having plans prepared for a hotel addition including a steam heating system. About $500,000. Warren & Wetmore, 10 East 47th St., New York City, Archts. and Engrs.

Mich., Lansing—The Michigan Agricultural College engaged A. E. Bowd, Archt., 127 West Allegan St., to prepare plans for a 3 story memorial union building, including a steam heating system. About $250,000.

Ill., Chicago—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids for a 2,000 capacity air compressor for the Illinois Malleable Iron Co., 1801 Diversey Blvd.

Ill., Newton—The city plans to extend and improve the electric light and power plant. About $20,000. Fuller & Beard, Chemical Bldg., St. Louis, Engrs.

Wis., Hartford—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids for an air compressor of a 1,500 capacity, for the Kissel Motor Car Co.

Wis., Milwaukee—The M. J. Walsh Co., 141 Sycamore St., is in the market for one Gleason generator for cutting bevel and spiral gears, etc.

Ia., Cherokee—The State Bd. of Control, Des Moines, will soon award the contract for a waterworks system, including a pump house, pump pit, reservoir and pumping machinery, etc., at the State Hospital here. W. E. Buell, 229 Davidson Bldg., Sioux City, Engr. Noted Jan. 27.

Ia., Muscatine—The Muscatine Packing Co. has awarded the contract for a 5 story, 100 x 200 ft. cold storage building and a 1 story, 50 x 100 ft. power house, in connection with the proposed packing plant, to the Federation Constr. Co., 532 Davidson Bldg., Sioux City. About $1,000,000.

Minn., Farmington—The city plans to construct a pump pit, and install a 500 gal. duplex or triplex pump, motor, etc. About $10,000. J. F. Druar, Globe Bldg., St. Paul, Engr.

Minn., North Branch—The city is having plans prepared for the construction of a sewer and waterworks system, including a deep well and pump, etc. About $75,000. J. F. Druar, Globe Bldg., St. Paul, Engr.

Minn., South St. Paul—The Bd. Educ. is having plans prepared for a 2 story high school, including a steam heating system. About $475,000. J. R. Steveson, Clk. Tolz, King & Day, Pioneer Bldg., St. Paul, Archts.

Kan., Paola—The City Council will soon award the contract for material, including a low and high service pump and a 1,000,000 gal. compound duplex, non condensing double action plunger type pumping engine, etc., to complete the waterworks system. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engrs.

Ariz., Duncan—Joseph Hardy plans to build a 100-ton cyanide mill and install a 75 hp. gas or steam engine, at its gold mine here.

Cal., San Diego—The Pub. Wks. Office received bids for furnishing and installing refrigeration equipment at the Marine Naval Base here from The Kroeschell Bros. Co., 460 North Perry St., Chicago, Ill. Noted June 8.

Ont., Acton—H. N. Farmer, Village Clk., will receive bids until July 19, for a waterworks reservoir and pump house. E. A. James Co., Ltd., 36 Toronto St., Toronto, Engrs. Noted March 9.

Ont., Milverton—S. Petrie will receive bids until July 19, for a waterworks reservoir and pump house. E. A. James Co., Ltd., 36 Toronto St., Toronto, Archts. Noted June 9.

Ont., Stamford—The town plans to construct a waterworks system, including tank, pumps, etc. About $125,000. C. F. Munroe, Niagara Falls, Clk.

Man., Virden—J. M. Leamy, Power Comr., will soon award the contract for the supply of a power house building to be built here, for the Manitoba Power Comn.

Man., Winnipeg—J. M. Leamy, Power Comr., will soon award the contract for the supply of two Semi-Diesel Engines for direct connection to a.c. generator for the Manitoba Power Comn.

B. C., Vancouver—The Canadian Pacific Ry., Windsor St., Montreal, is having plans prepared for a hotel addition, including a steam heating system, on Georgia St. About $1,500,000. Warren & Wetmore, 10 East 47th St., New York City, Archts. and Engrs.

CONTRACTS AWARDED

Mass., Boston—The Schoolhouse Comn. has awarded the contract for the installation of new boilers, etc., in the Lucretia Crocker School, to J. P. Dwyer, 183 Harrison Ave., $7,588.

N. Y., New York—The Dept. of Pub. Charities, Municipal Bldg., has awarded the contract for installing refrigerating machinery at the New York City Home on Blackwell's Island, to H. A. Johns-Manville Co. 41st St. and Madison Ave., $6,500. Noted June 29.

N. Y., New York—The Phillips Jones Co., 1150 B'way, has awarded the contract fo an 8 story office building including a stea heating system, at 1225 B'way, to G Richard Davis, 30 East 42nd St. Abo $500,000.

N. Y., Syracuse—The Atmospheric Nitro gen Corp., Milton Ave., has awarded the contract for a 1 story atmospheric nitroge plant, including a steam heating system on Willis Ave., to J. E. White Eng. Cor 43 Exch. Pl., New York City. About $50 000.

N. Y., Watertown—F. W. Woolworth, 2 B'way, New York City, has awarded th contract for the construction of a 6 stor store and office building, including a stea heating system, to C. T. Wills, 286 5th Ave New York City. About $800,000.

N. J., Passaic—The Manhattan Rubbe Co., Willett St., has awarded the contrac for a boiler house addition, including steam heating system, to Stone & Webster 120 B'way, New York City. About $500,00

Pa., Duquesne—The Bd. Educ. ha awarded the contract for installing a stea heating system in the proposed school addi tion on Hill St., to the McGinness Co., 3 Liberty Ave., Pittsburgh.

Md., Baltimore—The Consolidated Ga Electric Light & Power Co., Lexingto Bldg., will build a 1 story, 56 x 111 f sub-station on the Philadelphia Rd. Abou $42,000. Work will be done by day labor

W. Va., Beech Bottom (Wellsburg P. O —The Beech Bottom Power Co. ha awarded the contract for a 1 and 2 stor 100 x 140 ft. steel building to be used a a machine shop, locomotive repair shop an blacksmith shop, to the Austin Co., Unio Arcade, Pittsburgh, About $80,000.

S. C., Charleston—The Cyclone Starte & Truck Co. has awarded the contract f a 1 story, 100 x 260 ft. factory and a x 44 ft. boiler house, to the H. K. Ferguso Co., Vickers Bldg., Cleveland, O. Abou $200,000.

O., Cleveland—The city has awarded th contract for furnishing and installing hydraulic operated sluice gates for th easterly and westerly sewage treatmen plants, to the Coffin Valve Co., Wade Bldg at $34,140. Noted June 22.

Ill., Centralia—The Illinois Central R.R Co. has awarded the contract for the con struction of a passenger station, freigh house and power house, etc., here, to Jose E. Nelson & Sons, 3240 South Michiga Blvd., Chicago. About $400,000.

Wis., Milwaukee—The Milwaukee Coke Gas Co., foot of Greenfield Ave., will bui a 1 story, 50 x 125 ft. addition to boil house. About $75,000. Work will be do by day labor.

Need Competent Men?

Executives, Operating Engineers, Assistants, Etc.

You can get into prompt communication with the kind of men you need through the

SEARCHLIGHT SECTION

of this paper. Some of the ads in this issue may be of interest to you——

See Pages 82 to 96 **See Pages 82 to 96**

POWER

olume 52 New York, July 20, 1920 Number 3

Are You in the Federation?

THE engineer won the war, but two newspaper men are nominated against each other for the Presidency.

The engineer designs the product, routes it through the shop, and conducts and oversees the complicated processes of production, but the salesman and the financier sit upon the board of directors.

The engineer has expert knowledge of most of the problems of government, national and local. In the Sixty-sixth Congress there were 334 lawyers, 76 business men, 26 journalists, 12 farmers, 13 bankers, 4 engineers and a scattering of other occupations.

Ask the next ten men you meet to name the leading citizens of their communities, and see how many engineers are mentioned.

The submergence of the engineer is nobody's fault but his own. He has been content to be the hired man and let the paymaster's name be on the doorplate. His habit has been to sit quiet in meeting, and let the lawyers, doctors, bankers and business men do the talking.

To change the nature of the engineer, to enhance the public estimate of his status, will take more than time. Public recognition will follow upon public service, if the public, which is fickle and inattentive, knows who renders it.

The engineers can become articulate and be mobilized for collective public service through organization, and a federation ot engineering societies is in process of formation. An account of the organizing congress appeared in Power of June 15, pp. 978, *et seq*. It will succeed if it has behind it a live, quickened, impelling constituency, of which it is the mouthpiece and executive. It will not succeed if it is to be an aggregation of higher lights appointed by preferment and left to try to work out some service which will warrant its continued existence. The united collective interests, the inspiration and incitement of a constituency that knows what it wants done and is watching to see it done, and responsive to every suggestion for supporting action, will make it go.

And if it goes by doing things for the profession of engineering, it will carry you along with it if you are an engineer. It will cost the members of its constituent local societies one dollar a year each. Is it worth this to you ?

This is the engineer's opportunity. He was never so much in the public eye, never the subject of so much public encomium. It is time to act, and the action has already started. If you want it to succeed, your cue is to get your own association to join the federation, and if you do not already belong to an association, club or society which is eligible, join one or organize a local, and help to mobilize the hundred-thousand and more engineers of America for public service and their own welfare.

Reconstruction of a Power Plant Under Operation

By THORLEIF FLIFLET
Designing Engineer, Walter Kidde & Co., Inc.

AN INTERESTING job of boiler replacement work has recently been completed in the plant of the Surpass Leather Co., Philadelphia, Pa. Power production was maintained at normal over the entire period, during which a battery of seven old return-tubular boilers was replaced, two at a time, by three water-tube stoker-fired boilers. This work covered not only boiler replacement, but the elevation of the boiler-house roof, reinforcement of the old stack, the installation of new breeching, the erection of a 60-ton coal-storage tank above the boilers, and a vertical bucket-type coal conveyor to fill this tank. Fig. 1 shows the old boiler-room equipment in the foreground.

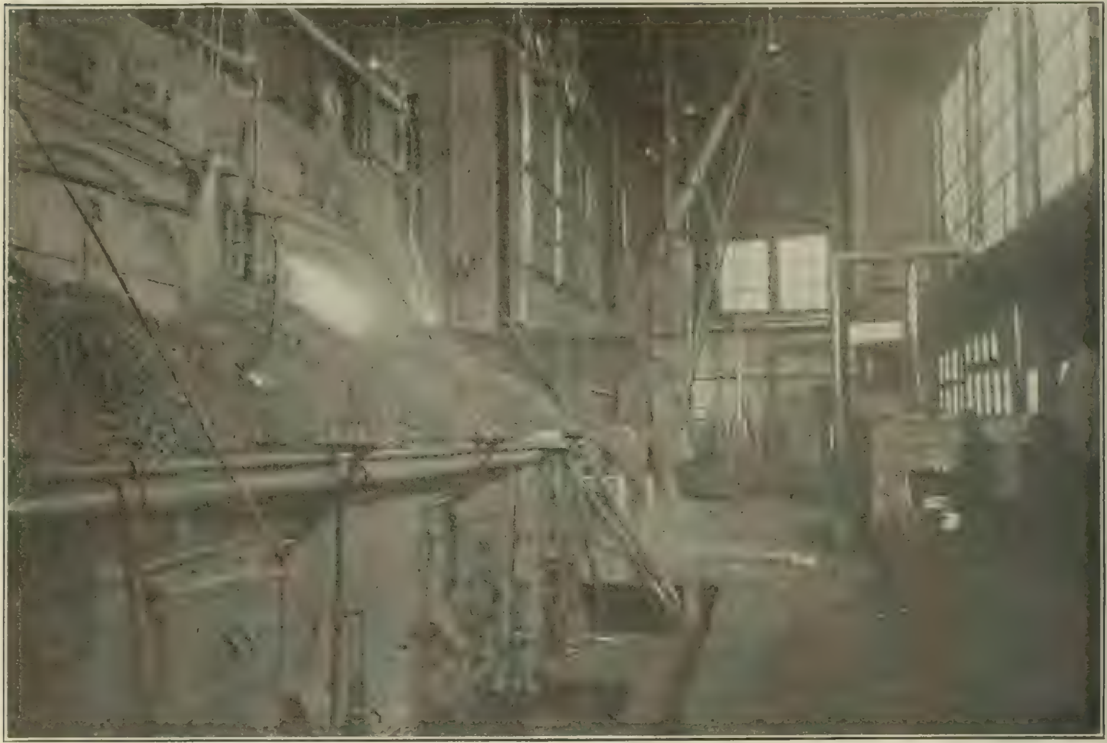

FIG. 1 THE OLD END OF THE BOILER ROOM IS SHOWN IN THE FOREGROUND

A shutdown of the plant would have entailed a loss of many thousand dollars a day. Owing to the necessity of uninterrupted operation and the general cramped condition of the boiler house, the obstacles to be overcome were many.

The system, under the original condition, consisted of a battery of seven horizontal return-tubular boilers of 150-hp. rating, built in 1900, and equipped with overfeed stokers. These boilers completely filled the boiler house. The roof of the latter was set so low that all the steam headers ran through the trusswork. The coal handling was of the crudest type, the coal being dumped from carts on the floor in front of the boilers. It was impossible to use automobile trucks for this purpose without another handling of the coal, inasmuch as they could not be backed into the fireroom. Ashes were wheeled in barrows to an elevator for filling the ash bin. A maximum steam pressure of 110 lb. was carried. Normal evaporation from and at 212 deg. F. was 5.6 lb. of water per pound of coal; the latter averaged about 13,000 B.t.u. per pound.

The primary reason for the replacement of this plant was the fact that the boilers would not pass insurance-inspection regulations because of their age and general obsolete condition. An incidental reason was the need for increased production.

After an investigation of the plant it was decided that the existing boilers would have to be torn out and replaced in separate units. There was no available land for the erection of a new boiler house, which construction would probably have been the simplest solution of the problem in the end. As a result of the investigation a decision was made to install three 500-hp. water-tube boilers, one of these to serve in general as a reserve unit. The question of using the old overfeed stokers or replacing them with the multiple-retort underfeed type was ultimately settled by the decision to use the old stack, after suitable reinforcement of the base to allow for the new breeching required. It was only with a forced-draft stoker that this was possible. Had natural-draft stokers been used, the construction of a new stack would have been necessary to care for the extra rating in boiler horsepower which was desired. The existing stack was 150 ft. high and 6 ft. 6 in. in diameter.

On account of the increased height of boiler house required by the new water-tube boilers, and to allow for the erection of the proposed overhead larry track above the boilers, the roof had to be raised approximately ten feet with a corresponding increase of the height of all four walls. Steel ventilating sash to replace the old wooden sash were installed in the front wall to improve the lighting facilities in the new plant. The running of the steam headers from the old boilers through the trusses presented complications that had to be overcome by installing temporary headers at a lower level to extend below the trusses and to allow for complete freedom in raising the roof on its truss supports. Fig. 2 shows a sectional view of the plant after the new equipment was installed. Prior to the demolition of the old boilers, two temporary, hand-fired boilers of approximately 100 boiler horsepower each were installed in the yard and connected into the main steam header by temporary lines, suitably covered. With these boilers operating as substitutes for boilers 6 and 7 at the end of the original battery, the latter boilers were torn out and the foundation laid for the first unit of the new battery. The coal-storage bin was then erected, with its elevator, which was of the vertical bucket type. The elevator pit was installed in the boiler room. Under the new operating conditions this elevator pit is supplied either by dumping the carts or the automobile trucks through a sidewalk grating. From the overhead storage bin coal is delivered by a motor-driven traveling weigh larry of 2,000 lb. capacity, with a spout to discharge directly to an extended hopper on each respective stoker. Fig. 3 shows the foundation for one of the new boilers.

The first new boiler, the storage bin, larry and track were all installed at the same time so that they would constitute a complete operating unit and be ready for service before demolition was begun on any of the other boilers. Then, maintaining steam by the new 500-hp. water-tube boiler, and boilers 1, 2 and 3 of the old battery, boilers 4 and 5 were demolished and the second water-tube boiler of the new battery installed complete with fittings, etc., ready for operation.

The next step was to operate the two new boilers for the entire plant requirements, cut out old boilers 1, 2 and 3 and demolish the latter two; the third new boiler was erected to take the place of these. Boiler No. 1 of the old battery was left in place until the new battery was complete and operating. Then it was demolished and the foundation laid ready for a possible additional boiler at some future date.

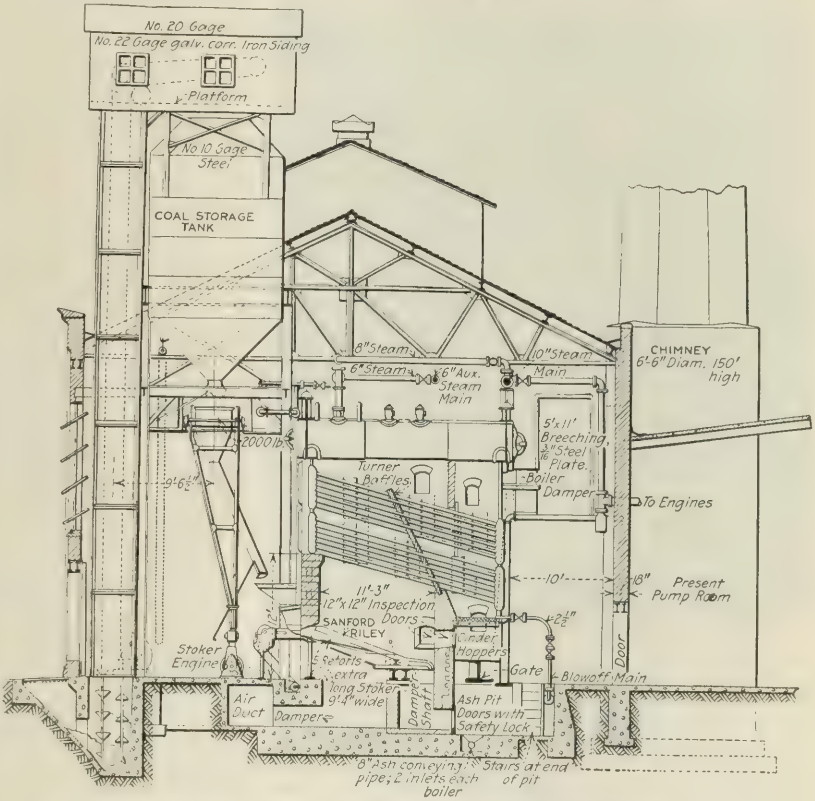

FIG. 2 SECTIONAL VIEW OF THE REMODELED PLANT

During the work of demolition of old boilers 2, 3, 4 and 5 and the erection of the new boilers the two temporary boilers in the yard were kept ready for service with steam up, as a reserve should an accident occur to the operating units.

In carrying out this replacement work one of the most difficult jobs was to cut in the new breeching for each successive new boiler without affecting the draft conditions in the other operating units. After the reinforcement of the base of the stack, the opening for the new breeching was cut in and sealed temporarily. The new breeching was then constructed to provide for each boiler as it was erected. When this was completed, it was then but a question of knocking out the seal left in the breeching at each boiler to cut the boiler into the stack and into draft series with the other operating boilers. It was simple to leave the original breeching in place for the old boilers, as it was fortunately possible to place the new breeching above the old.

The question of feed-water heating and obtaining suitable makeup feed for the remodeled plant involved considerable revision of the old system. Under previous conditions no means of water treatment had been installed. Boiler-feed water was taken from the same feed-water heater (open type) that supplied process water for the tanning plant. Owing to the variable quality of the Philadelphia water in this locality, considerable scale was deposited. It was, therefore, decided to install a feed-water treating system for all necessary makeup feed. An open feed-water heater, was decided upon to serve the boiler plant only, and all condensate was led to this heater. The original open-type feedwater heater was arranged for the sole purpose of furnishing hot process water for general use in the tannery. This water was heated by the main engine exhaust. This revised boiler-feed water system under maximum conditions is based on 8,000 gal. an hour requirements for day load, and 2,000 gal. per hour for night operation. The water-heating system has been constructed so as to be interchangeable with the pump suctions, so that in case either heater should fail it would be possible to swing to the other to supply the plant requirements.

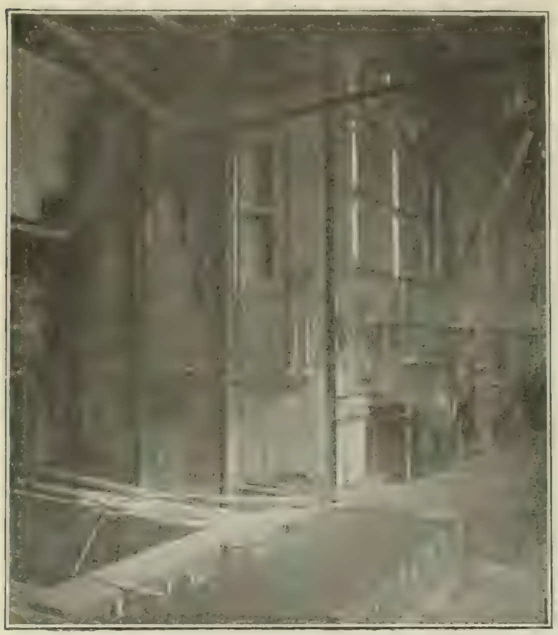

FIG. 3 THE FOUNDATION FOR ONE OF THE NEW BOILERS

Ash handling in the reconstructed plant is carried out by means of a standard steam ash conveyor with outlets adjacent to the ashpit doors in the bridge wall. No basement construction was necessary in laying out this system, as the cross-section of the boiler room shows. Ashes are discharged to an overhead ash bin and run by gravity through a chute to wagons or automobile trucks on the sidewalk.

Forced draft is effected by a duplicate blower system; that is, one small, 50-hp. turbine-driven multivane blower, and one engine-driven plate blower. A forced-draft volume of 30,000 cu.ft. a minute is obtained with one unit operating; the other is held in reserve as a spare for emergency.

Under revised operating conditions, two boilers are operated at 150 lb. steam pressure; the third is kept as a reserve unit. The present normal load averages 1,400 boiler-horsepower with a peak load of 1,800; the normal load for the old plant was 1,200 with a possible maximum of 1,400 attainable. Two water-tube boilers as operating at present under forced-draft conditions with the stoker system develop 150 per cent rating, or 1,500 boiler-horsepower with a possible maximum of 200 per cent rating. The fireroom force is reduced from five to three men on the day shift, and from three to two on the night shift. Today this plant, under the able supervision of Chief Engineer Louis Fletcher, of the Surpass company, is showing an increase in efficiency of more than 25 per cent over the former plant. An average evaporation of 10 lb. of water to a pound of coal is a general feature.

The revised design and construction of this plant were carried out by Walter Kidde & Co., of New York City.

The Public Estimate of the Engineer

The public is beginning to see the engineer; witness the following editorial from the Lexington (Ky.) *Leader*:

"Outside of the professor and the captain of industry few people realize the evolution that has come in engineering. Plain humans have evolved but slowly in a half century, but today you find the engineer everywhere.

"In all walks of production and industry except, perhaps, the industry of farming, the engineer is called in first. Few capitalists will risk their money, and time, on a project until competent engineers have gone over the ground thoroughly and endorsed it. Indeed, it is now a large practice for engineers of ability to seek out independently opportunities for the investment of capital or for the utilization of natural resources. Herbert Hoover himself is one of the successful examples of this latter class, who are sure to grow in numbers and influence every year.

"The engineer is becoming so important, as a matter of fact, that the day may not be long distant when he will take first place in industry and progress, the place occupied for centuries by the capitalist.

"And will not the world be a better place for humans when that happens? The capitalist sits in his office by day, the lord of all he surveys, and at night associates with his own class. His chief affair in life is how to make money and how to spend it. In most cases he is totally materialistic—not entirely because he wants to be, but because his environment and habits of life restrict him. He is cold spiritually because he doesn't mingle personally with the world's throngs. Thus when a problem comes to him involving masses of people, he naturally trends to the materialistic side.

"But the engineer! The very nature of his life's work carries him daily among the people, where he sees their problems, where he is often compelled to live as they live, work as they work and take risks that they take.

"It is easy to recognize which man should have first place in this worldful of human beings—the capitalistic captain of industry or the engineer."

A part of the exhaust steam from an engine should be used for heating purposes and for heating the feed water to the highest temperature, not less than 190 deg. F. in any event. The exhaust main should grade in the same direction as the flow, be drained and trapped and the condensation returned to a feed-water heater after filtering through a separating trap in order to prevent any grease or oil from entering the feed water and making its way to the boiler, as oil will decrease boiler efficiency and is dangerous as well.

Use no live steam at any time where exhaust can be utilized.

Operation and Adjustment of Turbine Machinery—II*

Putting a Machine in Service

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

"ALL those machines running with scarcely a man visible." Such is the comment of many who visit turbine-driven plants. This kind of machinery seems better fitted to take care of itself than other kinds. Inspection can be done by one man at regular intervals, while in the meantime the machines attend to their own business in their own way.

Efficient production of power is a matter of design plus intelligent execution. Regulating steam and water valves requires an understanding and judgment which can be acquired with instruction and practice. Operating does not appear to involve deep and responsible problems.

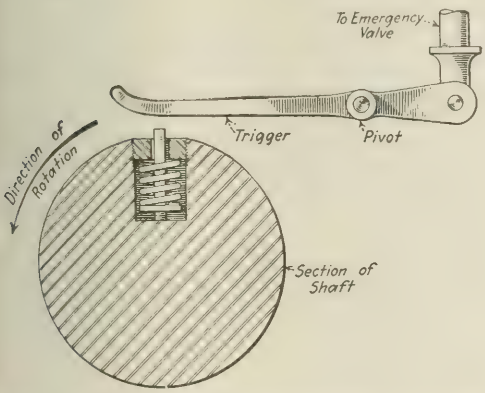

FIG. 1. USUAL FORM OF EMERGENCY SPEED TRIP

However, if a shutdown of the plant should occur, the matter would appear in a different light. Quick action and hard work would be the order until the load was again restored to the plant. A total shutdown might not cost much as actually charged up to loss, but the ultimate effect on the plant might be so great that it could not easily be expressed in figures. The most efficient plant would have to suspend business if shutdowns occurred at frequent intervals, stopping all industrial activities in a community. Most plants would prefer to lose considerably on efficiency rather than a small amount due to a shutdown. The greatest element in operating appears to be the production of power in a dependable way. Manufacturers spare no pains to insure reliability; the salesman dwells on it and the purchaser banks on it. It is up to the engineer to deliver it.

The machinery is often too expensive to be bought in much greater capacity than actually required. Repair work must frequently be done as the load permits, and the engineer is thereby forced to act quickly and to the point. His task is somewhat heavier than listening to the hum of machinery.

Placing a machine in operation for the first time is one of the most important steps of operation. This not only includes bringing the machines up to speed and building up load, but with it goes the responsibility of making sure that the machine is in proper condition so that there will be no risk of damage. If a small machine of about 100 kw. or under is ready to be started, the routine would shape itself as follows: (1) Inspection of foundation, supports and piping; (2) clean thoroughly; (3) fill with oil; (4) inspect mechanical condition and adjust; (5) warm up; (6) start and bring to speed; (7) apply load and carefully observe.

When inspecting the foundation, make sure that the grouting is solid, also of the proper thickness, which should be ⅝ in. to 1 in. between the bottom of the bedplate and the top of the foundation. Grouting inside of the bedplate should be as thick as can conveniently be made.

Piping should be supported so that little strain is carried on overhanging parts such as valve chests or exhaust heads. Usually, 200 to 400 lb. is all the strain that is necessary at any time, and with proper supports it can easily be made less. Expansion should be taken care of by flexible joints or flexible arrangement of piping. In some cases the piping can be anchored at the turbine and provided with rollers so that it is free to expand in a direction away from the turbine.

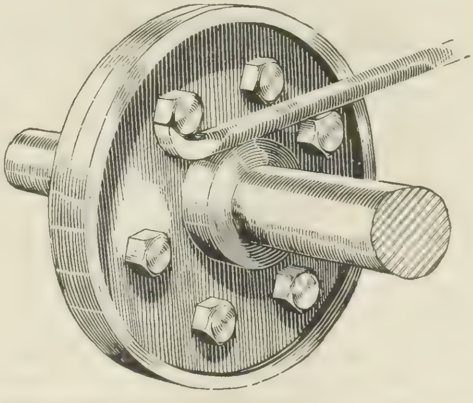

FIG. 2. TURNING MACHINE WITH BAR AT COUPLING

The steam line should contain a drain close to the throttle as well as a strainer for keeping solid objects from entering the turbine through the steam line. The exhaust header should be designed so as to be free of water. If a machine is condensing, see that an atmospheric relief valve is provided through which the exhaust may blow in case the vacuum fails. In some installations with a jet or barometric condenser, the exhaust, under such conditions, would blow freely through the condenser, so that a relief valve would not be absolutely necessary. However, it is better practice to have one so that the relief will be instantaneous.

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*The first article of this series, in the July 6 issue, took up placing the turbine on its foundation.

When cleaning, be careful to follow up splashes of concrete from the grouting so that this will not be left in delicate parts of the generator or the oil system. Dirt and cinders are likely to be carried into the machine during shipment. Loosely covered parts and small spaces should be inspected closely with this in mind.

Look over the generator windings and polepieces carefully with an extension light to make sure that no solid objects are left in the machine. Tools and bolts have been left in this manner with the result that costly damage was produced when the machine was put in operation.

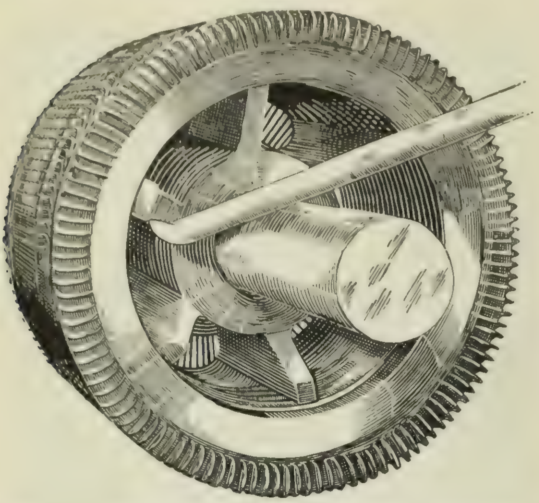


FIG. 3. TURNING ARMATURE WITH BAR INSERTED IN SPIDER

Fill the machine with oil of the proper quality. There is an oil pocket under each bearing as well as a reservoir and, in some cases, a large pumping chamber beside this, which must all be filled with oil. As it is easy to skip one of these pockets when filling with oil, it is advisable to locate all of the oil-system gage-glasses. If one of these pockets is not filled, the oil level will become lower when the pump goes into operation. As soon as this is completed, look over the oil system for possible leaks. There is often a strainer in the oil system, and this should be cleaned before filling and also after the first day's run, as waste and other impurities are likely to clog the strainer when the machine is first started.

In small machines the clearance between the rotating and stationary parts is set in the factory and usually can be depended on to be in good adjustment owing to the rigid construction of small machines. Peepholes are usually provided in the turbine casing for the purpose of observing and measuring these clearances. This examination, together with turning the machine over by hand (see Fig. 2), should be all that is necessary. Clearances in the generator should be looked at with a drop light. Usually, these are correct, but if this should be a special case where they are appreciably unequal, the clearance should be measured from one spot on the rotor to several points on the stator, by revolving the rotor so that the marked spot comes to each point of measurement in turn. With direct-current generators this should be correct within 10 or 15 per cent. Measure to centers of pole faces.

The governor and valve gear should be carefully inspected. If the valve gear is controlled by a steam or hydraulic cylinder, the pilot valve should be disconnected and moved by hand to make sure that there is no sticking. Friction of all kinds must be avoided, including mechanical friction between disk and cylinder of the dashpot, if there should be one.

The overspeed emergency trip should be set and tripped by hand a number of times. It is most important to see that this mechanism works freely. Fig. 1 shows a sectional view of the usual overspeed emergency trip for small turbines.

If there is reason to suspect dirt in the main bearings, they should be looked into. Ordinarily, the test of turning the machine over by hand is sufficient.

When turning over, it is generally easiest to use a small bar about two feet long. Pry between the shaft and a coupling bolt or the inside of the armature spider (see Fig. 3) or some other equally solid part. Be careful not to touch the generator windings, commutator bars or other delicate parts with the bar. Always turn in the direction of rotation. This can usually be ascertained by looking at the trigger arrangement of the emergency trip. The trigger extends from its pivot in the direction of rotation.

If cooling water is supplied to the oil system, this should be tried out. Note if the overflow piping is large enough to carry the water off fast. See that there is no splashing which can be carried into the generator by air suction. If the machine is equipped with a vacuum breaker or other auxiliary devices, they should all be tried out to make sure that they are in good condition.

Before warming up the machine, blow the scale out of the steam pipe. There should be a drain close to the throttle valve which can be used for this. If the drain is trapped, disconnect the line temporarily so that the drain will freely blow. If there is no suitable drain, open up a convenient pipe joint or remove a blank flange so that the pipe scale can be thoroughly blown out. Go over the exhaust line to see that all valves are open. If the turbine is condensing, turn on the steam which seals the packing rings and start the condensing equipment. The turbine casing drains should be well opened. Make sure that the atmospheric relief valve is in good working condition. In case the machine is noncondensing and exhausts into a main with back pressure, the exhaust valve should be slowly opened to allow the exhaust steam to warm it gradually. After this the throttle valve can be used to warm up a little more.

Just before starting, trip the emergency valve by hand and drain the steam line. This is a precaution that should always be taken just before starting a machine. Turn on enough steam to start the turbine. Allow it to speed up a small amount and then shut off the steam. Listen at several points on the wheel casing in succession to see if there is rubbing between rotating and stationary parts. A good way to listen is to place a rod or piece of pipe on the turbine casing and touch the ear to the other end of the rod. Some men hear or feel better by touching the teeth to the rod. Clicking from the valve gear and oil rings is usually heard, but a rub has a strong metallic ring that is unmistakable, and usually loud enough to be heard without a rod.

Next look at the oil rings in all bearings to see that hey are turning properly and carrying oil.

Allow the machine to slowly accelerate. Watch the emperature of each bearing by feeling the liner itself. Also observe closely the amount and temperature of overflow oil from each bearing if it is possible to see this. If the overflow is not accessible, gage the temperature by feeling the return oil pipe from each bearing. Watch the oil-pressure gage as the pump picks up the pressure, and be prepared to regulate the pressure at the relief valve for this purpose. Small machines usually require 3 to 6 lb. per square inch oil pressure, while larger ones run 8 to 20 lb. The oil pressure should be as low as is consistent with safety. The reason for this is that oil will last longer at the lower pressure.

Final adjustment should be made when the machine has reached its highest temperature under load, as the oil is then thinnest and pressure for a given setting of the relief valve is lowest. It is best to consult the manufacturers' instruction book for actual information, and it is the best policy to use an oil pressure that will have two or three pounds in excess of the minimum for good operation. Carefully watch the oil level in case it happens that any important part of the oil system is left unfilled. The bearings close to the turbine generally run hottest on account of the shaft being heated by the steam. In some machines such bearings have been known to run constantly at a temperature of 90 deg. C. or 190 deg. F. Judge the condition of the bearing by the speed with which it heats rather than by the actual temperature. A tight bearing will reach boiling temperature about as soon as the machine will reach full speed, and in some cases, even more quickly than this. It usually takes about half an hour to reach a constant running temperature under proper conditions.

Let the machine accelerate slowly until normal speed is attained. Watch the valve gear closely as the governor goes into action. In case the machine should keep on speeding after the governor has acted, it would indicate improper seating of the valves or bad adjustment of the valve gear.

After an hour's run at full speed, the emergency governor should be tested. Hold a tachometer on one end of the shaft so that the speed can be read by an assistant. Make the macnine overspeed slowly by pulling against the governor or by disconnecting some part of the valve gear so that a valve will be held open. The emergency trip should shut the machine down at 10 per cent above normal speed. It is usually safer and more practical to adjust this emergency to shut down at 6 or 8 per cent above normal. If the emergency trip is too close to normal speed, the machine will shut down when the load comes off suddenly on account of a circuit breaker tripping out.

The generator can now be put into action and the machine run under load for several hours, during which it should be carefully and constantly observed.

(The next article deals with directions for examining and starting large turbines after their erection.)

Trouble-Hunting in Refrigerating Plants

By J. C. MORAN

An incompetent crew lets a plant get in such condition that only about one-half capacity can be had from it. The owners are nearly ready to buy more machines when they call in an engineer troubleman. Under his direction the present equipment is made to give more than adequate capacity. What he finds and does is told in the article.

THE installation consisted of two 100-ton single-acting twin-cylinder machines, two double-pipe condensers, and direct-expansion coils in most of the rooms. A small brine cooler was installed for brine circulation in part of the rooms. The owners were having a lot of trouble in getting enough capacity out of their refrigerating machinery. There was no license law either in the little town where the plant was located or in the state, and as a consequence he who could get a job was an engineer, getting the job being, in most cases, a matter of agreeing to work for the smallest wages.

Engineer and Crew Incompetent

This was also the case in this plant. The engineer had formerly been assistant in the flour-mill plant in a near-by town, but not getting along very well with the chief, had quit and gone back to farming. When the new cold-storage plant was built, he applied for the job and with his flour-mill experience to back him he got it, mainly because he was willing to work long hours for small wages. The manufacturers recommended a man for the job, but he would not take it under the working conditions and for the wages offered. A fireman was obtained that previously had been firing in the flour mill, and he was put in charge as night engineer. A couple of laborers were hired for firemen.

The erecting engineer remained on the job for about two weeks after the plant was in working order and showed them as much as possible about operating it. When he left, the new chief and night engineer were confident that they could operate the plant satisfactorily and that nothing would happen that they could not take care of.

As Load Increased Operation Became Unsatisfactory

The machines had about double the capacity required when the plant was first started, and for a long time it was necessary to run only one machine, even during the hottest part of summer. However, the load increased until it was 40 or 50 per cent greater; this was at the end of three years. By this time the machines were running as fast as they dared to run them and still the temperatures in the rooms were far too high. The engineers claimed that there was nothing else to do but get more machines.

Happening to be in the town on a case of trouble with a small machine in an ice-cream plant, the writer met one of the owners and was asked to look the place over and give an opinion as to what should be done, and to make an estimate of the equipment that would be required.

The plant was in a bad shape. It could be seen without taking the machines apart that some of the valves were leaking, because they would lunge and yank like a pair of horses that do not pull together After figuring everything over several times, I somewhat surprised them when I told them that they had more capacity than needed at present. This I proved by their own records, which showed that they were handling only 40 per cent more goods than at the time the machines were started. And at that time one machine had been big enough for the load.

A New Chief the Best Remedy

When asked what could be done to remedy matters, I frankly told them that the best thing would be a chief who knew his business and who would have a free hand in overhauling the plant. I then gave them an estimate on what it would probably cost to overhaul the plant, which was quite a shock, but when convinced that this was a lot cheaper than to buy new equipment, they finally asked me to recommend a man for the job. This I did, and the new man was on the job a few weeks later. The plant was put on an eight-hour day basis and the two other men were kept working under the new chief.

This was in the middle of winter, and it was possible to handle the load with one machine by running it fast. The worse of the two machines was shut down and overhauled. The false head on one cylinder had probably lifted at some time and a piece of scale had stuck between the head and seat, keeping it open about 1/16 in. around the greater part of the circumference. This accounted for the lunging action of the machine. The valves were also badly scored and the piston rings a loose fit in the cylinder. The seats were ground in both on the false heads and the valves and the piston rings peened to spread them slightly. The piston rods also were taken out and turned true, being slightly smaller in the center and scored from the three years' wear. The old crew had been liberal with oil and packing, and the wear on the machines all around was really less than one would at first expect. Yet most of the oil used in the compressor and stuffing box had gone into the system and accumulated in the expansion coils, and this was largely the cause of the decreased capacity.

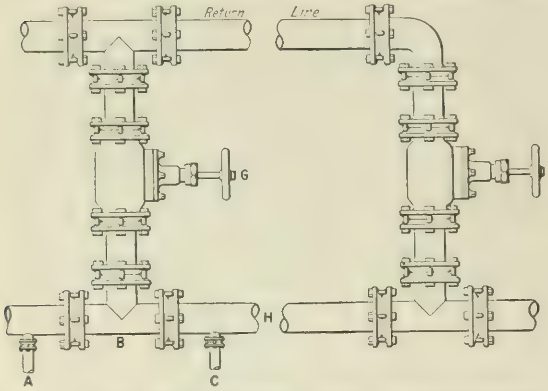


FIG. 1. A LIME-LIKE DEPOSIT PLUGGED THE CONDENSER-WATER CONNECTIONS AT *B*

The bearings, steam cylinder and the rest of the machine were also gone over and adjusted and the steam valves reset. When again started, it seemed like a new machine. When put on the load, it handled the entire plant at reduced speed and the temperatures were held lower than had been the practice for a whole year before.

When the second machine was opened, it was found that the discharge valve had jammed about half open and probably had not worked for several months. At least the night man informed the new chief that this machine had acted like this for several months, but as long as they could keep going they had not dared to shut down and look into it. Besides, they were a little nervous about taking the machine apart, he told the chief.

On the other cylinder one of the screws that held the suction-valve seat in place had worked out and evidently at some time or other jammed between the seat and suction valve, making a heavy dent in the seat and slightly warping the valve. Of course a large proportion of the gas handled had leaked back through this opening, and it is a wonder that the machines had done as much work as they did under the conditions. When the work was finished on the second machine, the result was just as favorable as on the first, and the load was handled easily with either machine.

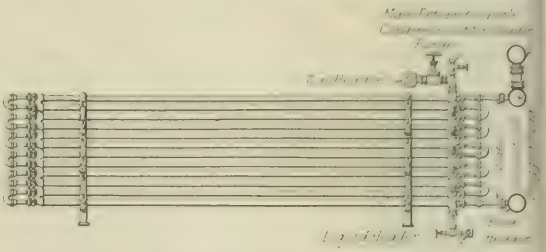


FIG. 2. A SPLIT PIPE IN THE CONDENSER HAD ALLOWED AMMONIA TO BLOW INTO THE COOLING WATER

Overhauling the Condensers

While the work was being done, the chief had been investigating the condensers. This was about midwinter, as stated before, and the water temperature was around 38 deg. The water was taken directly from the city main and pumped through the condensers to a laundry next to the cold storage plant which used all the water the cold storage plant could spare. Consequently, it was to be expected that the condenser pressure should have been pretty low, but it was about 200 lb. Both condensers were in service, too.

The chief cut out one of the condensers and purged it thoroughly two or three times. Then he cut it in and shut down the other. A few minutes later one of the men came rushing up on the roof where the condensers were located and informed the chief that the condenser pressure had jumped to 230 lb. and that they had shut down the machine.

They again started the machine and the condenser pressure came up to 225 lb. in a short time. Only by running the machine very slowly could the pressure be kept down to 200 lb., and it was left to run this way until the other condenser was purged, it being a fairly cool day, and the coolers would probably have been in good order if the machine had been shut down for five or six hours. However, they considered it better to keep the machine turning over slowly and get what they could out of it.

After giving the second condenser a good purging, the condensers were changed over again and this time the pressure dropped to 110 lb. The condensers had never been purged since started, and this accounted for the high pressure, both condensers being full of air and foul gases. The fireman in particular was greatly pleased with the changed conditions as it made a material reduction in the amount of coal he had to shovel.

The next problem was to determine what was wrong with the other condenser. The new chief had an idea that the trouble was in the gate valve *G*, as shown n Fig. 1. When it was opened for inspection, it was found in good order. While inspecting this valve, however, one of the men noticed a white substance, like lime, just below it, and this was the cause of the trouble.

THE CONDENSER-WATER CONNECTIONS WERE CLOGGED UP

The condensers were of the double-pipe type; the diagram illustrates the water connections to both of them. No. 2 was the condenser that would not work. The lime-like mass lodged at *B*, and this had practically closed the passage through the tee to the return line; *A* and *C* are the water-pipe connections to the two stands on either side of the tee.

The caps were removed from the ends of the water header *H* of this condenser, and with a long rod the obstruction was poked out. In doing this a strong flow of water was kept going and the line and header cleared in a hurry. When the condenser was again put in service, it remained at practically the same pressure as the other.

No one was able to account for the presence of the foreign matter in the tee, and no further thought was given to it at that time. About two weeks later this condenser was cut out for a thorough overhauling, and the first thing to be done was to remove the water-return bends on each stand, Fig. 2, to test the pipes for leaks. When these were taken off the stand, it was found that the pipes were filled with this same lime-like substance for several pipes down. This was poked out and the pipes run through with a tube scraper. When a pressure test was tried on this stand, it indicated a bad ammonia leak in one of the pipes. The pipe was removed, and it was found that it had split for about an inch and a half and allowed the ammonia to blow continuously into the water.

The ammonia had formed some chemical compound with the foreign matter in the water. This had filled up the pipe at the tee where it connected to the return, and with the increased obstruction nearly all the water had taken the less obstructed path through the other condenser until circulation through No. 2 had stopped, or nearly so.

OBSTRUCTION IN COIL

In one of the rooms they had been unable to get the proper temperature for nearly a year. Originally, this room had maintained a temperature of about 15 deg. without much trouble, but for the last year they had been unable to keep it much below 40 deg. and they had been obliged to use it for storage for only high-temperature goods. The room had a single coil about 2,000 ft. long. At first, when a fair load was put into the cooler they had been able to open the expansion valve about half a turn without throwing liquid into the suction line. After the trouble appeared, it was possible to work it with the valve barely cracked, and even then it would sometimes throw such heavy slugs of liquid into the suction line that it would freeze the machines in a short while.

The new chief experimented with this coil and room for awhile without results. During the time he was making his experiments he noticed that the liquid level in the ammonia receiver bobbed up and down. If he shut this coil off and pumped it out he had the receiver full of liquid, and after he started the coil working he found that the liquid level in the receiver would drop out of sight. After studying the matter over for the better part of a week, he detected the cause of the trouble.

He came to the conclusion that there was an obstruction somewhere in the coil and that the most logical place to look for it was, of course, in the suction stop valve. When this was removed, it was found that the disc had worked loose from the stem, and as it had been placed in the line in the wrong position the flow of the gas through the valve had a tendency to pull the disc down on the seat instead of lifting it off, as would have been the case if it had been installed in the reverse position.

The disk had not seated squarely, but obstructed the passage enough so that when the coil was working a pressure was built up in the coil. This, in turn, raised the boiling point of the ammonia, and if the expansion valve was opened much the coil gradually filled with liquid. The feed was connected at the bottom, and as a consequence the coil filled nearly to the top with liquid. This was the reason the ammonia disappeared from the receiver when this coil was put in operation. After the valve was repaired, no further trouble was experienced.

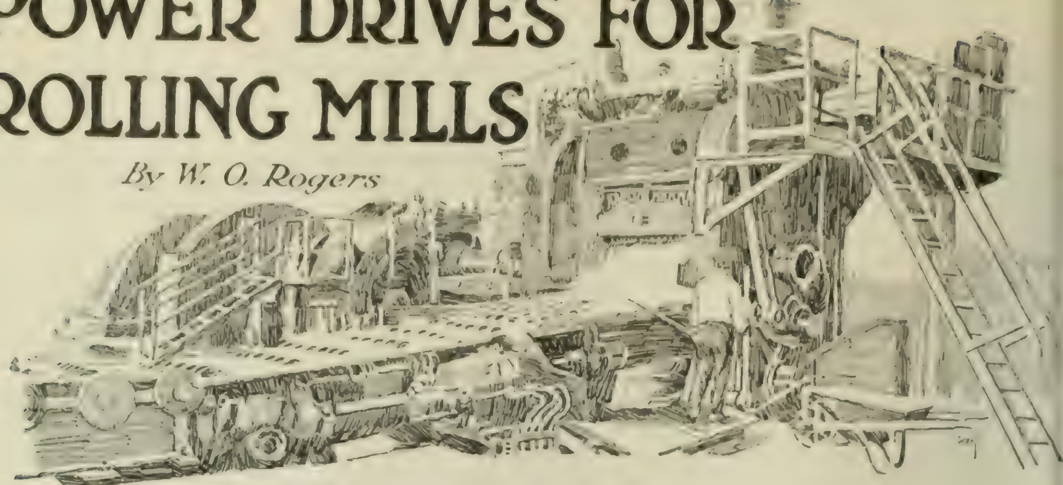
Diesel-Engine Speeds

The Diesel-engine manufacturer is confronted by a decidedly dangerous competitor. In the last few years a number of surface-ignition engines have been built in sizes above 200 hp. One European concern has installed engines of 600 hp. and is now building a 1,000-hp. unit. These engines are cheaper to build and are rapidly encroaching on the Diesel-engine field.

If the Diesel manufacturer does not wish to lose that part of his business devoted to units under 500 hp., it will be necessary for him to increase the Diesel speed and thereby lower the manufacturing cost. There is no structural reason to prevent Diesel engines, when properly designed, from operating at speeds as high as 400 r.p.m. Units of 500-hp., if operated at 300 or 400 r.p.m., could be manufactured at one-half the present cost. The chief objection that might be raised would be that this speed would be impossible for the air compressor. The compressor could be motor-driven or abandoned altogether. Lighter valve rigging and reciprocating parts would reduce the frictional loss, which in the present-day Diesel is excessive. Marine Diesels have been designed to operate at the higher speeds; provided with a suitable foundation, this same engine would have a life equally as long as has the present-day ponderous slow-running machine.

With tight boiler settings, preventing infiltration of air, a clean heating surface, covered pipes, tight steam valves, pipes properly drained, and all condensation returned to a feed-water heater or economizer and using exhaust steam whenever it is practical, a good start has been made to prevent waste of fuel.

POWER DRIVES FOR ROLLING MILLS



By W. O. Rogers

Rolling mills are driven by both direct-current and alternating-current motors. Direct-current motors are operated at constant speed; so are the single-speed induction motors, but both types are also operated at variable speeds, a regulating set being used to control the speed of the main motor when of the alternating-current type.

As IS well known, the first commercial use of electricity was for lighting, and it was next applied to street-car propulsion. It was not long, however, before it was introduced in industrial fields. Naturally, motor drives were tried out with some apprehension on the part of mill owners, but this soon gave way to confidence, and today there are something like 10,000,000 hp. in electric motors in use in the United States. In recent years great strides have been made in the application of motor drive to rolling mills, so much so that something like 900,000 hp. in motors, devoted to steel-mill practice, have been installed.

As with steam-driven mills, electrically driven main rolls are divided into three classes—single speed, three-high and two-high nonreversing mills, and two-high reversing mills. In the first and second class of mills they generally consist of a single stand containing three rolls, as for instance, mills rolling plate; or they may consist of a group of stands containing two rolls each or three-high stands, such as are used in rod or merchant mills, and driven by a single engine or motor.

The third class of mill consists of a single stand containing two horizontal rolls such as used in reversing blooming mills, or a combination of two horizontal and two vertical rolls, as mentioned in the preceding article in reference to the reversing universal mill. These rolls may all be driven by the same engine or motor or each set may be driven by a separate source of power.

Single-speed mills are generally driven by single-speed induction motors, largely because alternating current is distributed about the plant, but direct-current motors may be used. As in the case of engine drive a flywheel is generally used to assist the motor in carrying the peak loads, which are high but of short duration. When flywheels are used, provision is made for controlling the motor by automatically cutting in or out resistance in the rotor circuit, when the load exceeds a predetermined amount. This causes the motor to slow down, and the flywheel then carries its part of

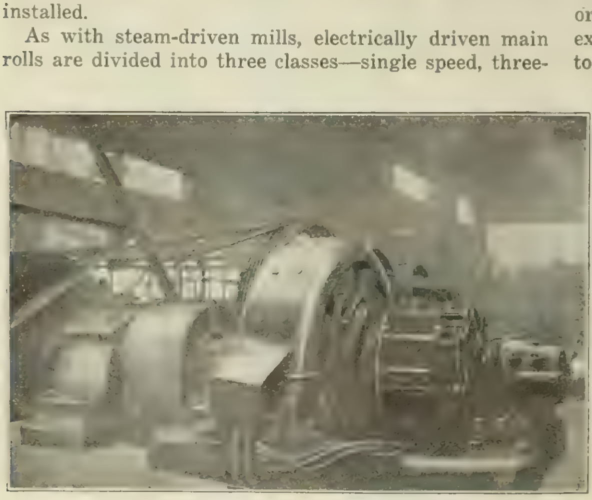


FIG. 1. A SMALL 500-HP. DIRECT-CURRENT MOTOR

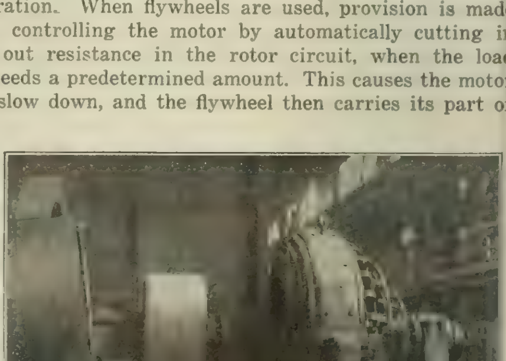


FIG. 2. A 1,500-HP. FLYWHEEL D.C. MOTOR

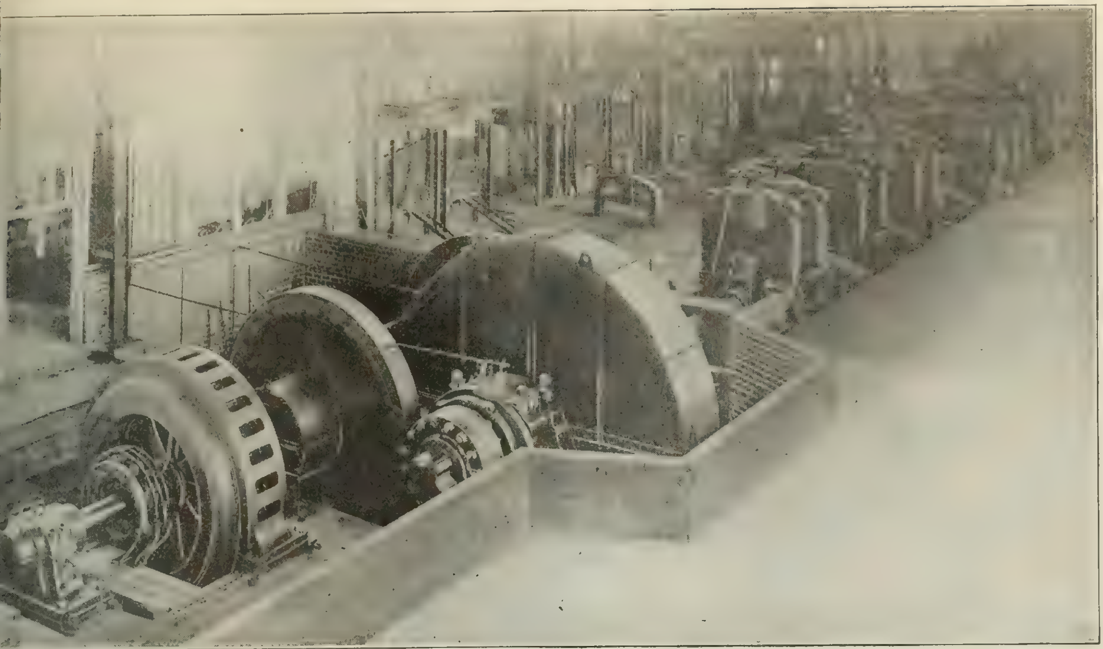


FIG. 3. DOUBLE FLYWHEEL INDUCTION MOTOR DRIVING A PLATE MILL

he load. The flywheel also reduces the shock which, f there were no flywheel, would be transmitted from he mill back to the motor.

In Fig. 1 is shown a small General Electric 230-volt, 00-hp. direct-current motor, with a speed of 190 r.p.m. t is of the flywheel type and operates the roughing tand of the 14-in. bar mill at the Sharon Steel Hoop o., Sharon, Ohio. In this instance a rope drive is sed. The 14-in. bar mill is driven by a flywheel-type, 30-volt direct-current motor, Fig. 2. It is of 1,500-hp. apacity and is directly coupled to the mill by means f a spring coupling.

A double flywheel unit shown in Fig. 3 consists of a Vestinghouse induction motor of 1,500 hp. capacity running with a speed of 234 r.p.m. It receives current at 2,200 volts, 60 cycles. The motor has two flywheels, one being mounted on each side of the pinion. The inner flywheel is between the pinion and the coupling to the motor. The other flywheel is mounted on the end of the pinion shaft that extends beyond the outboard bearing. The herringbone pinion meshes with a large gear of like design on the roll shaft of this plate mill, which is at the Canton Sheet Steel Co., Canton, Ohio.

The motor is provided with a slip regulator which slows down the motor automatically during periods of heavy load, thus permitting the flywheels to give up their energy and reduce the peak load on the electrical

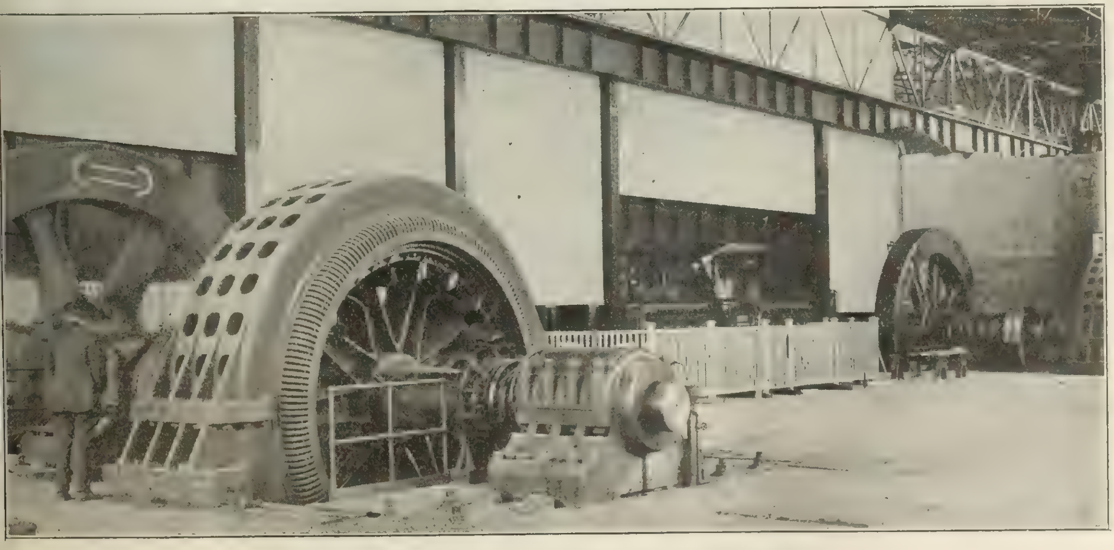


FIG. 4. TWO 2,000-HP. FLYWHEEL INDUCTION MOTORS

power system. It will be seen that the flywheels are arranged on the pinion shaft instead of on the mill shaft, which permits the use of comparatively light wheels with large flywheel effect. It is necessary to place the flywheel on the pinion shaft, because, in this type of mill, which runs at about 30 r.p.m., there would not be sufficient flywheel effect in the system if the flywheels were placed on the mill shaft.

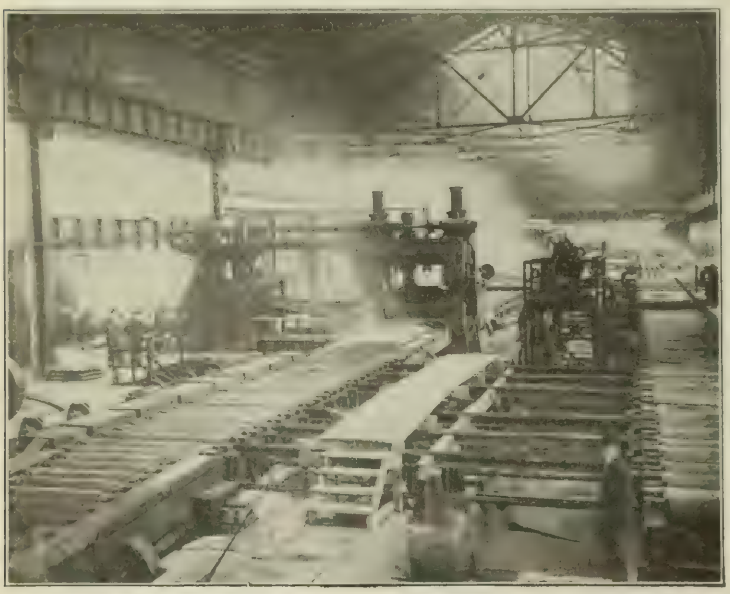


FIG. 5. AN 84-IN. THREE-HIGH PLATE MILL, MOTOR-DRIVEN

A view of the motor room of the 84- and 96-in. plate mill at the main plant of the Youngstown Sheet and Tube Co. is shown in Fig. 4. Both of these Allis-Chalmers motors are of 2,000-hp. capacity and are of flywheel type, operating at 81½ r.p.m. Both use 6,600-volt, 25-cycle three-phase current. These plate mills are shown in Figs. 5 and 6. Both are of the three-high type, and the rolls on the 96-in. mill are lifted by hydraulic pressure. The adjustment is by means of a motor drive.

A 3,500-hp. 78-pole General Electric induction motor was found operating the 18-in. sheet bar mill at the Trumbull Steel Co., Warren, Ohio. This unit, Fig. 7, runs at 92 r.p.m., with a voltage of 2,200. The motor drives the mill through gears, the mill stands being at right angles to the motor shaft. Still another General Electric motor of similar character was found driving the 110-in. plate mill at the Sparrows Point works of the Bethlehem Steel Co. This unit is of 4,000-hp. capacity and is of the flywheel type. As seen in Fig. 8, the flywheel is mounted on the shaft between the motor and the outboard bearing.

The flexibility of mill operation with electric drive has permitted a wide range of production and a variation in mill schedule that has been a factor in increasing tonnage. In three-high mills the adjustable-speed alternating-current motor drive gives a wide range of speed with a variation ranging in many cases down to 40 per cent. The equipment can be designed for either constant-horsepower or constant-torque requirements, but a majority of mills require approximately a constant horsepower. Fig. 9 shows a 1,500-hp. adjustable-speed alternating-current motor that is directly connected to an 18-in. merchant mill at one of the Carnegie Steel Co.'s plants; another one of the same capacity operates a 12-in. merchant mill at the same plant, and a 2,500-hp. unit operates a 16-in. hoop and bar mill at the Phillips Sheet and Tin Plate Co., Wenton, W. Va. This drive uses 6,600-volt current. The first two motors are 25-cycle, the latter two motors are geared connected to the mill, the speeds being 28-218-145, 360-240 and 176-352 r.p.m. respectively.

Although direct-current motors are used to drive adjustable-speed mills, the three-phase induction type of motor with phase-wound rotors is generally used. The stator winding is the primary and the rotor winding is the secondary. When voltage is sent to the primary winding, the alternating current in the coil builds up a magnetic field which revolves at a speed that depends upon the frequency and inversely upon the number of poles. In the secondary winding a voltage is generated which is a maximum when the rotor is at a standstill,

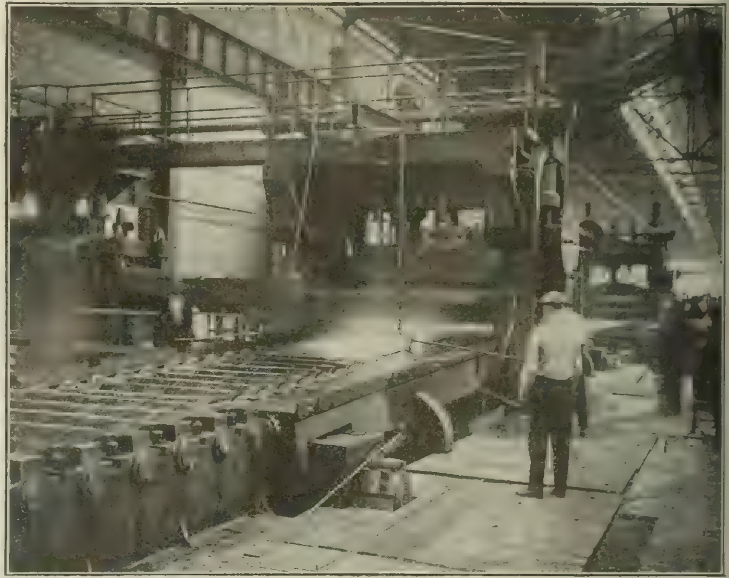


FIG. 6. A 96-IN. ELECTRICALLY DRIVEN PLATE MILL

and the secondary frequency is then the same as the primary frequency. The current flowing in the secondary winding exerts a torque that causes the rotor to revolve in the direction of the rotating field. The rotor speed continues to increase, but the secondary voltage and frequency will decrease until the secondary voltage is of a value to send sufficient current through the winding to produce the necessary torque. If the load remains constant and the speed of the motor is reduced by means of putting resistance in the secondary circuit, then at any other speed the voltage and frequency are practically proportional to the slip in percentage of the synchronous speed.

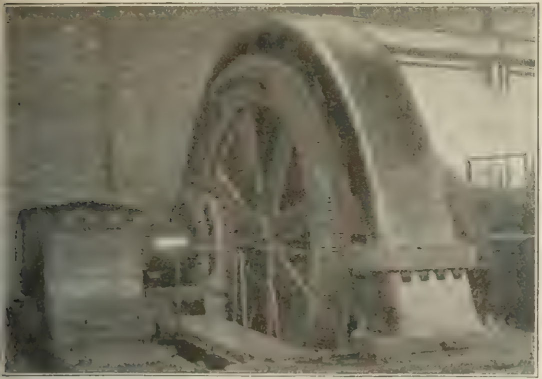


FIG. 7. THE 3,500-HP. INDUCTION MOTOR DRIVING AN 18-IN. SHEET BAR MILL

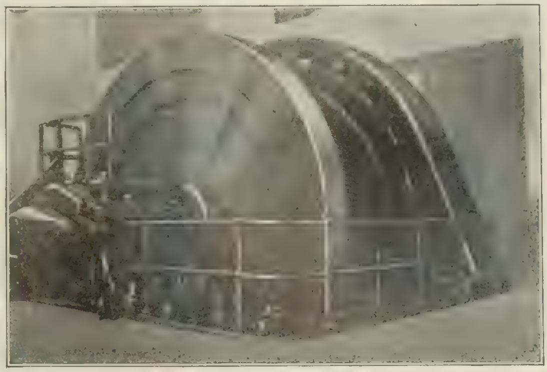


FIG. 8. A 4,000-HP. FLYWHEEL-TYPE INDUCTION MOTOR

But if a constant voltage at rotor frequency is used to oppose the secondary voltage, the rotor speed will adjust itself to such a value that the secondary voltage exceeds the opposing voltage by an amount equal to that necessary to send through the circuit sufficient current to develop the required torque. The speed of the motor can be changed by varying the opposing voltages if the opposing voltages are adjustable. A means of adjusting the voltage on the secondary winding of the main motor is provided in a regulating set. This regulating set consists of a squirrel-cage induction generator, and a direct-current machine, the induction generator returning energy to the line.

Induction motors are generally provided with magnetic control when speed-regulating sets are used, which provides for the proper interlocking of the various circuits. The control is so designed that certain operations must follow in sequence when starting the main motor when operating with the regulating set.

In starting, the master control which governs the operation of the contactors controlling the main motor must be in the off position. Next, the speed-regulating rheostat must be placed in the starting position, which corresponds to the setting at which the regulating machine generates no voltage. Then the regulating set must be started from a starting compensator by the squirrel-cage machine acting as a motor. The main motor may then be started with resistance in the secondary circuit, by the operation of the master controller, and this resistance cut out as the motor comes up to speed. Provision is also made for operating these motors without the regulating set if such became desirable.

A three-high finishing stand of the 84-in. mill at the Briar Hill Steel Co., is driven by a 2,500-hp., 2,200-volt induction motor running at 240 r.p.m. It is coupled to the mill through a single reduction gearing in the pinion housing, which gives the rolls a speed of 50 r.p.m. This unit carries a 31-ton flywheel mounted between the motor and the pinion bearing. Two stands are used in tandem, the roughing stand reversing and the finishing stand three-high continuous..

The 132-in. plate mill is a three-high unit and is driven by a 5,000-hp. motor having the same general features as the one that drives the finishing stand of the 84-in. mill. It runs at 197 r.p.m. and is connected to the mill through reduction gears in the pinion housing, which gives the rolls a speed of 45 r.p.m. The flywheel weighs 60 tons, and a liquid slip regulator limits the peaks on the motor. This mill rolls a slab having an average weight of 2,670 lb., an average thickness of 7 in. and 28 in. wide; the average size of the finished plate is $\frac{7}{16}$ in. thick and 72 in. wide.

It will be interesting to note that the power consumption of the entire 84-in. mill during one run of 12 hours was 52.3 kw.-hr. per long ton, and that the power consumption on the main drive was 4,850 kw.-hr. and 9,950 kw.-hr. on the main motor of the three-high finishing mill. On the new 132-in. plate mill the figures available show that the consumption was 43.6 kw.-hr. per ton; the power consumption of the main motors was 31.5 kw.-hr., and the power consumption per ton of the auxiliaries was in this instance 12.1 kilowatt-hours.

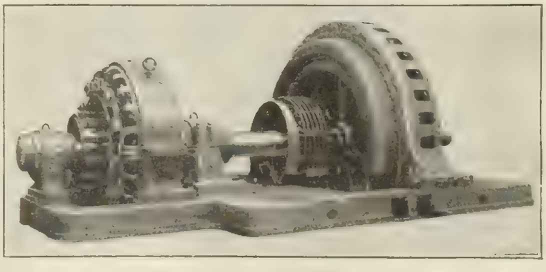


FIG. 9. A 1,500-HP. ADJUSTABLE-SPEED ALTERNATING-CURRENT MOTOR

(Large reversing mill motors will be taken up in the next article.)

Steam-Engine Operation and Maintenance—Knocks Due to Connecting Rods and Pistons

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

THE connecting-rod brasses are subject to more or less trouble. There is first of all the wear in the bore; this is taken up by adjustment, as far as it will go. It will happen that the wear on one half of the boxes is much greater than on the other, in which case one or more liners may be inserted behind each box, as shown in Fig. 1. As the brasses wear, the distance between centers should be checked and readjusted; if both wedges are on the inside, shims are again resorted to. There is also a possibility of the brasses showing some wear on one or the other of the faces, which is generally due to the engine being out of line; this may cause a disagreeable pound. It can be remedied by soldering a thin washer of copper or brass on the face of the box, as shown in Fig. 2. A pair of spare brasses for each end of the rod help if there is trouble with the old ones. Trouble with the adjusting bolts is always a probability. With the increase in engine speeds this trouble has multiplied; it seems to be due to vibration caused by the fore and back movements of the wedges, which expose the bolts to bending strains; they break under the heads, which is naturally the weakest spot for steel on account of the large reduction in diameter. These bolts should never be made from machine steel and should not be cut from a solid bar; they should be forged of the best quality of wrought iron having a good fiber and great difficulty, like Norway or Swedish iron. A simple test of the quality of the material would be to clamp one of the bolts in a vise and hit the head several hard blows with a hammer in different directions. This will show whether the head can be broken off or not.

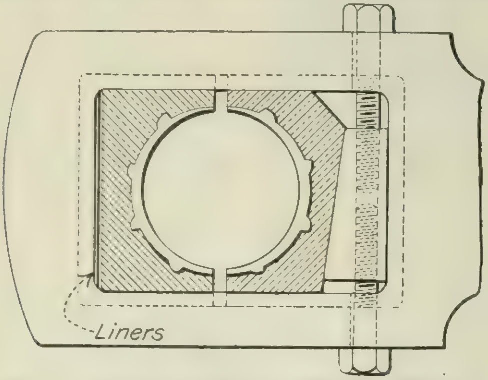


FIG. 1. LINERS TO TAKE UP UNEQUAL WEAR IN CONNECTING-ROD BRASSES

Probably 90 per cent of the connecting rods made have solid ends, similar to the design shown in Fig. 3. If one of the bolts breaks under the head, it is sometimes quite a job to remove the wedge, especially if the bolt fits tight. Since brasses and wedge have to come out together in this construction, the wedge bolts must be first removed. Sometimes there is a chance to get hold of the broken bolt with a pipe wrench, but if not or if the bolt cannot be backed out with a chisel, a hole must be drilled into it so that it can be screwed out by using a reamer. Some engineers prefer one long bolt (shown at *B* in Fig. 3) to the two short ones; it is less likely to break, and if it does there is a better chance to back it out. The disadvantage is that the wedge cannot be locked.

The crosshead end of the connecting rod is mostly rounded to conform with the cavity in the crosshead, as shown in Fig. 4. The small half of the brasses is rounded, following the shape of the rod, which is inconvenient for inserting shims. It requires some skill to solder the strips to the brass and fit it again so it will bear all around the cavity.

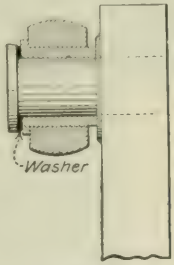


FIG. 2. WASHER SOLDERED ON FACE OF BRASSES TO TAKE UP SIDE PLAY

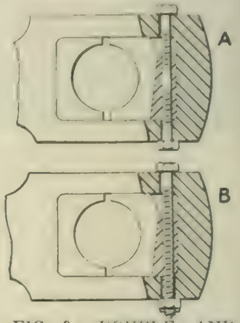


FIG. 3. DOUBLE- AND SINGLE-BOLT WEDGE ADJUSTMENT

There are quite a number of places on the piston and rod where a pound may develop. The fastening at the crosshead, of whatever kind it may be, may get loose, a cotter will back out or the rod unscrew, even far enough to let the piston strike the back head. The trouble with the cotter or wedge is sometimes attested by the outer end being mashed by hammer blows in efforts to tighten the rod. Where this has been done, it would be worth while to do a little investigating, there is evidently some trouble that should be corrected. For some reason or other the taper end of the piston rod may have been forced into the crosshead deeper than was originally intended, the insignificant shoulder on the rod not offering sufficient resistance, and the condition may be as represented in Fig. 5. In that case no amount of hammering will permanently tighten the rod. It will tend to break off the end of the rod. The only effective remedy will be a new rod and wedge with plenty of clearance between the shoulder and face of the crosshead.

If the nut on a screwed-in piston rod, as shown in Fig. 6, gets into the habit of backing off, it usually is a sign of the piston rod and crossheads being out of line. The nut can be secured by setting it up tight, but that will only throw the strain on some other part. It will be more advisable to get a new crosshead which is commercially perfect in every respect.

A pound or noise in the cylinder is usually blamed on the piston, and in perhaps nine cases out of ten the suspicion will be found to be correct. A piston composed of a dozen or more parts may certainly become a source of trouble. To reduce the number of parts and he chances of any of them getting loose, pistons are ometimes made of one piece with a couple of snap ings, as shown in Fig. 7. Since there is no way of aking up wear on horizontal engines, pistons of this ind should be made long. There should be a number of il grooves cut in the circumference, and lubrication ust be well attended to. Generally, pistons of this ind are pressed on the rod and the ends riveted over. n account of the long fit there is not much danger of heir getting loose. The conventional Corliss engine iston is shown in Fig. 8; it embodies most of the ood features that a piston should have, some of which re lacking in other designs. One of the good points ften omitted is the collar on the rod. To reduce expense some engine builders turn down the rod for the fit n the piston spider with a small shoulder that is ntirely inadequate.

As a rule pistons are rarely examined. They are left everely alone as long as no trouble develops. Every ossible precaution should therefore be taken to prevent them getting out of order. Any nut, bolt or pin sed in the construction must be well secured. The follower bolts may become a source of great trouble; f ordinary studs or tapbolts are used, there is always he possibility of one of them getting loose and working ut. When it strikes the back head, there is first perceptible a light click, which gradually increases to a ound, indicating that not much time must be lost in topping the engine and remedying the trouble. If the ollower bolts are secured as shown in the illustration, nd made of high-grade Norway iron, there is little hance of their breaking or working out. The nuts can e easily secured by prickpunching. The question of hich is the best kind of a piston ring, split or sectional, as never been definitely decided; for pistons up to 24 n. diameter the split ring, either concentric or eccentric, eems to be favored. It does not require springs, which re always objectionable, and it can be easily replaced nd fitted to the piston and cylinder. A horizontal ylinder wears out of round; a new ring should, therefore, be carefully filed to a good all-around fit. The plit should be placed down and the ring kept from otating by a pin. For some apparently unaccountable eason a horizontal cylinder sometimes wears down ery rapidly. This may be due to the material of which it is made, probably soft and open iron, unsuitable for the wear it has to stand. The best mixture for cylinders consists of half pig iron and half scrap, first melted and cast into pigs and then remelted again in a cupola. Air-furnace iron cannot be recommended for the purpose; it is generally too open and spongy. On pistons 25 in. in diameter and over it is good practice to face part of the junk ring with some soft metal like red metal; babbitt has been tried, but with little success; it will melt, and in a short while nothing more is left of it than a few pieces which are knocked about in the grooves. Red metal is an alloy the composition of which is not recorded in any text or reference books, although it has been used considerably as an antifriction metal for the last twenty years.

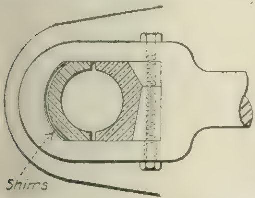


FIG. 4. SHIMS FITTED TO ROUNDED END OF CROSS-HEAD-PIN BRASSES

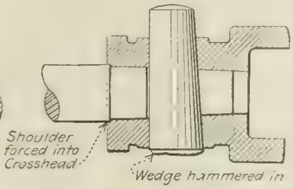


FIG. 5. TAPER END OF PISTON ROD FORCED INTO CROSSHEAD

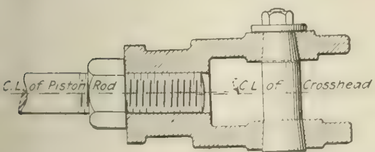


FIG. 6. SHOWING THE PISTON ROD OUT OF LINE WITH CROSSHEAD

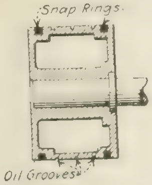


FIG. 7. ONE-PIECE PISTON WITH SNAP RINGS

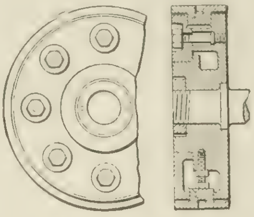


FIG. 8. CONVENTIONAL PISTON FOR A CORLISS ENGINE

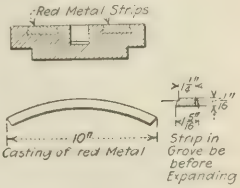


FIG. 9. RED-METAL STRIPS IN JUNK RING

The ingredients of a red metal that has been used successfully are 51 per cent copper, 48 per cent lead, ½ per cent tin, ½ per cent nickel with 2 oz. of ferromanganese per 100 lb. as a flux; the copper is melted first, the ferromanganese is added, then lead and tin. The metal must be kept well stirred, otherwise the lead settles to the bottom. The alloy is cast in strips, which are hammered into dovetailed grooves turned into the face of the junk ring, as shown in Fig. 9, and turned flush with the face. They have been let project about $\frac{1}{32}$ in. or even $\frac{1}{16}$ in. with the idea of supporting the piston solely on the soft metal strips, but this is not feasible since in a short time they wear down to the face of the ring, with the result that the junk ring gets too much play in the cylinder.

Some engineers are of the opinion that a furnace designed for coal fuel can be converted into an oil or gas-burning furnace. This is a false idea. It is possible to either cover the grates with firebrick, leaving air spaces between them and placing burners in the furnace doors, or placing the burners below, say in the ashpit doors, but the result is not always satisfactory. First, the combustion chamber must be designed differently so as not to allow the flames to come in contact with the comparatively cold boiler shell. The bridge wall, its design and height, should receive consideration, as well as the location of the burners. Sometimes it is necessary to place them in the rear of some types of water-tube boilers to get the best results.

In hand-fired plants, using coal for fuel, do not permit the rate of combustion to fall below fifteen pounds per square foot of grate surface per hour. With stokers the rate of combustion may be as high as the design of the plant will permit. When firing with fine steam-size coal, the rate should not be less than ten pounds per square foot of grate area per hour.

Connections for Measuring Power with Single-Phase Wattmeters

BY H. C. YEATON

A SINGLE-PHASE wattmeter may be used to measure not only a single-phase load, but also the power of a balanced four-wire two-phase, a balanced three-wire two-phase, a balanced three-wire three-phase, or a balanced four-wire three-phase circuit. If the polyphase circuits are not balanced or the power factors of all phases of the polyphase circuits are not the same, only the approximate power of the circuits can be ascertained, which in some instances might be satisfactory to temporary measurement in case of emergency. The following descriptions and diagrams explain how the foregoing can be attained.

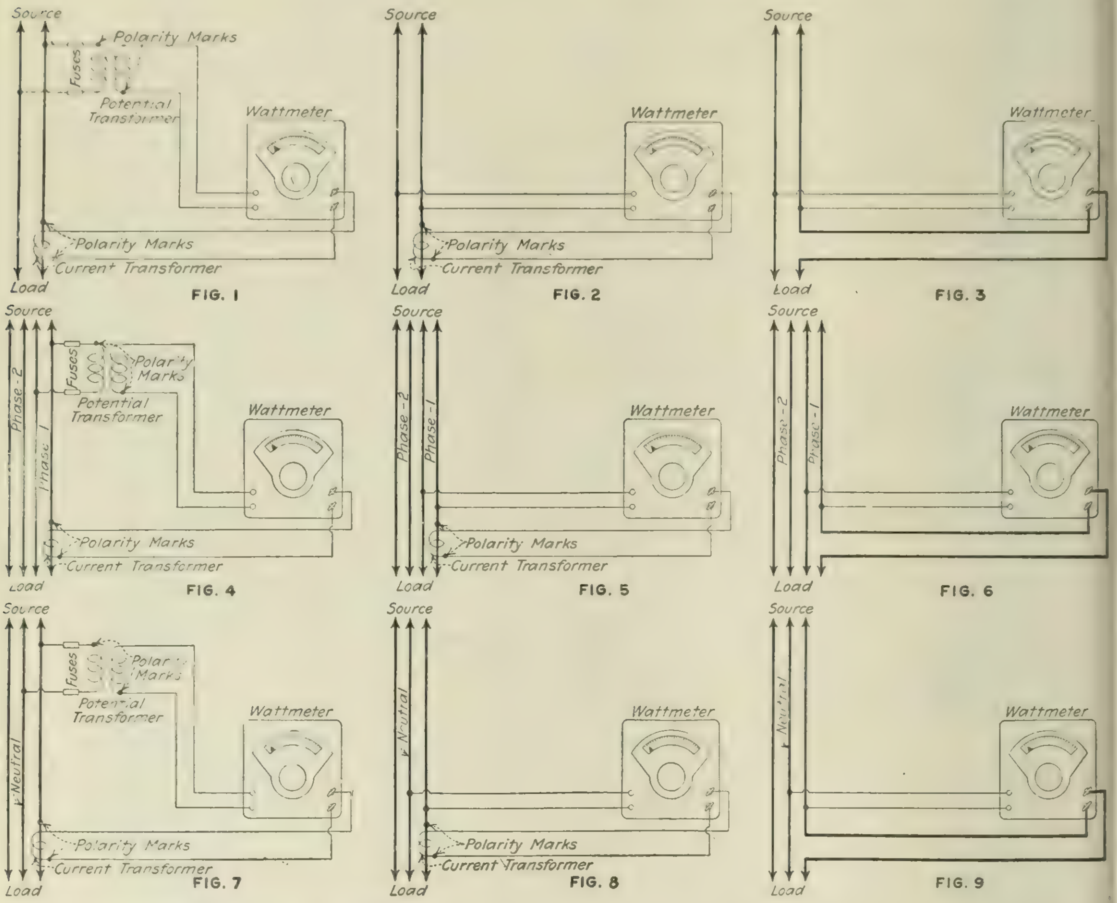


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7 FIG. 8 FIG. 9

FIGS. 1 TO 9. SINGLE-PHASE WATTMETER CONNECTIONS FOR MEASURING POWER IN SINGLE-PHASE AND TWO-PHASE CIRCUITS

Connection for measuring the power with a single-phase wattmeter in a single-phase circuit is shown in Figs. 1, 2, and 3. If the instrument is used in connection with current and potential transformers, as in Fig. 1, the readings must be multiplied by the ratios of both transformers. In case the pointer tends to move in the wrong direction, indicating wrong polarity, it is simply necessary to reverse the leads on the potential studs of the instrument to obtain correct polarity.

Modern instrument current and potential transformers have one primary and one secondary terminal marked, which indicates that if the instantaneous current flows into one marked terminal, it flows out of the other marked terminal. This explains the meaning of polarity marks shown in the figures. Fig. 2 gives the connections of the instrument where only a current transformer is used and Fig. 3 the connections of the instrument when no transformers are used.

The scales of portable wattmeters are almost invariably marked in accordance with their windings and have to be multiplied by transformer ratios when used with transformers. Switchboard wattmeters usually have their scales marked in primary watts and are calibrated for use with transformers with which they are going to be used. This eliminates all calculations, as the wattmeter scale reads direct.

If it is desired to measure the power of a balanced ur-wire two-phase circuit with a single-phase watt- eter, connect the instrument as shown in Figs. 4, 5 6, according to conditions. Should the pointer indi- te incorrect polarity, reverse the leads on the poten- al studs of the instrument. In Fig. 4 the instrument connected into the circuit with both potential and rrent transformers, in Fig. 5 current transformers ly are used, and in Fig. 6 the instrument is con- cted directly into the circuit without transformers. is obvious from the figures that the instrument easures the power in only one phase of the system, d as there are two phases, the scale readings must multiplied by 2, and if current and potential trans- rmers are used, the scale readings should be multi- ied by the ratios of the transformers also. For ex- mple, if the wattmeter indicates 5.4 kw. and the ratio the potential transformer is 20:1 and that of the rrent transformer 10:1, then the scale reading of e wattmeter is multiplied by 2, 20 and 10, or the lowatts in this case are 5.4 × 2 × 20 × 10 = 2,160.

To measure the power of a balanced three-wire two- ase circuit with a single-phase wattmeter, the instru- ent is connected as shown in Figs. 7, 8 or 9. Like at for the four-wire two-phase circuit the scale read- gs are multiplied by 2 and also by the ratios of each ansformer when used to obtain the power in the circuit.

Power of a balanced three-wire three-phase circuit may be measured with a single-phase wattmeter, by connecting the instrument, as indicated in Figs. 10, 11 and 12, through a "Y" box resistor. The "Y" box resistor consists of two legs, the resistance of each leg being equal to that of the potential circuit of the instrument. To obtain the total power in the circuit, multiply the scale readings of the instrument by 3 and also by the potential and current transformer ratios, provided transformers are used. Like all single-phase wattmeters, the potential connections should be reversed if the instrument indicates incorrect polarity by the needle tending to rotate in the wrong direction. It is essential that a "Y" box be used with the single-phase wattmeter in order that the current passing through the instrument will have the same phase relation as the potential across the instrument. A brief explanation of this follows:

Referring to Fig. 13, the current through the instrument is taken from the phase 0-1, and in order to obtain a corresponding potential an artificial neutral point is obtained by means of a "Y" resistor. The leg *A* which includes the instrument has the same phase relation as the phase 0-1. Therefore, if the current and an equivalent potential of phase 0-1 is measured by the single-phase wattmeter, the scale will read the true watts in the phase; and if the power factor of each phase is the same and the system is balanced, then the wattmeter reading may be multiplied by 3 to obtain the total power in the system.

If the instrument is connected as in Fig. 14, the potential across the instrument is out of phase with the current passing through the instrument by 30 deg., at unity power factor. At other power factors the current and voltage in the three phases have different phase relations. Therefore, it would not be advisable to use this method for measuring the power of three-wire three-phase circuit. However, in this case, if the system is balanced and the power factor is unity, the

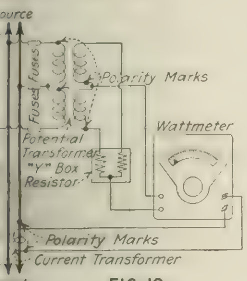


FIG. 10

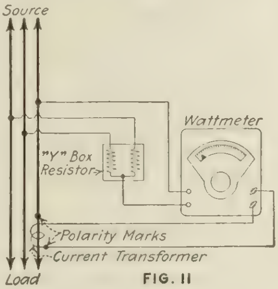


FIG. 11

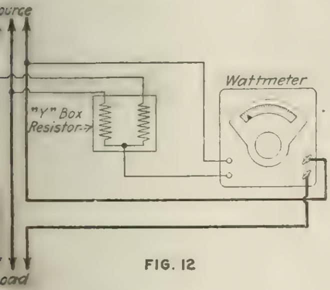


FIG. 12

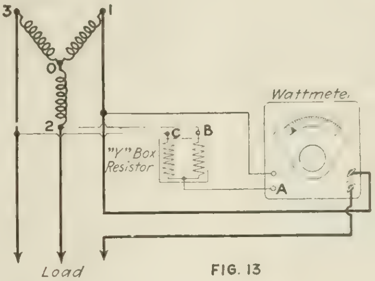


FIG. 13

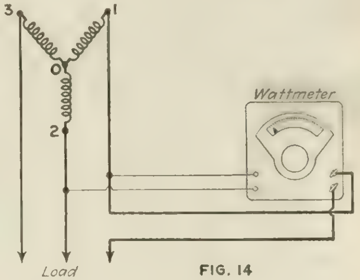


FIG. 14

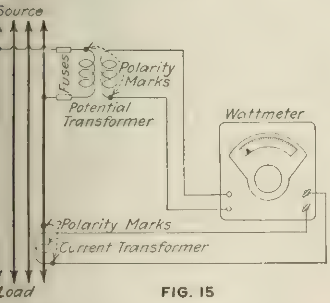


FIG. 15

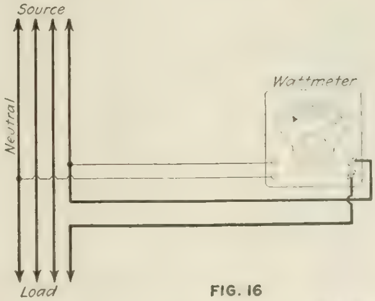


FIG. 16

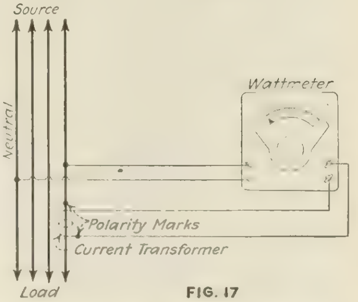


FIG. 17

FIGS. 10 TO 17. SINGLE-PHASE WATTMETER CONNECTIONS FOR MEASURING POWER IN A THREE-WIRE OR FOUR-WIRE THREE-PHASE CIRCUIT power of the circuit is equal to the wattmeter reading multiplied by 2 (not 3 as when the "Y" resistor is used) and the ratio of the transformer if used.

Balanced four-wire three-phase systems are not quite so common as the foregoing circuits, but if it is desired to obtain the power of such a circuit with a single-phase wattmeter, the connections given in Figs. 15, 16 or 17 are used. The power of the circuit is equal to the scale readings multiplied by 3 and also multiplied by the ratios of the transformers being used.

The Cammellaird-Fullagar Diesel Engine

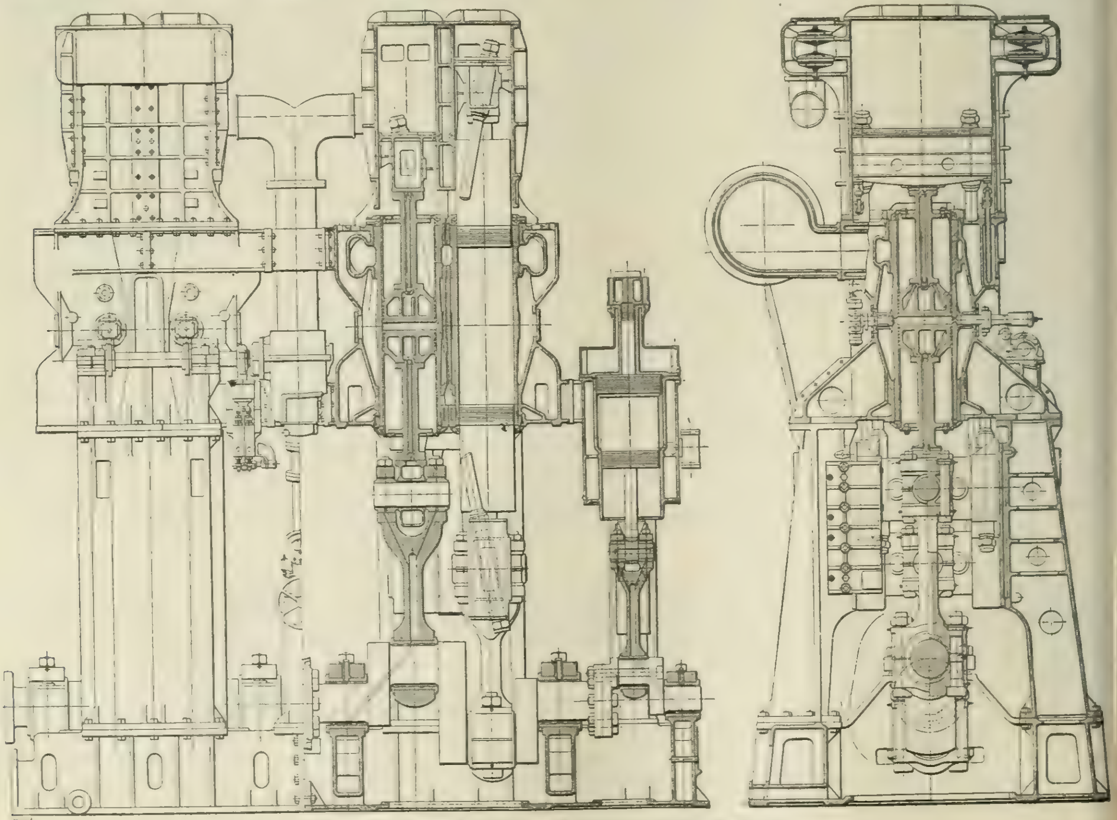
Recently, a 500-ton coasting motorship was launched at Birkenhead, England. One unusual feature was the welding of all plate seams, riveting being entirely absent. The vessel is of interest since it is fitted with two Cammellaird-Fullagar high-compression oil engines.

The Fullager engine is of the two-cycle opposed piston type. The engine is made up of two units, each unit consisting of two cylinders. In each cylinder are two pistons, moving inward together on the compression stroke, the combustion chamber being formed between the tops of the two pistons. The fuel is injected into this central space. As the pistons move outward under the influence of the burning charge, the upper piston uncovers a series of ports which allow the gases to escape. At the same time the lower piston uncovers the scavenging ports. The air then completely clears the cylinder of the burnt charge.

The engine differs from the usual opposed-piston engine by having the upper and power pistons of adjacent cylinders linked together by diagonal tension rods. This design eliminates the cranks that would otherwise be required for the upper pistons. The engine is, as a consequence, considerably shorter, fore and aft, than either a two-cycle or four-cycle engine of equal capacity. The diagonal rods are always in tension, relieving the crank of all pressure on the compression stroke. This feature should reduce the lubrication difficulties experienced with many two-cycle engines. The upper pistons have rods and crossheads with which to resist the side pressure of the diagonal rods. The crossheads are inclosed, and the cavities thus formed act as the scavenging cylinders. The scavenging piston is rectangular in form, but it is claimed that the leakage at the corners is negligible.—*Gas and Oil Power.*

In designing a boiler furnace for burning oil or gas, whether of the vertical or horizontal return-tubular type, careful consideration should be given to the combustion chamber, bridge wall, additional checker wall to separate the flames of the burners, the draft, whether natural or forced, location of burners, water- or fire-tube boilers, the transportation of fuel and tight settings.

Poor firing causes holes to develop in the fuel bed. Carrying an uneven fire, too thin or too heavy a fire, shaking the grates or using the slice bar too frequently (which causes clinkers) and improper care of dampers reduce the boiler efficiency. Attention to what the boiler is doing from day to day will pay good returns, if faulty conditions are remedied when first detected.



THE CAMMELLAIRD-FULLAGAR DIESEL ENGINE

Government Standards for Oils and Greases

Here follows an abstract of the report of the United States Government's Committee on Standardization of Lubricants. Under these standards of test methods and qualities, lubricants for the Government will be purchased. All the test methods here given may readily be applied in the usual power plant by the engineers in charge.

METHODS OF TESTING LUBRICANTS

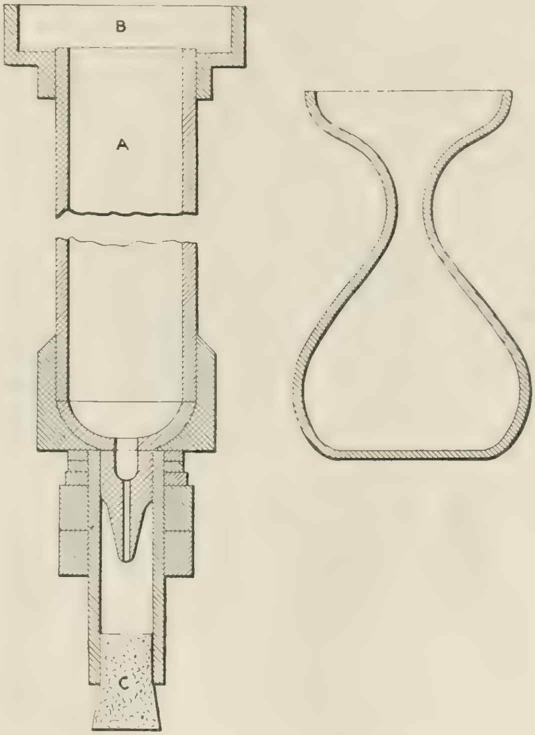
FLASH POINT—This test shall be made in the Cleveland open-cup tester, the apparatus being used without any bath or outer cup surrounding ne oil cup. The oil cup should have two marks on the nside, the first ¼ in. below the top, and the second ⅜ in. elow, the first to be used when testing oils with a ash point below 425 deg. F. and the second when testng oils with a flash point at or above 425 deg. F. he clean oil cup should be inserted into the tripod ng, which must be level, and the cup filled to the proper ark with the oil to be tested. Care should be cercised not to spill any oil on the sides or top of the ıp, and if this accident should happen, all such oil ust be carefully removed. A "bulb immersion" ermometer should then be inserted into the oil and ıspended from a suitable support. The bulb of the ermometer should be ⅜ to ⅝ in. in length. During ıe test the bulb must be fully covered by the oil and ıe bottom of the thermometer must not be less than in. from the bottom of the cup. The thermometer ust be suspended in the oil midway between the center nd inside edge of the cup. The alcohol or gas burner then placed under the oil cup so as to heat it niformly. The oil may be heated rapidly at first, but ıe rate of heating should be 8 to 10 deg. F. per minute ıring the last 80 deg. of heating prior to attaining ıe flash point. As the flash point is approached, a test made for every 5 deg. F. rise in temperature (on the eadings which are multiples of 5) by slowly passing small bead-like test flame, not exceeding ⅛ in. in ngth, across the center of the cup ¼ in. above the ırface of the oil, the movement occupying one second. The temperature when a flame first jumps from the est flame to the oil is called the flash point of the oil. he test must be made where the cup is free from rafts and must also be made in a subdued light.

Fire Point—After the flash point has been obtained, ıe same method of testing shall be continued until the l takes fire and continues to burn. The temperature which the oil continues to burn is the fire point of the l.

Viscosity (A. S. T. M. method. Revised in 1920.)— Viscosity shall be determined by means of the Sayolt standard universal viscosimeter.

2. The Saybolt standard universal viscosimeter (see ection) is made entirely of metal. The standard oil ıbe *A* is fitted at the top with an overflow cup *B*, and ıe tube is surrounded by a bath. At the bottom of the andard oil tube is a small outlet tube through which ıe oil to be tested flows into a receiving flask, (right) hose capacity to a mark on its neck is 60 (±0.15) c.c. he lower end of the outlet tube is inclosed by a larger ıbe, which when stoppered by a cork *C*, acts as a closed air chamber and prevents the flow of oil through the outlet tube until the cork is removed and the test started. A looped string may be attached to the lower end of the cork as an aid to its rapid removal. The temperatures in the standard oil tube and in the bath are shown by thermometers. The bath may be heated by any suitable means, The standard oil tube shall be thoroughly cleaned, and all oil entering the standard oil tube shall be strained through a 60-mesh wire strainer. A stop watch shall be used for taking the time of flow of the oil, and a pipette shall be used for draining the overflow cup of the standard oil tube.

The standard oil tube, which may be standardized by the United States Bureau of Standards, Washington, D. C., shall conform to the following dimensions:



SECTION OF OIL TUBE USED WITH SAYBOLT STANDARD VISCOSIMETER; RECEIVING CUP IS SHOWN TO THE RIGHT

Dimensions	Minimum, Cm.	Normal Cm.	Maximum Cm.
Inside diameter of outlet tube	0.1750	0.1765	0.1780
Length of outlet tube	1.215	1.225	1.235
Height of overflow rim above bottom of outlet tube	12.40	12.50	12.60
Diameter of container of standard oil tube	2.955	2.975	2.995
Outer diameter of outlet tube at lower end	0.28	0.30	0.32

3 Viscosity shall be determined at 100 deg. F. (37.8 deg. C.), 130 deg. F. (54.4 deg. C.) or 210 deg. F. (98.9 deg. C.). The bath shall be held constant within 0.25 deg. F. (0.14 deg. C.) at such a temperature as will maintain the desired temperature in the standard oil tube. For viscosity determinations at 100 deg. and 130 deg. F., oil or water may be used as the bath liquid.

For viscosity determinations at 210 deg. F., oil shall be used as the bath liquid. Viscosity determinations shall be made in a room free from drafts and from rapid changes in temperature. All oil introduced into the standard oil tube, either for cleaning or for test, shall first be passed through the strainer.

To make the test, heat the oil to the necessary temperature and clean out the standard oil tube. Pour some of the oil to be tested through the cleaned tube. Insert the cork stopper into the lower end of the air chamber at the bottom of the standard oil tube, sufficiently to prevent the escape of air, but not to touch the small outlet tube of the standard oil tube.

Heat the oil to be tested, outside the viscosimeter, to slightly below the temperature at which the viscosity is to be determined and pour it into the standard oil tube until it ceases to overflow into the overflow cup. By means of the oil-tube thermometer keep the oil in the standard oil tube well stirred and also stir well the oil in the bath. It is extremely important that the temperature of the bath be maintained constant during the entire time consumed in making the test. When the temperature of the bath and of the oil in the standard oil tube are constant and the oil in the standard oil tube is at the desired temperature, withdraw the oil-tube thermometer; quickly remove the surplus oil from the overflow cup by means of a pipette so that the level of oil in the overflow cup is below the level of the oil in the tube proper; place the 60-c.c. flask in such a position that the stream of oil from the outlet tube will strike the neck of the flask so as to avoid foam. Snap the cork from its position, and at the same instant start the stop watch. Stir the liquid in the bath during the run and carefully maintain it at the previously determined proper temperature. Stop the watch when the bottom of the meniscus of the oil reaches the mark on the neck of the receiving flask.

The time in seconds for the delivery of 60 c.c. of oil is the Saybolt viscosity of the oil at the temperature at which the test was made.

Pour Test (A. S. T. M. Method D47-18)—1. The pour test indicates the temperature at which a sample of oil in a cylindrical container of specified diameter and length will just flow under specified conditions.

Apparatus For Pour Test

2. Apparatus: The apparatus for the pour test consists of the following: glass jar, approximately 1¼ in. inside diameter and 4 to 5 in. high, provided with a tightly fitting cork; mercury thermometer, fitted securely in the cork so that the shaft will be held centrally in the jar with the tip of the bulb ½ in. from the bottom (the thermometer specially made for this test has a bulb ¼ to ⅜ in. long); metal jacket, closely fitted around the glass jar and provided at the bottom with a disk of cork felt about ¼ in. thick.

3. Method: Place the oil in the jar to a depth of about 1¼ in., or to a sufficient depth to reach ¼ in. above the bulb of the thermometer; fit the cork tightly into the jar and place the jar in the metal jacket; then place the jacket in a freezing mixture. At each drop in temperature of 5 deg. F. (on the readings which are multiples of 5 deg.) remove the jar from the jacket and tilt it just enough to make the oil flow. The pour test of the oil shall be taken as 5 deg. higher than the reading of the thermometer when the oil has cooled so that it will not flow when the jar is tipped to a horizontal position.

4. The rate of cooling should be such that the pour test be completed in about one-half hour.

5. The materials used in the freezing mixture vary with the temperature required to cause the lubricant to solidify. Cracked ice will be sufficient for a temperature above plus 35 deg. F. For temperatures between plus 15 deg. F. and plus 35 deg. F. a mixture consisting of one volume of salt and twenty volumes of ice may be used. The salt for this purpose should be dry and fine enough to pass a 20-mesh screen. From plus 15 deg. to minus 5 deg. F. ice and salt in the proportions of one to two are suitable. From 0 deg. to —25 deg. F. a mixture of ice and calcium chloride is used. For temperatures lower than —5 deg. F. a mixture of solid carbon dioxide and acetone is more convenient and will produce temperatures of —70 deg. F. or less.

6. To obtain the solid carbon dioxide, invert an ordinary liquefied carbon-dioxide cylinder, open the valve carefully and let the gas flow into a chamois-skin bag. Rapid evaporation will cause the carbon dioxide to solidify.

7. The carbon dioxide-acetone mixture may be made as follows: Place a sufficient amount of dry acetone in a covered copper or nickel beaker; place the beaker in an ice-salt mixture and when the acetone reaches plus 10 deg. F. or less, add solid carbon dioxide gradually until the desired temperature is reached.

Cold Test for Cylinder Oils

Cold Test of Steam Cylinder and Black Oils (A. S. T. M. Method D47-18)—The object of the cold test is to determine the lowest temperature at which oil will flow from one end of a container to the other, in case it should become frozen and the resulting solid oil stirred till it has assumed a sufficiently pasty consistency to flow. The test is conducted by freezing an ounce of the oil solid in an ordinary 4-oz. sample bottle using a freezing mixture if necessary. A thermometer should then be introduced into the frozen mass, and after it has become cold, the bottle containing the congealed oil is removed from the cooling medium. The frozen oil is thoroughly stirred with a thermometer until the mass will run from one end of the bottle to the other, and at this moment the temperature as indicated is recorded. The reading is the cold test of the oil.

If the figures indicating the cold test are inside the bottle and covered by the softened oil, the reading can be obtained by grasping the bottle by the neck with one hand, having in the same hand a piece of waste which incloses the thermometer. The thermometer is then withdrawn through the waste with the other hand for a sufficient distance to enable the operator to see the end of the mercury column and read the temperature.

Saponification—Weigh 10 grams of oil into a 350-c.c. Erlenmeyer flask. Add from a pipette 50 c.c. of the alcoholic potassium hydroxide solution followed by 25 c.c. of the purified benzene (C_6H_6). Connect with a condenser loop. Boil on steam bath or electric hot plate for 90 min., shaking occasionally. Remove and add 25 c.c. of neutral gasoline, and titrate with the half normal hydrochloric-acid solution, after adding 2 or 3 drops of the phenolphthalein indicator solution until the pink color is destroyed. The absence of the pink color may be determined after the titration has begun, by allowing the solution to stand at rest approximately a minute and noting the color of the lower zone. Run two blanks with the same mixture of alcoholic potassium ydroxide solution and purified benzene. From the ifference between the number of cubic centimeters of alf-normal acid required for the blanks and for the etermination, the percentage of fatty oil may be alculated as follows:

$$\left[\frac{\textit{No. of c.c. N/2 acid used} \times .02805 \times 100}{0.195 \times \textit{weight of oil taken}} = \textit{per cent of fatty oil}\right].$$

Corrosion—A clean strip of pure copper about ½ in. vide and 2 in. long is heated to redness in a bunsen ame and while red hot dropped into alcohol. The strip s then allowed to dry as quickly as possible in the air nd dropped into a sample of the oil contained in a test ube. About half the length of the copper strip should e submerged. The test tube is then closed with a topper and left to stand for 24 hours. At the end of his time the copper strip is removed and washed clean vith proper solvents. It is then compared with a similar trip freshly cleaned as previously described. No disoloration of the test strip should be shown by this omparison.

Evaporation—Twenty grams of the oil is placed in weighted flat-bottomed glass crystallizing dish having diameter of approximately 3¾ in. The dish is then laced in an oven at a temperature of 212 deg. F. for wo hours, cooled in a desiccator, and weighed.

Precipitation—Five c.c. of the oil is mixed with 95 c.c. f petroleum ether in a tall stoppered graduated ylinder and allowed to stand. The petroleum ether nust be freshly redistilled and the portion boiling above 50 deg. F. discarded. It must not show perceptible olubility in concentrated sulphuric acid.

Protection—A clean polished steel plate 2 in. long, in. wide, and ⅛ in. thick, is coated by immersing in ne lubricant which has been heated to a temperature f 212 deg. F. The plate is removed while still hot, llowed to cool in a vertical position and suspended ertically within a 10 per cent salt solution.

SPECIFICATIONS FOR LUBRICATING OILS, CLASS A

1. This specification covers the grades of petroleum oil sed by the United States Government and its agencies for ne general lubrication of engines and machinery where a ighly refined oil is not required. This oil is not to be used or steam-cylinder lubrication.

2. Only refined petroleum oils without the admixture of atty oils, resins, soap, or other compounds not derived from ude petroleum, will be considered.

3. These oils shall be supplied in five grades, known as xtra light, light, medium, heavy and extra heavy.

roperties and Tests:

4. Flash and Fire Points: The flash and fire points of ne five grades shall not be lower than the following:

	Flash, Deg. F.	Fire, Deg. F.
Extra light	315	355
Light	325	365
Medium	335	380
Heavy	345	390
Extra Heavy	355	400

5. Viscosity: The viscosity of the five grades of oil : 100 deg. F. must be within the following limits:

	Seconds
Extra light	140–160
Light	175–210
Medium	275–310
Heavy	370–410
Extra heavy	470–520

6. Color: The color of the extra-heavy grade shall not be arker than No. 6 National Petroleum Association standard its equivalent. The color of the other grades shall not be arker than No. 5 National Petroleum Association standard its equivalent.

7. Pour Test: The pour test shall not be above the folwing temperatures:

	Deg. F.
Extra light	35
Light	35
Medium	40
Heavy	45
Extra heavy	50

8. Acidity: Not more than 0.10 milligrams of potassium hydroxide shall be required to neutralize 1 gram of the oil.

9. Corrosion: A clean copper plate must not be discolored when submerged in the oil for 24 hours at room temperature.

10. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

SPECIFICATIONS FOR LUBRICATING OILS, CLASS B

1. This specification covers the grades of petroleum oil used by the United States Government and its agencies for the lubrication of turbines, dynamos, high-speed engines and other classes of machinery where an oil better than Class A is required. The oil must be satisfactory for use in circulating and forced-feed systems.

2. Only refined petroleum oils without the admixture of fatty oils, resins, soaps or other compounds not derived from crude petroleum will be considered.

3. These oils shall be supplied in five grades, known as extra light, light, medium, heavy and extra heavy.

Properties and Tests:

4. Flash and Fire Points: The flash and fire points of the five grades, shall not be lower than the following:

	Flash, Deg. F.	Fire, Deg. F.
Extra light	315	355
Light	325	365
Medium	335	380
Heavy	345	390
Extra heavy	355	400

5. Viscosity: The viscosity of the five grades at 100 deg. F. must be within the following limits:

	Seconds
Extra light	140–160
Light	175–210
Medium	275–310
Heavy	370–410
Extra heavy	470–520

6. Color: The color of the extra-heavy grade shall not be darker than No. 6 National Petroleum Association standard or its equivalent. The color of the other grades shall not be darker than No. 5 National Petroleum Association standard or its equivalent.

7. Pour Test: The pour test shall not be above the following temperatures:

	Deg. F.
Extra light	35
Light	35
Medium	40
Heavy	45
Extra heavy	50

8. Acidity: Not more than 0.07 milligrams of potassium hydroxide shall be required to neutralize 1 gram of oil.

9. Corrosion: A clean copper plate must not be discolored when submerged in the oil for 24 hours at room temperature.

10. Emulsifying Properties: The oil shall separate completely in 30 minutes from an emulsion with: (1) Distilled water; (2) 1 per cent salt solution; (3) Normal caustic soda solution. The demulsibility shall not be less than 300.

11. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

SPECIFICATIONS FOR LUBRICATING OILS, CLASS C

1. This specification covers the grades of petroleum oil used by the United States Government and its agencies for lubrication of air compressors and internal-combustion engines, except aircraft, motor-cycle and Diesel engines; also for the lubrication of turbines and other machinery where an oil better than Class B is required. This oil must be satisfactory for use in circulating and forced-feed systems.

2. Only refined petroleum oils without the admixture of fatty oils, resins, soaps, or other compounds not derived from crude petroleum, will be considered.

3. These oils shall be supplied in five grades, known as extra light, light, medium, heavy and extra heavy.

Properties and Tests:

4. Flash and Fire Points: The flash and fire points of the five grades shall not be lower than the following:

	Flash, Deg. F.	Fire, Deg. F.
Extra light	315	355
Light	325	365
Medium	335	380
Heavy	345	390
Extra heavy	355	400

Oil for use in air compressors where the air leaving any stage or cylinder has a temperature above 212 deg. F. shall have a flash point not lower than 400 deg. F.

5. Viscosity: The viscosity of the five grades at 100 deg. F. must be within the following limits:

	Seconds
Extra light	140–160
Light	175–210
Medium	275–310
Heavy	370–410
Extra heavy	470–520

6. Color: The color of the extra-heavy grade shall not be darker than No. 6 National Petroleum Association standard or its equivalent. The color of the other grades shall not be darker than No. 5 National Petroleum Association standard or its equivalent.

7. Pour Test: The pour test shall not be above the following temperatures:

	Deg. F.
Extra light	35
Light	35
Medium	40
Heavy	45
Extra heavy	50

8. Acidity: Not more than 0.05 milligrams of potassium hydroxide shall be required to neutralize 1 gram of the oil.

9. Corrosion: A clean copper plate must not be discolored when submerged in the oil for 24 hours at room temperature.

10. Emulsifying Properties: The oil shall separate completely in 30 minutes from an emulsion with: (1) Distilled water; (2) 1 per cent salt solution; (3) normal caustic-soda solution. The demulsibility shall not be less than 300.

11. Carbon Residue: The carbon residue shall not exceed the following:

	Per Cent
Extra light	0.10
Light	0.20
Medium	0.30
Heavy	0.40
Extra heavy	0.60

12. Further tests on oils of Class C may be required at the option of the department of the Government using the oils.

13. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

MINERAL STEAM CYLINDER OIL FOR NON-CONDENSING ENGINES

1. This specification covers the grade of petroleum oil used by the United States Government and its agencies for non-condensing steam-engine cylinder lubrication where a mineral oil is required; also as a stock oil for compounding.

Properties and Tests:

2. The oil must be a well-refined petroleum oil without compounding of any nature.

3. Flash Point: The flash point must not be less than 475 deg. F.

4. Viscosity: The viscosity at 210 deg. F. must be within the following limits: 135 to 165 sec.

5. Cold Test: The cold test must not be above 45 deg. F.

6. Precipitation Test: When 5 c.c. of the oil is mixed with 95 c.c of petroleum ether and allowed to stand 24 hours, it shall not show a precipitate or sediment of more than 0.25 c.c. (5 per cent by volume of the original oil).

7. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

COMPOUND STEAM CYLINDER OIL FOR NON-CONDENSING ENGINES

1. This specification covers the grade of petroleum oil used by the United States Government and its agencies for the lubrication of steam cylinders of non-condensing engines and pumps where a compounded oil is required.

Properties and Tests:

2. The oil must be a well-refined petroleum oil, compounded with not less than 5 nor more than 7 per cent of acidless tallow oil or lard oil.

3. Flash Point: The flash point must not be less than 475 deg. F.

4. Viscosity: The viscosity at 210 deg. F. must be within the following limits: 120 to 150 sec.

5. Cold Test: The cold test must not be above 45 deg. F.

6. Precipitation Test: When 5 c.c. of the oil is mixed with 95 c.c of petroleum ether and allowed to stand 24 hours, it shall not show a precipitate or sediment of more than 0.25 c.c. (5 per cent by volume of the original oil).

7. Acidity: The oil must not contain more than 0.40 per cent of acid calculated as oleic acid (equivalent to 0.80 mg. K.O.H. per gram of oil).

8. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

GEAR CHAIN AND WIRE-ROPE LUBRICANT

1. This specification covers the grade of petroleum oil used by the United States Government and its agencies for the lubrication and protection of chains, wire ropes and gears of cranes, dredges, steam shovels and all other heavy equipment, for the lubrication and protection of the gears and ropes of balloon hoists; and for swabbing the wires and cables of aircraft.

2. The oil must be a petroleum product only, free from vegetable or animal oils or products derived from them. It must be entirely free from fillers, such as talc, resin and all materials of every nature not related to the original product.

Properties and Tests:

3. Viscosity: The viscosity at 210 deg. F. must be within the following limits: 900 to 1,100 sec.

4. Protection: When applied to a plate of polished steel the lubricant must protect the steel for a period of thirty days when immersed in a 10 per cent salt solution.

5. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

CUP GREASE

1. This specification covers the grades of cup grease used by the United States Government and its agencies for the lubrication of such parts of motor equipment and other machinery as are lubricated by means of compression cups; No. ½ and No. 1 to be used in spindle cups or transmissions.

2. The grease must be a well manufactured product, composed of a calcium soap and a highly refined mineral oil.

Properties and Tests:

3. The mineral oil used in reducing the soaps must be a straight well-refined mineral oil with a viscosity at 100 deg. F. of not less than 100 sec.

4. Soap Base: This base to be a whole fat such as pure tallow oil, neatsfoot oil, lard oil, horse oil or other pure animal oils used singly or in combination.

(a) No. ½ cup grease shall contain approximately 13 per cent of a calcium soap made from an approved fat.

(b) No. 1 cup grease shall contain approximately 14 per cent of a calcium soap made from an approved fat.

(c) No. 3 cup grease shall contain approximately 18 per cent of a calcium soap made from an approved fat.

(d) No. 5 cup grease shall contain approximately 24 per cent of a calcium soap made from an approved fat.

5. Consistency : These greases must be similar in consistency to the approved trade standards for No. ½, No. 1, No. 3 and No. 5 grease.

6. Moisture: The grease must be a boiled grease, containing not less than one or more than three per cent of water when finished.

7. Corrosion: A clean copper plate must not be discolored when submerged in the grease for 24 hours at room temperature.

8. Ash:

No. ½ grease. The ash shall not be greater than 1.7 per cent
No. 1 grease. The ash shall not be greater than 1.8 per cent
No. 3 grease. The ash shall not be greater than 2.3 per cent
No. 5 grease. The ash shall not be greater than 3.5 per cent

9. Fillers: The grease shall contain no fillers such as resin, resinous oils, soapstone, wax, talc, powdered mica or graphite, sulphur, clay, asbestos, or any other filler.

10. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

ICE-MACHINE OIL

1. This specification covers the grades of petroleum oil used by the United States Government and its agencies for cleaning and oiling guns and small arms where aircraft machine-gun oil is not required; also for lubrication of cylinders of ice machines; for lubrication of pneumatic tools and for hydraulic systems.

2. The oil must be a straight-run, highly refined petroleum oil, free from vegetable or animal oils or products derived from them; must be suitable in every way for the uses listed in Par. 1; and must not gum or corrode metals under any conditions.

3. These oils shall be supplied in two grades known as Io. 100 and No. 125.

Properties and Tests:

4. Flash Point: The flash point must not be less than 00 deg. F.

5. Viscosity: The viscosity at 100 deg. F. must be within the following limits: No. 100 oil, 95 to 110 sec.; No. 125 oil, 120 to 135 sec.

6. Pour Test: The pour test shall not be higher than deg. above zero F.

7. Acidity: Not more than 0.03 milligrams of potassium hydroxide shall be required to neutralize 1 gram of oil.

8. Emulsifying Properties: The oil shall separate completely in 30 minutes from an emulsion with: (1) Distilled water; (2) 1 per cent salt solution; (3) normal caustic-soda solution. The demulsibility shall not be less than 300.

9. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Diesel Engineers

In a recent article on an installation of two 200-hp. Diesel engines mention was made of the troubles occurring during a six months' period of operation. The damages consisted of a fractured crankshaft, two fractured cylinder heads, two damaged piston heads and a fractured cylinder liner. The trouble, apparently, was due to the cooling water. It might have been impossible to install a water-purifying system, but there is no excuse for the failure to keep jackets free from scale by a frequent dose of muriatic-acid solution.

The list of breakages might well be considered an indictment of the operating force. In fact, the trouble is deeper seated. The claim that any ordinary man can operate a Diesel engine has been sponsored too frequently by the manufacturer. It is time to realize that an oil engine requires a man of more than ordinary mechanical skill and one who is possessed with a fund of patience and willingness to work. In the sale of an oil engine the manufacturer should arrange to furnish an erector who would not only erect the engine, but would also remain for a period of nine months to a year to operate the plant and to instruct the plant engineer. In the plant cited, the pay of an erector would not have been one-half the repair bill. The economy of the Diesel is amply attractive, and there is no necessity of employing or advocating the employment of other than high-grade engineers.

Explosion of Blowoff Tank

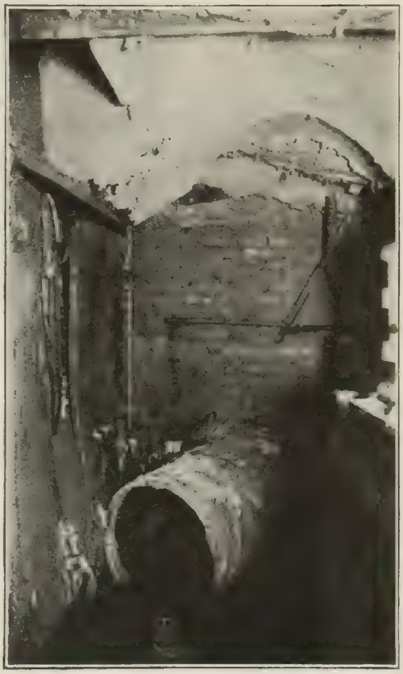
By George B. Longstreet

On Monday morning, June 15, a cast-iron blowoff tank in the steam plant of Riverbank Court, Cambridge, Mass., exploded. Fortunately, no one was seriously injured. The tank was 26 in. in diameter and ft. high, with flanged heads, top and bottom. It was situated in one corner of the boiler room behind No. 1 boiler and directly beneath the smoke flue.

The rupture occurred in the barrel of the tank close o the bottom flange. At the point of rupture the shell was corroded from its original thickness of ¾ in. to in., while directly opposite the ¾-in. shell showed no signs of corrosion. The inlet was at the top and the outlet near the top, on the side. The outlet pipe ran down inside to about eight inches from the bottom, and he point of rupture was directly under it. The tank was vented from the top and was clean, also the valve on the discharge was wide open, as the bent stem showed.

Referring to the illustration, the fracture occurred at the bottom, as shown. The pipe shown inside the tank is the discharge. The tank stood in the corner beneath the broken piping. The pipe shown in the vertical position was the vent pipe and originally was horizontal, connecting at the top of the tank. The explosion drove the tank up against the flue, shearing the rivets and bending the angle iron above the boiler back doors upward enough to allow the doors to pass under it; they were struck during the downward course of the tank.

Pipe fittings that were on the rack shown at the right were blown about, and the weights of a damper regulator, not shown, were hurled back of another boiler, one of them striking the engineer, who was blowing down No. 2 boiler. All lights in the boiler room were put out at the time. The engineer "stuck" and shut off the blowoff, although he was bruised and his arms and face were somewhat scalded.



RESULT OF EXPLOSION OF BLOWOFF TANK

Seizure of Fuel

An opinion of the United States District Court for the Southern District of Ohio defines the right of a railway company to seize coal shipments, as against a person to whom the shipper intended to make delivery.

In the Ohio case—Springfield Light, Heat and Power Co. vs. Norfolk & Western Railway Co.—it was decided that where a railway company accepts a shipment of coal designed for delivery to the shipper's customer, the company cannot seize the coal without becoming liable in damages as for wrongful conversion.

But it is held that where a shipping coal operator is in default under a contract to furnish the railway company's fuel requirements, the company may refuse to accept for transportation coal loaded on its cars, for delivery to the company's intended customer, and retain the fuel for application on its contract with the operator.

Oscar C. Merrill, Secretary of the Federal Water-Power Commission

OWING to the small amount of governmental work pertaining to water powers, few specialists in that subject have been developed in the Federal service. Foremost among these, however, is Oscar C. Merrill, who has just been designated executive secretary of the Federal Water-Power Commission.

Mr. Merrill was born in Manchester, Maine, in 1874. He attended high school at Augusta and Lisbon Falls, Maine, and later entered Bates College from which he was graduated in 1899. After two years as an instructor in the high school at Lubec, Maine, he entered the Massachusetts Institute of Technology, graduating in 1905. In the autumn of 1905 he became an instructor in engineering at the University of California.

In 1906 he began consulting work with Charles G. Hyde, specializing in power and sanitary engineering.

In May, 1909, Mr. Merrill was engaged by the Forest Service to make a special study of water powers in California. In 1910 he was placed in charge of all water powers coming under the jurisdiction of the Forest Service and in 1914 was made chief engineer of the Forest Service, in which capacity he made an exhaustive investigation and report to Congress on the ownership and control of water power sites. As chief engineer he had charge of all water powers, mapping, surveys and road construction. He prepared the regulations which have been followed by the Forest Service and formed the foundation for the present Water-Power Act.

EDITORIALS

Availability and Reliability of Power-Plant Equipment

AVAILABILITY for service is a consideration quite often overlooked by engineers in selecting and installing new equipment. Salesmen handling the machinery wish to present the best possible case for their companies and endeavor to convince their customers that their particular machines can run all the time and need never be out of service. Experience with power-plant equipment indicates that such is not the case and that every machine should receive a thorough overhauling at regular intervals to correct small troubles which may grow serious if allowed to develop. Furthermore, there are periods when the machines are out of service from incidental causes and from inherent troubles.

It is therefore apparent that there is an availability factor for each machine which, if known, would assist engineers greatly in the choice of equipment and particularly in the determination of the number of spare units necessary. Unfortunately, there are no published records of the proportion of time that various classes of machinery are not available for service. It is doubtful if any such records exist. It would therefore seem advisable for engineers to collect data from which "availability factors" can be determined.

Availability for service depends to a large extent on the reliability of the equipment. This leads to a determination of which types are less liable to accident. Every engineer desires to have only reliable machines in his plant. Some types are more susceptible to accident than others. For instance, many of the old-style steam turbines, running at comparatively slow speeds had relatively few accidents as results of vibration. On the other hand, the newer high-speed machines have, in some cases, had considerable difficulty with blading, with vibration and with wear in the bearings. All these difficulties have not been entirely overcome yet, and these considerations will naturally affect the availability factor of such units.

The aim of the machinery builder should be to increase the reliability of his equipment, even at some added expense. In the long run the most reliable machine, since it is available a greater length of time, performs the greatest and most satisfactory amount of service.

Reliability and availability are also dependent on operating methods. For instance, a water-tube boiler will operate at a moderate percentage above rating for a considerable period without needing overhauling. If this same boiler is forced to, say, three hundred per cent rating, its tubes will slag up much more rapidly than the increased overload would indicate, and it will probably require proportionately much more cleaning. The influence of operating conditions will, therefore, be a determining factor in availability.

It is not necessary to discuss the predicament in which an engineer finds himself when a machine fails at the time that his only spare unit is not available. Yet some big plants are being planned with the smallest possible margin of spare units. These may by good fortune "get away with it," but to a conservative engineer it would appear that the availability factor has been given little, if any, careful thought in these designs.

Reserve Strength of Elevator Ropes

ONE of the most important factors in the safe operation of elevator machines is the strength of the cables. When the cables are new, if properly installed they may have a factor of safety of eight or ten, but as they wear and some of the wires in the different strands become cracked, this factor of safety is reduced. The question, How much is the factor of safety reduced with different numbers of wire broken in each strand? has always been debatable. In this issue is published an article, "Reserve Strength of Elevator Ropes," by W. Voigtlander, in which are given the results of a series of tests made on wire ropes to determine their reserve strength under various conditions. Although these tests were made on new cables, they give, if applied with reservations, some idea of what the reserve strength of cables in service may be with various combinations of broken wires per strand.

As a handy approximation of the condition of elevator cables it is general practice to condemn them when six wires per strand are broken. This condition is somewhat similar to that given in test six by Mr. Voigtlander. According to this test a new cable having six wires per strand cut has approximately seventy-five per cent of its original strength; in other words, if in service it had, when new, a factor of safety of eight, with six wires per strand broken this factor of safety would be reduced to six. However, a cable that has been in use for a considerable period, and six wires per strand are cracked, will not have the reserve strength of a new one with the same number of wires per strand broken, on account of the wear and various abuse that the cable may have been subjected to in service. No doubt on the average the reserve strength of a cable in service with six wires per strand broken is nearer fifty or sixty per cent than seventy-five. However, these tests are worthy of careful study by those who are responsible for the safety of elevator operation.

Another interesting subject that Mr. Voigtlander has given valuable data on is the method of socketing wire rope. Undoubtedly his statement, "It has been conclusively demonstrated by repeated tests that the most efficient socket attachment is made by a straight wire brush held in the conical basket of the socket by means of spelter (pure zinc)," will be somewhat of a surprise to many who are familiar with the general practice of socketing cables. It is common practice, and in general is considered the best method, to cut the hemp center out for a short distance back into the cable and turn the ends of the strands back into the center, pull the end back into the basket of the socket and pour it full of a holding metal, usually lead or babbitt.

What can be obtained under ideal conditions with high-grade workmen and that produced by the average workman out on the job are two entirely different things. If cables are socketed by Mr. Voigtlander's method, it is absolutely essential that a high-grade job be done or there is danger of their pulling out of the baskets. On the other hand, where the ends of the strands are turned into the center of the cable, even if the filling metal has not been properly poured, the terminal will stand a large percentage of the maximum stress that it is capable withstanding. There is little doubt that the practice recommended by Mr. Voigtlander is an excellent one where a high degree of care is exercised, but where the average workman is depended on to do the socketing, then the "turned-in" method is to be recommended, if for no other reason than that it offers a higher degree of safety. Further discussion on this subject by *Power* readers would be of general interest.

Burning Coal Under Emergency Conditions

IN THESE days of coal shortage one cannot be too particular as to the kind and quality of coal he buys; more often he is glad to take what he can get as an alternative against shutdown. Therefore, aside from inferior quality, we find many boilers operating with a coal entirely different from that for which the furnace or stoker was designed. Especially is this true in the Middle West, where cases have recently come to our attention of boilers designed for Iowa and Illinois soft coals being compelled to burn coke breeze or anthracite screenings and buckwheat; and this, in one case with high Stirling boilers.

The advent of the mechanical stoker, the forcing of boilers and the elimination of smoke, together with a realization that the boiler room was the place of greatest waste or saving, all have been responsible for much study of combustion; and engineering literature is rich in the results of such investigations. But the aim was always to arrive at a design best suited to the burning of a particular class of coal, and usually under given conditions of operation. There was no thought of building a universal furnace or stoker equally adapted to all coals, because the necessity was not there and it was better engineering to adapt the design to the available fuel. Consequently, there is not available much published information that would aid our friends in the Middle West in the present emergency. However, there may be those among our readers who have had a similar problem, and their experience toward solution will be helpful to others. Discussion of the problem is invited.

Automatic Starting of Synchronous Motors

WHEN a type of electric motor and control equipment is developed to the state where it can perform its function automatically, it is generally considered to be a reliable piece of apparatus. This is apparently what the present development in synchronous motors and synchronous-motor controllers is approaching. Not so long ago this class of equipment was considered one requiring high-class attention to assure satisfactory operation. The experience that G. G. Rehfield gives in a discussion letter, "Synchronous Motors for Driving Centrifugal Pumps," on page 108 in this issue, is very interesting and shows what is possible to accomplish with a synchronous motor of modern type, properly designed for the service to which it is applied.

The early types of synchronous motors required auxiliary starting equipment to bring them up to speed so that they could be first synchronized and thrown on the line as generators, after which the starting machine was cut out and the load thrown on the motor through a clutch or by some other means. If everything was favorable, the motor carried its load without further trouble, otherwise serious difficulty was liable to develop from hunting. The motor Mr. Rehfield discusses starts up automatically and pulls into step in less than five seconds when driving a centrifugal pump fully primed, with all valves open.

The first synchronous motors were for the most part standard-type alternators adapted to motor applications. During the last few years engineers have given careful study to the characteristics of these motors and have attempted to design them with due regard to these characteristics. As a result this class of equipment is today operating satisfactorily on applications which a few years ago were thought impossible.

Fine—If It Could Be Done

EUGENE MACAULIFFE proposed to the Interstate Commerce Commission in its coal hearings on July ninth that it require the railroads to move from the mines not less than two million tons of coal per working day for the next three months, and 1.9 millions per day for the next two months. Thus there would be established a daily required performance which he estimated would be adequate to supply this year's coal, and to which all parties in the much disputed coal matter would agree as fine. But—

Eight hours sound sleep each night is, in our humble lay opinion, the finest cure for insomnia known. But the M.D. who would so prescribe for this malady might find his patients were not wholly responsive to orders. We fear that the railways are likely to be about as difficult to handle in their present state of ill health.

Nevertheless, the basic fact remains that this minimum amount of coal must be moved if we are to get along this year. Perhaps the most successful measure by which we may insure its movement is to put this responsibility directly upon the carriers. If they can move other classes of freight only after their coal-handling job is done, maybe we have created the best possible incentive to do this necessary task.

The manager of a Texas company recently wrote the Geological Survey asking the Director's opinion of the efficiency of his power plant, which his returns show consumes one barrel of oil for each thirty kilowatt-hours. He was anxious to know whether his consumption was above or below the average of plants reporting to the Survey. Dr. Smith advised him that in Texas the average consumption of oil is one barrel for each two hundred kilowatt-hours. In addition, the Texan was informed that there are two oil-burning plants in Arizona which average nearly three hundred kilowatt-hours to the barrel of oil. Dr. Smith suggests that this correspondent probably will have no grievance regarding the interference of the Federal Bureau in the affairs of his private company.

The Economy of Non-Condensing Turbines

John A. Stevens, in his article, "Economies To Be Expected of the Superstation," in the June 1 issue, brings out points regarding the economy of non-condensing turbines which are of great importance.

His curves, Fig. 6 and Fig. 7, show that, making proper allowances for the heating value of the exhaust steam, a 4,000-kw. non-condensing turbine, even when running at the unusual back pressure of 80 lb., produced electricity at a water rate per kilowatt-hour of 4 lb. to 5 lb. actually chargeable to power. No condensing turbine can approach such a performance.

The superior economy of non-condensing turbines, when the exhaust steam can be utilized, is of course due to the fact that no heat is lost to the condensing water.

There are only three ways in which the heat energy in the steam entering a non-condensing steam turbine can go:

1. In the form of useful work. Regardless of the water rate of the turbine, the heat energy converted into work is 2,545 B.t.u. per horsepower-hour.

2. Escape to the atmosphere. This item includes radiation, the heat from bearing friction and from steam leakage.

3. As heat in the exhaust steam. This heat includes the energy dissipated by all the internal losses in the turbine.

The only energy loss is in Item 2, which may be kept small compared to Items 1 and 3, with resulting very high efficiency of utilization of the heat in steam.

It is safe to say that when the exhaust steam can be utilized for heating or industrial processes, power can be produced by a non-condensing steam turbine with far less consumption of fuel than by a condensing turbine, either directly or through motors.

One very significant clause in Mr. Stevens' article reads, " . . . it is suggested that power contracts be made with the permission to manufacture what power is desired by byproduct turbines—that is, byproduct to power production. . . ."

For best economy, and minimum national fuel consumption, those buildings, manufacturing plants, etc., which require considerable steam for heating or industrial processes, should generate steam at reasonably high pressure and use it first in generating power before putting it into the heating mains. If a non-condensing turbo-generator set is used, tied in with an electrical distribution system from a central station, it will be possible to carry just enough load on this unit to supply the required exhaust steam. The additional fuel for generating power will be far less than in the most efficient condensing unit possible.

This feature should be brought out more prominently in connection with superstation discussion, as it is a vital one. Many engineers now have a mistaken idea that the construction of a few very efficient large power stations would eventually do away altogether with the small plant. Mr. Stevens' article is a valuable contribution on the subject of national fuel conservation and will bear careful study. M. D. CHURCH,

Chief Engineer, Terry Steam Turbine Co.
Hartford, Conn.

Compressor Used Wet Steam

On a recent visit to a large manufacturing plant in Buffalo, I noticed that the main steam-driven duplex air compressor, which supplied compressed air to the various pneumatic tools throughout the plant, was in continual operation. Instead of shutting it down when there was sufficient air in the tanks, the governor was apparently adjusted so that the compressor turned over slowly until the air tanks needed replenishing. It is the ordinary practice to have the governor adjusted to shut off the steam supply when the air tanks are filled to capacity, and so I naturally concluded that considerable steam was being wasted, since the compressor was kept in operation all day and shut-off periods were of considerable duration.

The chief engineer quite agreed with me and took me out to the boiler room, where I saw a very faulty piping installation. The steam pipe feeding the steam cylinders of the compressor joined the main steam line of the plant at the bottom of the main and within two feet of the feeder from the boiler. With this installation all drip and condensate and any foam from the boiler naturally went along with the live steam to the compressor, making it necessary to keep the latter in continual operation to prevent the accumulation of water in the compressor or supply line and steam cylinders during periods when the air tanks were filled.

It seems to me that the application of a little common sense when this installation was first made would have resulted in a considerable saving in view of the fact that the compressor has been operated as outlined for the past eight years.

East Orange, N. J. HOWARD S. FISHER.

Synchronous Motors for Driving Centrifugal Pumps

In the Jan. 20 issue of *Power* Soren H. Mortensen discussed synchronous motors for driving centrifugal pumps. The starting characteristics were further discussed by B. S. Stevens in the April 13 issue by presenting additional data from a synchronous motor driving an ammonia compressor. To bring out additional data presentation is made herewith of a graphic record of the starting of a synchronous motor driving a centrifugal pump installed in Morris & Co.'s plant at Chicago. Fig. 1 shows the chart incorporated in Mr. Mortensen's article, giving the current taken and the time required for starting a centrifugal pump from stand-still to full speed, with the discharge valve closed. Fig. 2 is the chart taken by the writer on a 3,000-gal. centrifugal pump working under a head of 140 ft., the pump being driven by a 160-hp. 440-volt two-phase 60-cycle 1,200-r.p.m. motor of the self-starting, self-synchronizing type. This chart shows two complete starts, and it is to be noticed that the pump was started fully primed with the foot valve on the suction, the discharge valve wide open and the starting compensator set on the 50 per cent voltage tap. The chart is self-explanatory and reads from right to left.

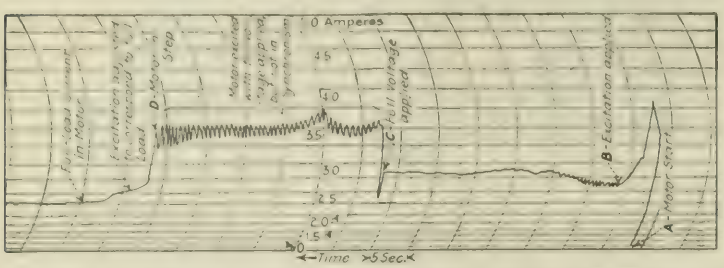


FIG 1. RECORD OF CURRENT TAKEN DURING STARTING BY SYNCHRONOUS MOTOR DRIVING CENTRIFUGAL PUMP

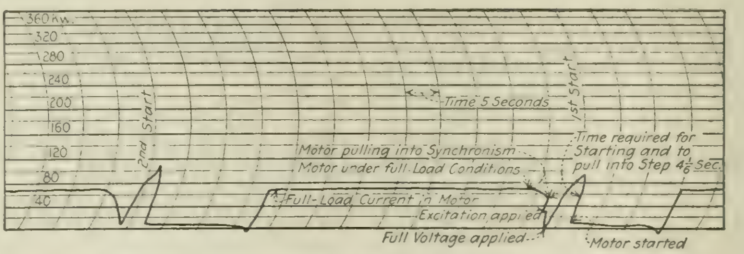


FIG. 2. RECORD OF CURRENT TAKEN BY AUTOMATICALLY STARTED SYNCHRONOUS MOTOR DRIVING CENTRIFUGAL PUMP

From the time the first voltage was applied to the motor until the latter had pulled into step under full-load conditions, approximately 4⅙ seconds had elapsed. The sharp peak as the motor started shows approximately 90 kw. drawn from the line, while the rapidly descending curve for a few seconds shows a rapid increase in speed of the motor, and of course, as the motor approaches near to full speed, a rapidly increased power factor.

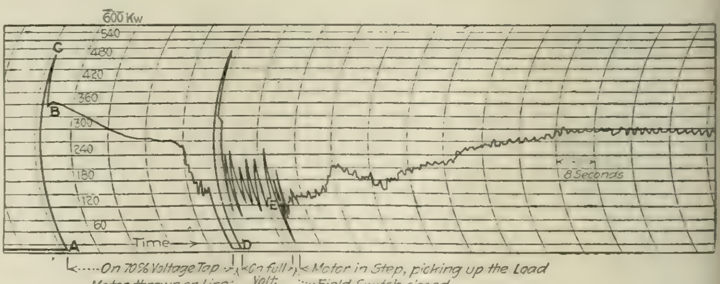


FIG. 3. RECORD OF CURRENT TAKEN DURING STARTING BY SYNCHRONOUS MOTOR DRIVING AMMONIA COMPRESSOR

It will be noticed in the curve that excitation was not applied until full voltage had been put upon the motor; and when excitation was applied, the motor pulled into step almost instantaneously. Results are entirely different from those obtained from Mr. Mortensen's method of applying the field, soon after the reduced voltage is applied to the motor. Throwing on the field before full voltage is applied to the motor simply retards the operation by prolonging the time required for the motor to reach full speed and pull into synchronism. The curve shown in Fig. 2 is a beautiful example of what can be done with a synchronous motor. To my knowledge no chart has been published previously showing where a synchronous motor has started from rest and pulled into step at full load, or approximately full load, at the pull-in point. It is admitted that the motor is a little large for the mechanical load it has to pull; but this has nothing to do with the characteristics shown in the curve. The primary idea is to show how a synchronous motor of good design can be started and put into service under full load, drawing the minimum amount of power from the line, with a continuous oncoming load being applied. It is my belief that the secret of the results obtained lies in the construction of the rotor, particularly the squirrel cage winding or starting winding as it may be called, and also in the large pole embrace and the small space between pole tips, which means a reduced electrical air gap for the motor and at the same time does not sacrifice the actual mechanical or running air gap. With a rotor designed to reduce the effective or electrical air gap to a minimum and thereby decrease the reluctance of the magnetic circuit, it is possible to secure a much larger starting torque with the same kva. taken from the line, or with same starting torque to be produced, the kva. from the line will be reduced.

Specifications on the machine as purchased are as follows:

Horsepower output	150
Kilovolt-amperes at unity power factor	119
Amperes per terminal	135
Per cent overload	0
To be used for continuous duty	

Following are the starting data as guaranteed:

Starting voltage in per cent of full voltage	45
Starting torque in per cent of full-load torque	30
Starting kv.a. in per cent of full-load kv.a.	105
Pull-in torque in per cent of full-load torque at 45 per cent full voltage	18
Pull-in kv.a. in per cent of full-load kv.a. at 45 per cent full voltage	105

The efficiencies guaranteed at 100 per cent power factor are 91.5 per cent at one-half load, 93.1 per cent at three-quarter load and 94.4 at full load.

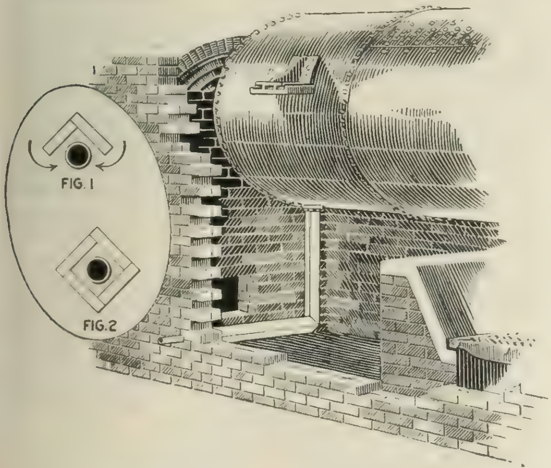
The foregoing has been given to bring out a more full discussion of the use of the synchronous motor in general. Although the present material has been confined to synchronous motors driving pumps, there is much to be said on other types of drive for synchronous motors, such as the ammonia compressor, on which B. S. Stevens had something to say in the April 13 issue of *Power*. In another article the writer will present data from a similar unit operating under practically the same conditions. G. G. REHFIELD,

Chicago, Ill. Electrical Engineer, Morris & Co.

Blowoff-Pipe Protection

A short letter in a recent issue told of a blowoff pipe that burst owing to being burned on account of not being properly protected. I had a similar experience at one time. Although the pipe was covered by a V-shaped baffle, as shown in Fig. 1, I have found that this design of baffle does not afford sufficient protection as the hot gases back in around the pipe, as shown by the arrows, and a burned pipe is the result. After having one blowoff pipe burn out, I hit on using a protection built as shown in Fig. 2, which permits air to enter the space between the baffle and the pipe where it goes through the back wall. I have, in service, three blowoff pipes so protected which are as good as new after five years' use. L. A. COLE.

Black Lick, Ohio.



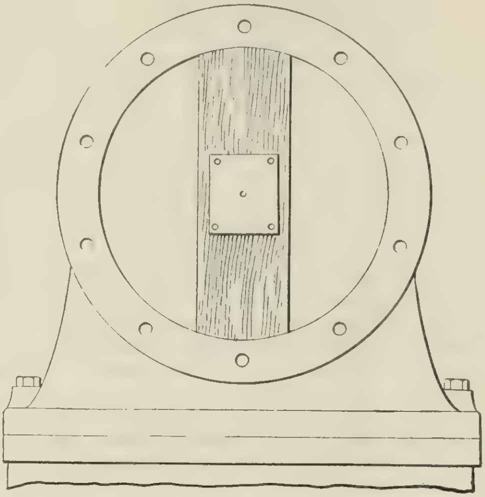
PROTECTIONS FOR BLOWOFF PIPE

Overhauling and Aligning the Engine

I have tried Mr. Airey's method of centering the line in the head of a cylinder, as described on page 764 of the May 11 issue, and found it tedious and open to inaccuracies when used by the average engineer.

I fit a dressed board, size about 1 in. by 6 in. in the counterbore with an inch hole in the center of the board. Over this hole I tack a piece of tin, mark the center of the cylinder on the tin, and punch a small hole through this center. The line is passed through this hole and is firmly held without any more measuring at that end of the cylinder. W. A. COOIL.

Esplanade, B. C.



CENTERING BOARD FOR LINING UP ENGINE

Electric-Arc Versus Gas Welds

I have read with considerable interest Mr. Miller's comments on my article on "Electric Arc Versus Gas Welds," published on page 934 of the June 8 issue of *Power*. Mr. Miller seems to assume that my statements regarding the superiority of the arc weld were based upon a few experiences in which I have been fortunate enough to have secured the services of competent arc welders and equally unfortunate in having only incompetent gas welders. Such however is not the case. I have had under my supervision, directly and indirectly, considerably over one hundred welders, over half of whom were gas welders. Some of the arc and some of the gas welders were very competent, some far from competent, but this fact did not affect the general average results obtained.

I also have examined hundreds of welds made in various metals and have made numerous tests and practical observations of arc, thermit and gas welds, and the results of these observations and tests were such as to place the electric arc weld first, the thermit weld second and the gas weld last in practical value and general adaptability. Mr. Miller states that a lack of thorough fusion is as likely to take place with an arc as with a gas weld. I have not found such to be the case, as with the extreme difficulty of localizing the heat when making a gas weld, there are likely to be portions of the weld in which imperfect fusion has occurred; this owing to these places not having been brought to a proper welding temperature. With the arc weld the metal is deposited in the weld by the so-called instantaneous fusion process and imperfect fusion is not nearly as liable to occur.

In mentioning some tests made on arc welds, Mr. Miller quotes the tensile strength as varying from 18,000 to 65,000. In order to answer this statement more data would be essential such as to the test specimens, welding system used, original metal, electrodes used and the physical properties of the weld (aside from the tensile strength), as the tensile strength alone is no criterion of a weld. The tensile strength does not follow with equal ratio the elasticity, enlongation and other valuable properties. I have increased the tensile strength of a welded specimen by hammering the weld, but I can assure the reader that I did not increase certain other essential properties by this operation.

Mr. Miller states that good welding can be done with all types of arc machines. This, to a great measure, I believe to be so, but I would qualify that statement in that some machines are capable of doing very much better welding than others. His statement that certain processes are best for certain classes of work I also agree with. But the jobs where the gas weld is the best are so few as found in plant repair work that I use the gas process for the cutting of metals only.

If I were to have a large quantity of thin sheet metal to weld, I would use the gas process, as I believe it best for that class of work. But in welding castings or other work where there is so great chance of failure by shrinkage or contraction stress, I would not consider making a gas weld if the arc-weld apparatus was obtainable. Even in cast-iron welding where users of the gas torch claim such advantage gained in the deoxidizing agency of the reducing flame, I would still prefer the arc weld, even if steel studs or reinforcement pieces were found necessary, this being on account of the severe contraction stresses set up consequent to the preheating required by the gas-welding system and the uncertainty that such stresses have been relieved by any after heat treatment used. I am not prejudiced in favor of any particular welding system except that I have used both for a number of years and have discarded the poorer for the better.

A word in regard to the propeller welding: Mr. Miller states that he would guarantee to weld these propellers satisfactorily by the oxy-acetylene process. Several other jobbing firms and the repair department of one of the leading manufacturers of gas-welding equipment agreed to do the same thing. Their welds on the propellers failed in a very short time; and although they lost the time spent on the welding and the gas used, this was a small item beside the amount the boat owners were out for the expense of docking vessel and renewing propellers after these failures. Another peculiar circumstance was this: Although on a propeller of four blades a different welder was employed on each blade with the gas process, still all the welds failed and failed in exactly the same manner; while with the arc welding process there were also four welders employed, each on a separate blade, and none of these welds failed. According to Mr. Miller the four gas welders were incompetent, the four arc welders competent, and the process used in no way at fault. This does not appear reasonable to me.

I have recently welded by the arc process a monel-metal runner shaft on a high-speed centrifugal pump, machined the same with ease, and it is in use and giving every satisfaction. The bronze and composition jobs that I have done by the arc process are far too numerous to mention. I find that in certain alloy welding the amperage and arc length are of fully as great importance as the copper ratio.

In regard to Mr. Miller's statement that no jobbing shop would take a chance on welding a cast-iron press frame by the electric arc process, last October a 3,000 ton cast-iron press frame was welded by the arc process by a jobbing shop which uses only that process and 2,194 lb. of metal had to be fused into the weld, so badly was the frame fractured. This press has been employed since that time under especially severe conditions, and with no sign of failure in the weld or elsewhere. This is only one of many repairs to cast-iron press frames by the arc process that have come under my observation.

Anyone has only to ask for the advertising matter of the many jobbing shops which do only arc welding, to find how very many of them are glad to tackle a cast-iron press frame job and furnish all required guarantees. If Mr. Miller cares to visit my shop at the present time, I will be very pleased to show him an arc weld I am making of a cracked high-pressure cylinder of a 3,500-hp. steam engine, boiler pressure 225 lb., and I can assure him that I anticipate no difficulty in making the weld and no failure after the work is completed. C. T. PERRY, M. E.

Staten Island, N. Y.

Repairing a Boiler Plate Lamination

Although I should hesitate to use the welding process to join the plates in a boiler shell, instead of using rivets, I see no reason for worry as to the consequence of filling a lamination by means of the electric arc, as stated on page 817 of the May 18 issue of *Power*.

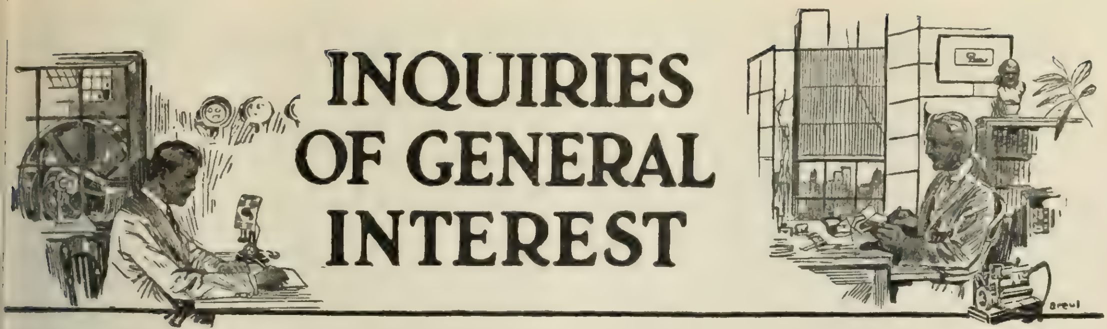
A patch and rivets might be preferable to the oxy-acetylene process on account of the heating of the surrounding plate. As stated in my original letter, there was $\frac{3}{16}$ in. of good plate. The metal was thoroughly cleaned and the edge of the cavity beveled. The cavity was then filled above the surrounding plate and the surplus metal ground off. A recent inspection of the part, which would have been difficult to locate if we did not know where it was, showed that it was in good shape and a hammer test failed to show any fault.

This method of repairing will naturally fail to meet favor with boilermakers, but that fact should not interfere with improvements in doing work.

Toronto, Ont., Canada. R. McLAREN.

Study the boiler conditions and provide a way to weigh the coal, measure the feed water, rate of combustion, the necessary draft, install water heating and reheating devices and take the temperature readings at different points at stated intervals.

Putting the plant in a good conditions is not all. A good plant badly operated or neglected will show very low efficiency; a poor plant skillfully operated will show comparatively high efficiency.



INQUIRIES OF GENERAL INTEREST

Heating Surface of Closed Feed-Water Heaters—What number of square feet of brass-tube heating surface is allowable per boiler horsepower for closed exhaust-steam feed-water heaters? R. W. R.

For heating feed water from 60 to 190 deg. F., allowing 30 lb. of water required per hour per boiler horsepower, the usual allowance is ⅓ sq.ft. of heating surface per boiler horsepower and for heating the water from 60 to 204 deg. F., ½ sq.ft. per boiler horsepower. The actual surface required depends on the condition of the heating surfaces; that is, whether clean or coated with grease or scales, and also depends on the character of circulation.

Advantage of Increasing Feed-Water Temperature—In the generation of steam at 100 lb. per sq.in. gage pressure, what percentage of saving is effected by heating the feed water by exhaust steam to 190 deg. F. in place of 110 deg. F.? R. N.

By referring to steam tables, it may be seen that a pound of steam at 100 lb. per sq.in. gage, or 115 per sq.in. absolute, contains 1,188.8 B.t.u. above 32 deg. F., and with the feed water at the temperature of 110 deg. F., or 110 − 32 = 78 deg. F. above 32 deg. F., each pound of the feed water for conversion into steam requires 1,188.8 − 78 = 1,110.8 B.t.u. If the feed-water temperature is 190 deg. F., then for conversion into steam each pound of the feed water would require 190 − 110 = 80 B.t.u. less, and the saving would be 80 ÷ 1,110.8 = 0.072, or about 7 per cent, provided there is no loss from additional back pressure on the engine.

Heating of Induction Motor—We have a three-phase, 3-hp., 220-volt induction motor which was rewound recently. The motor is star connected, runs up to speed and drives its load satisfactorily, but heats up evenly all around the stator, though not dangerously. What causes the heating? Would it be prevented by changing to a delta connection? J. E. F.

From the statement, it does not appear that there is anything wrong with the motor. If it heats up evenly all around the stator but not dangerously, that is true with any motor, even when operating under no load. It is understood that the machine was rewound by putting in the same kind of a winding that was originally on the motor. Changing from a star connection to a delta would only make matters worse, and probably the motor would not operate at all. A star connection will operate on 58 per cent higher voltage than a delta connection, and if the motor does not heat excessively and does its work satisfactorily, there is no ground for complaint.

Trouble with Glass-Gage Breakage—Much trouble is experienced with breakage of water-gage glasses on one of our boilers. What may be the cause and the remedy? W. R.

The durability of a water-gage glass depends largely on the method of packing the glands and on proper alignment of the gage-glass fittings. Test the alignment by placing through the fittings a round bar turned to the size of the bushings. A new glass should have a diameter not less than 3/64 in. less than the bore of the gland nut and bush; and the glass tube should have at least ⅛ in. end play to allow for expansion, observing, however, that the glass is long enough to prevent the packing from being forced over the end of the glass and cause obstruction of the glass-tube ends or the passages of the fittings. Tighten up the top and bottom gland nuts alternately. With the fittings in good alignment and glands properly packed, sufficiently tight joints should be secured from screwing up the gland nuts by hand, or at most by a gentle touch with a wrench. If the glass tube cannot be turned with the comparative ease by the finger and thumb after the gland nuts have been set pressure tight, it may be taken for granted that the glands are improperly packed or that the fittings are out of line.

Size of Instrument Transformer—How are the sizes of potential and current transformers for a polyphase meter determined? For instance, we have a polyphase wattmeter rated at 60 cycles, 80 amperes, 110 volts, connected to a three-phase 2,300 volt supply circuit through potential and current transformers. The potential transformers are marked "20:1 ratio, 0.05 kva." and the current transformers are marked "2,500 to 4,500 volts 16:1." V. K. S.

Current transformers are, in general, designed to give 5 amperes on the secondary at full load, and all ammeters, wattmeters, power-factor meters, etc., are designed, when supplied from current transformers, for 5 amperes in the current coil. Potential transformers are usually designed to step the voltage down to 110 volts, the transformers themselves to have 0.05 kilovolt-amperes capacity. This is standard practice, although sometimes there are exceptions made to this rule, which are special cases.

Boiler Horsepower for Stated Evaporation—How many boiler horsepower will be developed by evaporation of 100 cu.ft. of water per hour from a feed temperature of 50 deg. F. into steam at 150 lb. per sq.in. gage pressure? R. L. K.

A cubic foot of water at the temperature of 50 deg. F. weighs 62.4 lb., and 100 cu.ft. would be 6,240 lb. One boiler horsepower is equivalent to evaporation per hour of 34.5 lb. of water from and at 212 deg. F., each pound requiring the latent heat of evaporation at 212 deg. F. which, as ascertained from steam tables, would be 970.4. By further reference to the steam table it may be seen that a pound (by weight) of steam at the pressure of 150 lb. gage, or 150 + 15 = 165 lb. per sq.in. absolute, contains 1,195 B.t.u. above 32 deg. F. With feed water at the temperature of 50 deg. F., or 50 − 32 = 18 deg. above 32 deg. F., each pound of the feed water would receive 1,195 − 18 = 1,177 B.t.u., or 1,177 ÷ 970.4 = 1.2129 times as much heat as required for its evaporation from and at 212 deg. F. The quantity 1.2129 would be the "factor of evaporation" for the stated conditions of feed water temperature and the pressure at which the steam was generated and evaporation of 6,240 lb. of water per hour would be performed at the rate of 6,240 × 1.2129 ÷ 34.5 = 219.38 boiler horsepower.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Separation of Dissolved Gases from Water[*]

LABORATORY tests of a method for removing dissolved gases from water having demonstrated its commercial utility, further experiments were made on commercial apparatus, and the general conclusions are presented in this paper. The process consists of the rapid injection of heated water into a region of vacuo, the explosive boiling of the water by the heat of the liquid and the recovery of the heat liberated by a condenser cooled by the incoming water on its way to the heater. It is demonstrated that this process is able to handle water in quantities suitable for power-plant boiler feed, that it is capable of removing all the dissolved gases in a commercial sense, and that this involves no method or apparatus with which the average operating engineer is not familiar.

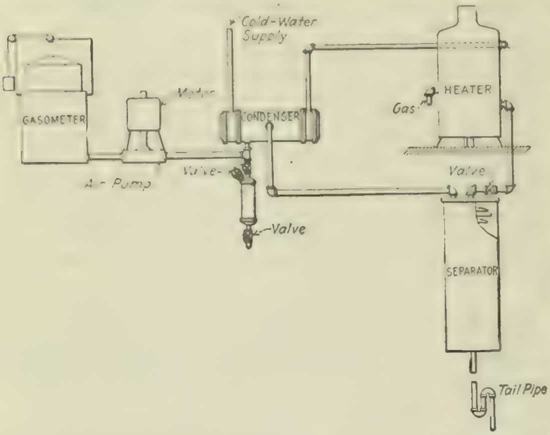


FIG. 1. LABORATORY APPARATUS FOR THE SEPARATION OF DISSOLVED GASES FROM FEED WATER

The laboratory apparatus is shown diagrammatically in Fig. 1. The water to be treated was heated in a gas water heater which delivered the hot water to the separator. The latter consisted of an airtight steel tank with a series of copper return-cascade trays, over which a sprayhead delivered the water uniformly in a thin sheet. A vacuum being maintained in the separator, some of the liquid boiled explosively, and the resulting vapor and any free gases were carried off to the condenser, which was a small commercial machine of the surface type. Here all the vapor was condensed and the heat reclaimed by using the water on its way to the heater as cooling water. The separator tank was connected with a barometric tail-pipe to remove the treated water. The condenser was drained out through a small receiver and trap and the non-condensable gases were drawn out by the air pump and delivered to the gasometer for measurement. It was found that the gasometer method of measuring the volume of non-condensable gases was not of consistent accuracy with the rest of the data, and it was therefore necessary to resort to direct testing of the water which had passed through the process. The method finally adopted was the iodiometric titration method of Winkler for dissolved oxygen.

At the conclusion of about four months' intermittent testing the apparatus was taken apart and examined. Steel tanks, copper pans and condenser gave evidence of very accelerated corrosion, and this led to the use of cast iron and non-corroding bronzes in the construction of the first commercial apparatus. These materials have withstood the corrosive tendencies for over four years of experimental operation. The laboratory experiments developed a further fact, that the water which has been passed through this process and completely degasified has an enormous avidity for redissolving small amounts of air. In any practical application of the process, therefore, absolutely rigid exclusion of air must be maintained if the full benefits are to be secured.

After the success of the laboratory apparatus was demonstrated, a commercial installation was made at the Jeannette, Pa., works of the Elliott Co., of Pittsburgh, and this apparatus has been in routine operation since the autumn of 1915. The separator consisted of a 1,000-hp. Elliott cylindrical heater shell with modified water injection, different proportions of water storage volume and pan area and a change of material to resist corrosion. At the outset a 300-hp. open feed-water heater was installed to supply the hot water, and the vacuum was maintained by a rotary motor-driven dry air pump in series with the condenser. The drip from the condenser was allowed to drain directly back to the separator and the air pump discharged directly to the atmosphere, otherwise the scheme of connection was identical with that shown in Fig. 1. Later, an increase in boiler capacity necessitated a 1,000-hp. heater, and an Elliott shell-type heater similar to that used for the separator was installed and the whole outfit repiped and made into an integral vertical unit. This heater-separator unit is shown in Fig. 2. A steam injector was substituted for the rotary air pump, and the condenser was mounted on the atmospheric side to recover the injector steam, the condenser drainage being now to the heater instead of to the separator.

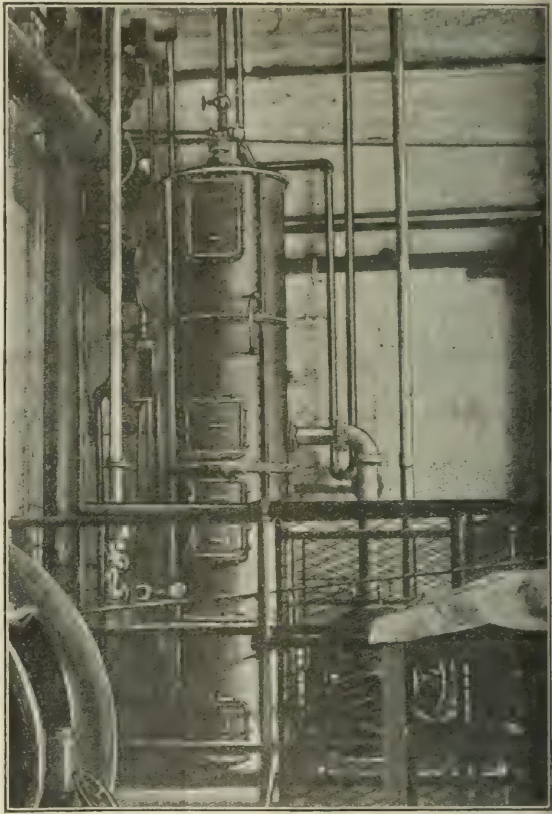


FIG. 2. INTEGRAL VERTICAL-UNIT COMMERCIAL TYPE OF APPARATUS

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[*] Abstract of a paper presented by J. R. McDermet at the Spring Meeting at St. Louis, May, 1920, of the American Society of Mechanical Engineers.

The mechanism of separation appears to depend on three factors: The natural decrease of solubility with temperature increase, the mechanical agitation of boiling and the reduction of pressure. The reduction of solubility with heating amounts, roughly, to 70 per cent of the volume at normal temperature, and separation to this extent was arbitrarily credited to the heater. Water at 212 deg. F. injected suddenly into the vacuum in the separator boils with explosive violence. Vapor bubbles form upon minute entrained air bubbles and in passing off into the region of reduced pressure, mechanically carry some of the dissolved air with them. By far the major portion of the separation, particularly in the elimination of the final traces of dissolved gases, is accomplished by reduction of partial pressure. With a separator water-storage volume corresponding to two minutes' operation at rating, it is impossible to detect any temperature depression in the vapor mixture or in the water leaving the separator, below the vapor temperature corresponding to the vacuum. The most logical conclusion from this is that with the continuous sweep of the wet dense water vapor from the separator, the air component of the total pressure has been reduced substantially to zero.

Fig. 3 is plotted with percentages of separation as ordinates and vacuum referred to a 30-in. barometer as abscissas for a water temperature at admission to the separator of 212 deg. F., corresponding to atmospheric equilibrium. This plot is a graphical average of a large number of determinations made both with the laboratory and a commercial-sized apparatus. Percentage of separation is defined for the purposes of these curves as the ratio of the quantity of gases removed to that actually present in the raw water, and the calculations were made in terms of volume. At separation values much in excess of 95 per cent, the quantity of gases remaining is so exceedingly small that accuracy of testing is a limiting feature in extending the conclusions to this range. It is the writer's frank opinion, however, that the flat portion of the curve in Fig. 3 represents complete separation of the gases, but it is impossible to prove it.

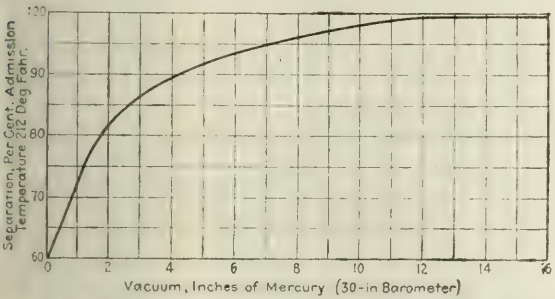


FIG. 3. RELATION BETWEEN AIR SEPARATION AND VACUUM FOR 212 DEG. F. WATER TEMPERATURE AT ADMISSION TO SEPARATOR

This work was undertaken as an industrial-research problem with the expectation that it would have two distinct fields of usefulness: The elimination of boiler and economizer corrosion in boiler plants, and of that of the entire distribution system in central-station heating; and the improvement of conductivity in surface condensation of steam. It developed in the course of experiment that it had additional merit in the removal of dissolved and half-combined carbon dioxide. The matter of corrosion has received wide attention from the engineering profession, and the pernicious effect of dissolved oxygen is unquestioned. A high-pressure steam boiler is so complicated a chemical factor that there can be no general panacea for its ailments, but the removal of dissolved oxygen and carbon dioxide is a decidedly effective step in the elimination of corrosion.

The removal of carbon dioxide and oxygen will also, undoubtedly, prolong the life of cast-iron economizer tubes and will make the installation of steel-tube economizers economically practical and conservative.

The bicarbonates of calcium and magnesium are soluble in water in any proportions in which they are likely to exist in natural supplies. They will, however, readily part with their carbonic acids under the conditions existing in the separator equipment, thereby being reduced to carbonates which may be precipitated before entering the boiler, thus avoiding the scale troubles from this class of compounds. The elimination of the carbon dioxide by this apparatus, therefore, should help in the solution of scale problems as well as in those of corrosion.

Exhaustive tests were made to determine the effect of air removal on the conductivity of heat in surface condensers. These tests show that the removal of air would cause an increase in conductivity of about 20 per cent based upon the entire area of the condenser. The economical limit of the removal of heat by the cooling water after it has been conducted will probably, however, limit conductivity to substantially the same values that are used in commercial practice today. Since in part of the condenser the heat transmission is from steam through metal to water, and in another part, from water through metal to water, and since the rate of heat transmission in these zones is so radically different, it is impossible in tests on condensers of different types with air-free steam to arrive at any data with which to formulate or verify laws.

It is possible, then, from the data of this paper to design apparatus that will accomplish the separation of dissolved gases from boiler water as completely as it may economically be desired to do it. Control of the process is secured through regulation of the temperature drop of the water in passing into and through the region of vacuum. The benefits to be derived from this removal of dissolved gases are at least a partial elimination of corrosion in boiler and economizers, the precipitation of dissolved bicarbonates and therefore a partial solution of the scale problem and a gain of approximately 20 per cent in the conductivity of surface condensers upon the condenser area as a whole.

MR. SPELLER'S DISCUSSION OF THE McDERMET PAPER

The following is an abstract of a written discussion of Mr. McDermet's paper by F. N. Speller, metallurgical engineer, National Tube Co.

The method of mechanical de-aëration described by Mr. McDermet affords another means whereby the gases may be removed from water, and illustrates again that the practical solution of the corrosion problem is mainly a question of special engineering design. At temperatures below 180 deg. F. our experiments have shown that the last 0.5 c.c. per liter (0.116 cu.in. per gal.) of oxygen is much more difficult to remove by mechanical means, while above 180 deg. F. equilibrium can be easily obtained when the temperature approximates the boiling point for the prevailing pressure.

The oxygen content (which is closely proportional to dissolved air) varies from 5 to 10 c.c. per liter (1.16 to 2.31 cu.in. per gal.) in natural water according to seasonal temperature. As it is simple enough to remove most of the gases without any special apparatus other than a well-vented heater, it is perhaps better not to consider percentage removal of gases, but rather as to how much remains after leaving the heater and how best can this residual oxygen be removed. The variation in reduction of dissolved air reported from 10 to 70 per cent at 212 deg. F., if I interpret these figures correctly, indicates the use of an undersized open heater. It would seem more desirable to plan to remove dissolved gases as far as possible in the heater. An open heater operating at the National Tube Co., McKeesport, Pa., at a temperature of 170 deg. F. left a daily average of 2.55 c.c. per liter (0.589 cu.in. per gal.) of free oxygen in the feed water, the theoretical minimum for these conditions being 2.35 c.c. per liter (0.543 cu.in. per gal.). Another series of tests made at another plant with an open-heater temperature of 204 deg. F., gave us 0.75 c.c. (0.173 cu.in. per gal.) residual oxygen, the theoretical minimum under these conditions being 0.50 c.c (0.116 cu.in. per gal.) per liter. A test on a large open heater at the Philadelphia Electric Co., reported to me by Mr. N. E. Funk, gave 0.70 c.c. per liter (0.162 cu.in. per gal.) in feed water leaving the heater at 209 deg. F. with some corrosion in economizer tubes, but much less than before when the heater was operated at 148 deg. F.; the feed water after heating in this case carried 2.06 c.c. per liter (0.475 cu.in. per gal.) of free oxygen. We have shown, however, that it is possible to approach quite close to the theoretical minimum oxygen in an open heater by a larger area of baffles or by spraying the water.

The method of collection of sample is not described and may have a bearing on the heater variations Mr. McDermet refers to. In taking samples of hot water under pressure for oxygen determination, we draw the sample slowly while under pressure through a copper or tin coil immersed in ice water so that, when drawn into sample bottle, the temperature of the water is about normal. This insures retention in solution of all gases, and if the sample tube extends to the bottom of the bottle, a sample can be collected in a minute or two without agitation and without reabsorption of air.

Corrosion Proportional to Free Oxygen in Solution

The amount of residual oxygen that will cause serious corrosion in a given time varies with the temperature at which the water is used. It has been demonstrated experimentally by the work done by Dr. W. H. Walker of the Massachusetts Institute of Technology and ourselves that corrosion of piping is closely proportional to the free oxygen in solution. Several years' experimental work on mechanical and chemical de-aëration has been done at the Massachusetts Institute of Technology and National Tube Company Research Laboratories in co-operation, and several plants have been put into service to test out these principles in hot-water supply systems for buildings and in central heating stations and power plants to develop the best type of apparatus for such service. This experience indicates that feed water used with steel economizers should carry less than 0.20 c.c. per liter (0.046 cu.in. per gal.). The foregoing tests therefore indicate that open heaters, as usually operated, will not reduce the oxygen low enough to stop corrosion.

The residual oxygen in feed water after passing through a properly vented open heater may be reduced below the danger point by further mechanical de-aëration such as passing the water from heaters over baffles at about the boiling point in a separate chamber at lower pressure (no condenser required) or injecting the superheated water into a low-pressure chamber with a condenser in series, as described by Mr. McDermet; or by chemical treatment; or by a combination of systems, as is most suitable and convenient. We have had in continuous use for nearly five years a process for removing oxygen by the latter principle. The heated water is passed under pressure through a large mass of expanded steel scrap, which I have termed "deactivating" the water in distinction to mechanical de-aëration. In this way the last trace of oxygen may be removed within a wide range of temperature and pressure.

Mr. McDermet calls attention to the very accelerated corrosion in the steel tank, copper pans and condenser of his experimental apparatus. We have frequently found when using *closed* heaters that about one-half of the corrosion is removed by contact with parts of the heater or connecting pipes, which indicates how very effective is this means for removing dissolved oxygen. Mechanical means for removing free oxygen from water require careful adjustment and control of temperature and pressure, whereas chemical means such as the use of a suitable kind of steel scrap, will "fix" the oxygen independently of such variations without further attention except for the renewal of material at long intervals.

Mr. McDermet's paper shows an interesting method that may be used for mechanical de-aëration of water, but he is hardly justified from the data and experience given in claiming that this process involves a minimum of operating expenses. There seems to be no doubt that the controlling factor in water corrosion is the presence of dissolved oxygen, carbonic acid being of minor importance. The most economical and convenient method for controlling corrosion in steel economizers will be developed by experience, but that control of corrosion can be accomplished by the application of these principles I believe has been established beyond doubt; therefore with attention to the relative temperature of waste gases and feed water so as to avoid outside condensation on tubes, there is no apparent reason why steel economizers cannot be used without any more deterioration than is now experienced in boilers.

Water Level Indicator for Boilers

The ordinary method of checking the water level in a steam boiler by means of test cocks has the disadvantage that with such pressures as are in use the fluid issuing from the cocks, when they are open, is in the form of a jet which is practically the same whether the water level be above, or below, the test cock. Partly in view of this it has long been usual in good practice to fit two water-level gage glasses instead of one. Even so, however, it is possible that the two glasses may be out of action at once, and in some cases it is not always easy to distinguish between a full glass and an empty one. A simple and effective form of water-level indicator which has all the advantages of the test cocks in checking the water level, but does not suffer from their disadvantages, has been patented by Messrs. Cammell Laird & Co., Ltd., and is being manufactured by Messrs. Bromell Patents Company, Ltd., of 64 Darnley St., Glasgow, says *Engineering*. It consists of a metal tube of external diameter and length such that it may replace the glass tube in an ordinary water gage. The metal tube is drilled with a series of small holes about $\frac{1}{32}$ in. in diameter, and at a pitch of a few inches apart.

When this tube is in position on a boiler and the gage cocks are open so that it is put in communication with the water and steam spaces, it is found that the jets which issue from the holes that are below the water level are very distinct in character from those which issue from the holes above the water level. The steam jets issuing above the water level are barely visible and have a very small angle of divergence, while the jets below the water level are in the nature of a distinct white, cloudy spray, and have a wide angle of divergence. It will be clear that this device enables a very close reading of the water level to be obtained with ease and certainty, and that there is nothing in it to go wrong. A hole may be stopped up, but if this happens it is at once evident and may easily be cleared. With the size of the holes used, this minor trouble is not very likely to occur.

It is found that the best contrast between the jets is obtained when the length of the jet passage is equal to its diameter, and to obtain this proportion a flat is filed on the tube at the point where the hole is drilled. It will be evident that these distinctive jets may be obtained by fitting suitable nozzles to ordinary test cocks, but the arrangement would not give the close reading of water level which is obtained with the indicator, unless an unusual and probably undesirable number of test cocks were fitted.

Pension Plan of Ontario Hydro-Electric Commission

In accordance with an act passed by the Ontario Legislature, the Ontario Hydro-Electric Commission has inaugurated for the benefit of its employees a pension plan, an insurance and sick benefit plan and a savings account for women employees.

About 2,500 employees will benefit from these plans. A pension will be paid to any male employee with service of 15 years and who has reached age of sixty-five or who has become permanently disabled before his sixty-fifth birthday. The pension will be an annual payment of one eightieth of the pensioner's average salary for previous 5 years, multiplied by the number of years he has been in the service. There will be no assessment on the employees for any of the benefits.

A savings account will also be opened for each woman employee, in which will be deposited 5 per cent of her salary each year, and the amount thus accrued will be paid to her when she leaves the service.

Reserve Strength of Elevator Ropes*

By W. VOIGTLANDER
Engineering Department, John A. Roebling's Sons Company,
Trenton, New Jersey

THE prime mechanism of the modern elevator is the wire rope, for upon its condition and life more than upon any part of the equipment is the service depen-lent. I will therefore touch upon the reserve strength of x 19 ropes, inasmuch as there seems to be much doubt as o the strength of ropes having one or more wires broken. y 6 x 19 ropes we nean six 19-wire trands laid about a emp center, as shown n the sectional view ig. 2. The construc-ion of the rope is uch that the outside ayer consists of al-ernate large and mall wires so as to orm a round strand. The upper diagrams how the dissected trand, and in the fol-owing discussion of roken wires reference vill be made to large outside and small out-side wires. Tests nade by Roebling's how the reserve strength for various conditions when using new ropes with wires cut. The results of these tests are given in the accompanying table, but only some xtreme conditions will be pointed out.

Test 1, having one large wire cut in each of the 6 strands at the same cross-section, resulted in a reduc-ion of both the metal- area and the breaking strength of the rope to approximately 93 per cent of the original.

Test 2, having one large and one small wire cut in each of the 6 strands at the same cross-section resulted in 89½ per cent of original area and 90½ per cent of orig-inal strength.

Test 4, two large wires and two small wires similarly cut in each of the 6 strands, resulted in 79¼ per cent area and 83¾ per cent strength.

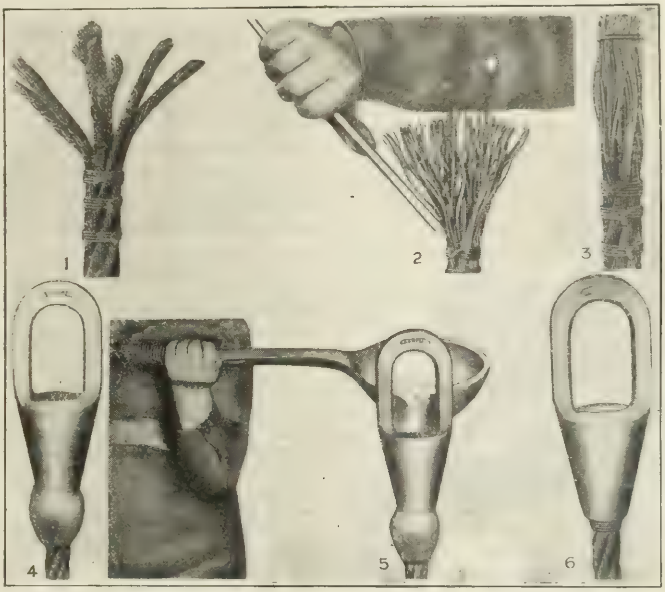
Test 8, all twelve outside wires cut in only one strand, resulted in 89½ per cent area and 75 per cent strength.

Test 1. One large wire cut from each strand. Each wire cut three times. End cuts a distance of two rope lays from center cut. Each series of cuts in same circumference.

Test 2. One large and one small wire cut in each strand on same axis. Each wire cut three times. End cuts a distance of one rope lay from center cut.

Test 3. Two large wires and one small wire cut in each strand in same manner as in test 2.

Test 4. Two large and two small wires cut in each strand, same manner as in test 2.



The Correct Method of Socketing Wire Rope

1. Measure from end of rope a length equal to basket of socket. Serve at his point with not less than three wraps. Cut out hemp center, open strands.

2. Separate wires in strands, straighten by means of iron pipe, cleanse with kerosene oil, wipe dry.

3. Dip wires into one-half muriatic acid, one-half water (use no stronger solution). Keep wires in long enough to be thoroughly cleansed--wipe dry, serve end that socket may slip over all of the wires.

4. After placing on socket, cut serving wire at top—have all wires evenly distributed and even with top of basket—place fire clay around bottom of socket.

5. Pour in molten pure zinc—do not use babbitt.

6. Remove all servings except one nearest socket. After cooling, it is ready for service.

Test 5. Three large and two small wires cut in each strand, same manner as in test 2.

Test 6. Three large and three small wires cut in each strand, same manner as in test 2.

Test 7. Four large and three small wires cut in each strand, same manner as in test 2.

Test 8. Three sets of four wires each or all outside wires in one strand only cut. Wires cut only once. Each set of four wires cut were a distance of one strand lay from each other.

Test 9. Same as test 7, except each wire cut only once.

Test 10. Same as test 8, except two strands were cut.

Test 11. Four large wires and three small outside wires in each strand cut. One large wire in each strand cut in center in same circumference. One end cut, two large and one small wires; other end cut two small and one large. Distance from center to end cuts one strand lay. Each wire cut only once.

Test 12. Same as test 10, except that each set of cuts was a distance of one rope lay apart.

Test 13. Same as test 8, except that each set of cuts was a distance of one rope lay apart.

The examples given are sufficient to point out that, where the broken wires are uniformly distributed in all six strands, the reserve strength is greater in proportion than the net metallic area. It has been demonstrated by us in tests that where every outside wire of all the six strands have been cut, the reserve strength is 42 per cent, whereas the net metallic area is 37.6 per cent.

It is seen from test 8 and also shown in test 10 that where all the cut wires occur in only one strand, the re-

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*Paper presented before the American Society of Safety Engineers and published in *Safety Engineering*.

serve strength is less in proportion than the net metallic area. This is due to the fact that the strand that is thus cut, collapses to a degree that allows the other five strands to change their relative positions and thereby reduces the original efficiency of the rope construction.

It is therefore of the utmost importance that any condition that causes one strand in any of the ropes on an elevator to wear more than other strands should be bettered or as much as possible done away with. The chief causes for this condition of one strand wear are improper socketing, unequal tensions in the ropes supporting the car and worn grooves in the drum and idlers.

It has been conclusively demonstrated by repeated tests that the most efficient socket attachment is made by a "straight wire brush" held in the conical basket of the socket by means of spelter (pure zinc). The proper method of socketing is shown on the accompanying plate. To bend the wires back not only reduces the efficiency of the connection, but has proved to have pushed back one or more strands, causing "high strands." These "high strands" are thus the first to wear and cause more rapid failure, as already pointed out. To use other metal than zinc will prove less efficient—perhaps not in a test sample in the testing machine, but in a long-endured load at only the working tension. This refers principally to the use of babbitt, solder, lead and other low-melting alloys.

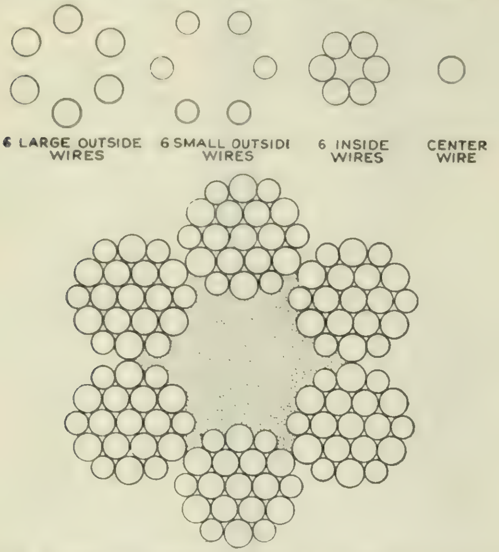


FIG. 2 REGULAR CONSTRUCTION 6 x 19 ELEVATOR ROPE

TESTS OF 6 x 19 ROPES SHOWING RESERVE STRENGTH

Test No.	Number of Strands Cut	Number of Outside Wires Cut in a Strand		Percentage of Metal Area	Percentage of Original Strength
		Large	Small		
1	6	1		93 02	92 60
2	6	1	1	89.56	90.46
3	6	2	1	82.62	84 50
4	6	2	2	79.20	83.74
5	6	3	2	72 23	77.51
6	6	3	3	68.79	74.51
7	6	4	3	61.83	69.45
8	1	6	6	89.56	75.09
9	6	4	3	61.83	72.71
10	2	6	6	79.20	67 60
11	6	4	3	61 83	73 54
12	2	6	6	79 20	90 29
13	1	6	6	89 56	95 85

Unequal tensions of the ropes cause rope failure shown in broken wires due to fatigue. Though the estimated factor of safety for a set of ropes may be 8 or 10, it has been shown that where, by unequal tensions, one rope may be carrying twice or even greater proportion of its supposed load, the combined load and bending stresses have so fatigued the steel that the wires break prematurely. The unequal tension also accentuates any faulty condition in socketing as well as placing more load on one groove or more of the multiple-grooved drum and idlers.

Worn grooves cause rope wear due to excessive slippag of which one instance will serve as an example. In a to 1 traction machine one of the grooves on the drum w found to be in. below the level of the others, whi would result in approximately [illegible] in. reduction in circu ference. The extreme points of travel resulted in 27 rev lutions of the drum, which caused the one rope to slip fi inches more than the others in each travel up or dow A groove worn down by an old rope will pinch a new rop and this causes short life for replacement ropes, and t ropes are usually blamed as inferior in workmanship quality.

Interstate Commerce Commission to Ac on Transportation Problems

Continuance of the Interstate Commerce Commission service order No. 7 may be expected. This conclusion based on the questions asked and the general attitude the members of the Commission who heard the argume in the matter of the supply, exchange, interchange and r turn of open-top equipment. Representatives of the buil ing industries and of the various activities connected wi the building of roads made strenuous pleas for the modi cation of the order, so that a portion of the open-top ca could be allotted to their more necessary uses. The publ utility representatives declared it to be their firm beli that nothing less than assigned cars at the mines wou meet their requirements. The coal operators contended th the order should not be modified. If the mines are give 100 per cent car supply for a few weeks, they asserted, t acute shortage will be met.

It was charged that contracts are being disregarded an coal sold at high prices in the open market. Since co costs can be passed along easily in the so-called luxur manufacture, those concerns could afford to pay nearly an price in order to keep their plants in operation. It w pointed out that in other industries coal forms a muc more important part of costs, and in such cases as publi utilities the increase in price cannot be passed along.

Recommendations made by Lemuel F. Owen of the Ch cago Building Material Exchange, representing the Buildin Material dealers of Chicago and Cook County to the Inte state Commerce Commission provide for an increase in th per diem rental charge on all open and closed cars, as b tween roads from ninety cents to two dollars per day; t prohibit the reconsignment of all cars and to establish demurrage charge based on the value of the commodity, o the freight rate, instead of the now prevailing per die demurrage, irrespective of the commodities contained in th car.

If, within a reasonable length of time, the enforceme of the foregoing fails to provide relief for the existing co ditions, it is recommended that at a reasonably later dat an order should be made effective limiting the furnishing all cars for the transportation of any and all commoditie excepting the absolute essentials—food, fuel, clothing, she ter and highways.

In an address before the National Association of Windo Glass Manufacturers at Atlantic City, Commissioner Colve said: "I hope that when the United States buys $200,000 000 of new equipment for the railroads that equipme will not be used that way. I hope cars will be charged t the road on whose tracks they go at a fair but stiff rent for each day. I hope that a higher demurrage charg mounting swiftly to severe penalties, will compel the shipp to load and unload with all speed. I hope reconsignme will be limited strictly to its use and that its abuse will b made impossible. As a single instance of such abuse I he of 100 cars of coal held on sidings near a coal-hungry cit and awaiting reconsignment to the highest bidder."

The Westinghouse Electric and Manufacturing Co. is t be congratulated upon the appearance of a book of Wester views beautifully illustrated and bound, which formed th company's contribution to the recent National Electr Light Association Convention at Pasadena, Cal.

Soft-Coal Shortage Acute

Hlow the country has run down in its stock of soft coal strikingly shown in a report just issued by the Geological rvey. These official figures, embracing every state in the ion, show that huge industrial and utility plants of the ion have been going along during the last few months h an average of from one to two weeks' supply of coal.

While in ordinary times there is a supply of some 35,000,- tons of coal in the country's bins in the early spring nths the country's surplus throughout last spring was nost entirely exhausted.

On May 31, the Survey's figures show, there were cks of bituminous coal at industrial plants, other than el, of 3,389,066 tons throughout the country, represent- an average of $3\frac{3}{4}$ weeks' supply. Public utility plants d on hand 1,372,880 tons, or a little over 3 weeks' supply. al-gas plants had stocks of 222,805 tons, or enough to last weeks. In some centers the shortage was much more ite than in others.

With an increasing demand for coal throughout the intry and lessened production because of car shortage, average of stocks in the hands of manufacturing plants, blic utilities and other large consumers throughout the intry gradually diminished during June. Unofficial re- rts show that many of the manufacturing plants by that ne had run down to a supply that would last only a little er a week.

Inability of coal operators to get anywhere near an ade- ate supply of cars to take coal from the mines is brought t by the Geological Survey. Reports embraced in the rvey's statement from some 3,000 mines, representing proximately 60 per cent of the aggregate soft-coal capac- of the country, show that there was an average of $\frac{3}{10}$ per cent of potential production lost through shortage coal cars, for the entire country. In some of the fields, tably West Virginia, Kentucky and Illinois, the loss of oduction due to shortage of cars ran from 50 per cent d up to 65 per cent of normal.

New England States Association, N. A. S. E. Convention

The annual convention of the New England States Asso- ation of the N. A. S. E. combined with the Mechanical Ex- bit of the New England Association of Commercial Engi- ers was held at Worcester, Mass., July 7-10. The Ban- oft Hotel was the headquarters.

There were upwards of seventy-five delegates in attend- ce. Among the visiters were numbered National Presi- nt John J. Callahan and many past presidents, also big delegation of prominent members of the organization om the New England States and elsewhere.

The Casino, situated in close proximity to the headquar- s, was arranged for the use of the supplymen in the dis- ay of their wares. Booths were occupied by 105 firms hibiting mainly new devices in the engineering field, the iole making a most attractive display, which was liberally tronized during the four days.

The exhibit at the Casino was formally opened on Wednes- y evening. Harry H. Atkinson, president of the New igland Association of Commercial Engineers, presided d introduced the following speakers, who made short addresses: Hon. Channing H. Cox, lieutenant governor of Massachusetts; Major James Myrick, treasurer of the supplymen; Robert Johnson, chairman of the local committee; Charles E. Hildreth, president of the Chamber of Commerce, and Tremont E. Eggleston, Jr., chairman of the exhibition committee. The exhibition was open from 10 a.m. to 10:30 p.m.

The opening exercises of the engineers were held in the banquet hall of the Bancroft Hotel on Thursday evening. The meeting was called to order by Chairman Robert Johnson, who introduced Herbert E. Stone, master of ceremonies. Alderman Joseph W. Leydon welcomed the convention to Worcester in place of Mayor Sullivan, who was called from the city. Warren H. Goodrich responded and spoke of the growth of the N. A. S. E. during the past year. Charles E. Hildreth, president of the Worcester Chamber of Commerce, told of the dignity of the engineering profession and expressed how pleased the citizens of the city were to have the delegates and visitors among them. He said that the engineer was undoubtedly the mainspring of civilization. Charles C. Gardiner, chairman of the Educational Committee, of Taunton, spoke of the help that the members of the N. A. S. E. have always given to the Government in the time of need and hoped that the members in Worcester and other cities would get in closer relation with the Chamber of Commerce, as much good could be accomplished in this way. Dr. Ira N. Hollis, president of the Worcester Polytechnic Institute, advised strict economy and frugality on the part of the engineers. He urged the necessity for internal peace in our own country. If this could be brought about there would be absolutely no fear of friction with outsiders. He said that happiness never comes in the pursuit of happiness, but in the pursuit of work; that man is happiest who is doing some interesting work for someone else. Vice President Elmer L. Dean responded for the engineers, and the ceremonies closed with the singing of the National Anthem.

On Friday evening a smoker was given in the banquet hall of the hotel. This event was well attended and an enjoyable program of entertainment was given by members of the Supplymen's Association and some local talent.

The outing at Lake Park on Saturday afternoon was a big success. Autos conveyed the company to the grounds where outdoor sports of all kinds were indulged in, with prizes to the winners. The baseball game resulted in a tie. The festivities ended with an appetizing sheep bake at the Winchester Boat House.

The election of officers of the delegates resulted as follows: Dudley S. Kimball, president, Cambridge; George C. Madison, vice president, Worcester; Freeman L. Tyler, secretary, Taunton; Walter H. Damon, treasurer, Springfield; John H. Graham, conductor, Fall River; Thomas Livingston, doorkeeper, Meriden.

The New England Association of Commercial Engineers elected officers as follows: Harry H. Atkinson, president, Economy Lubricating Co.; S. E. Smith, vice president, McClave-Brooks Co.; Maj. James W. Myrick, treasurer, Auto Force Ventilating Co. The three trustees elected to serve three years were: F. S. Eggleston, Eggleston Supply Co.; L. W. Merrihew, Strong, Carlisle & Hammond Co.; Fred M. Couch, V. D. Anderson Co.

The presentations were a past president's badge and diamond stickpin to Warren Goodrich, gold watch and chain to Harry Atkinson and a magnifying glass to Walter Damon.

N. A. S. E. MEMBERS AND DELEGATES PRESENT AT CONVENTION

Charges Anthracite Industry Is Controlled by a System

W. Jett Lauck, in arguing the admissibility of exhibits on profiteering and monopoly which he had submitted in behalf of the United Mine Workers of America and to which the representatives of the operators had interposed objections, declared that the real profits of the anthracite industry were at least seven times the apparent profits and charged that the anthracite coal industry is dominated by a monopolistic system that is squeezing both the consumer and the wage earner by diverting profits at points where neither can see through the screen of legal devices and bookkeeping.

Mr. Lauck contended that there is no warrant for the assertion that the anthracite industry cannot pay higher wages without a further increase in the price charged to the consumer. The anthracite industry is paying profits that are amply adequate to absorb the cost of a just increase in wages.

"Enough money is abstracted between the time when the coal leaves the mine and the time when it reaches the local dealer to pay the requested wage increase and at the same time to reduce the price of the anthracite to the consumer," said Mr. Lauck.

The anthracite industry is similar in structure to an octopus. Its head and body are a very small group of banking interests. Its arms are seven railway systems which control at their extremities the anthracite mining operations of the country.

The books of the entire concern represented by the seven great business organizations must be examined before anyone can say just what the profits are.

Mr. Lauck declared that such an examination of the books was necessary for the settlement of the controversy and that the bookkeeping evidences of the unity between the railroads and their coal companies was overwhelming. Such high rates for the transportation of anthracite were established by the railroad companies that it became impossible for a coal company to operate at a profit. The railroad coal companies were then supported by subsidies granted in one form or another by the parent railroad company. This was made possible by a bookkeeping system that rendered the finances of the two companies practically one.

In the rush to monopolize anthracite reserves, the railroad companies purchased thousands of acres of unproductive land for which the consumers and mine workers are being asked to pay by high prices and a non-living wage.

The point which Mr. Lauck emphasizes and brings out is that a well-defined process exists by which the profits of the anthracite industry are successfully concealed, the high prices being explained by apparent high costs. The losses of the railroad companies are written into the cost of transportation through advances without interest and through the funding operations which impose large fixed charges upon the railroad department. The high freight rates which such inflated transportation costs seem to justify are written into the cost of anthracite and serve to bridge the gap between the mine cost and the high prices which prevail.

Engineer Officer on Water-Power Commission

Another step in the organization of the Federal Power Commission was taken July 8, when the President designated Lieut. Col. William Kelly as its Engineer Officer.

Much of Colonel Kelly's experience has been in California on engineering projects which brought him in close contact with the water-power situation. He was graduated from the United States Military Academy in 1899. He trained the 117th Engineers and took that regiment to France in 1917. Later, he became Chief Engineer for the Fourth Army Corps. From that post he was promoted to Base Commanding Officer. He is now engaged in river and harbor work at San Francisco.

Engineering Foundation and an American Hydraulic Laboratory

Certain engineers have recently proposed an endowed American Hydraulic Laboratory. There are many needed contributions to hydraulic engineering and the underlying science which can best be made by a laboratory with sufficient resources.

In Engineering Foundation there exists the instrumentality for bringing into existence such a laboratory as is suggested. Engineering Foundation Board is thoroughly competent to receive and administer endowment funds in any amount, including those which might be especially designated for an American Hydraulic Laboratory.

Instead of creating a new laboratory, it might be found advisable for Engineering Foundation, if funds should be provided, to serve as an American Hydraulic Institute. The institute could enlarge the usefulness of the existing hydraulic laboratories of the universities, the Government and the industries by directing experimenters and allocating problems to the laboratory best equipped for each specific project undertaken. It could contribute to the support of the experimenter and, if existing facilities were not adequate, could improve the facilities in the laboratory selected for the work.

The Water Power Commission Begins Organizing

Regulations governing the administration of the Water-Power Act are to be drafted by a committee consisting of Oscar C. Merrill, Gen. Enoch H. Crowder and Herman Stabler. Two or three months will be required to draft the regulations, it is believed.

The first official act of Mr. Merrill, as secretary of the Federal Power Commission, was to present formally to the Solicitor of the Treasury the questions pertaining to the employment of the personnel of the commission. Due to an oversight, the act does not provide any specific authority for the employment of specialists, clerks or assistants of any kind.

The wording of the act in several places makes it very clear, however, that it was the intention of Congress for the commission to employ the necessary personnel. If the solicitor should find that no authority for employment is given, the work of the commission will be considerably hampered, as it will have to depend entirely upon such help as can be loaned by the War, Interior and Agriculture Departments.

Major Max C. Tyler has been selected by Gen. Lansing H. Beach, the chief of engineers, to make the report on the Great Falls power project, which was authorized by the act

Advisory Board for Power Survey

Prof. L. P. Breckenridge, head of the department of Mechanical Engineering of Yale University, has been appointed chairman of the advisory board which will play an important part in the power survey of the North Atlantic seaboard between Boston and Washington. He will work in close co-operation with William S. Murray, the chairman of the engineering staff which will be engaged on this work Professor Breckenridge will represent fuel engineering on the board.

The full membership of the board has not been selected as yet. E. G. Buckland, vice president of the New York New Haven & Hartford R.R., has accepted an appointment to the board, as has James H. McGraw, president of the McGraw-Hill Co., Inc. Among other members of the board yet to be designated, are representatives of the National Electric Light Association and the American Electric Railway Association.

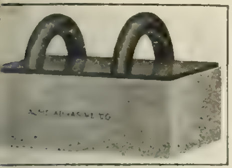
The super-power survey is to be directed from New York City, where the United States Geological Survey just has opened offices in the Buckley-Newhall Building, 709 Sixth Avenue.

Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

ne, Acme Commutator Smoothing

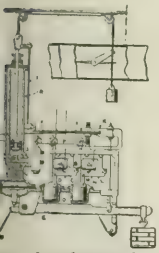
reen Equipment Corporation, Monadnock Block, Chicago, Ill.
"Power," 1920



This stone possesses high insulating quality and when held against the surface of a commutator or collector ring while a machine is in motion will smooth down the uneven surfaces. The cutting down is done with one grade of stone and the finishing surface is made with another of finer texture. Although the stone is made with a flat surface its contour, due to wastage, will really conform to the convex shape of the commutator that is being treated.

gulator, R. K. Hydro-Electric Pressure

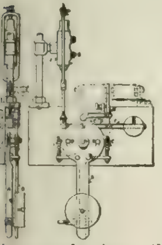
Ruggles-Klingemann Manufacturing Co., Salem, Mass.
"Power," June 1, 1920



This special regulator is designed to eliminate all erratic action in operation. The scale beam is free to respond accurately to variations in pressure of ¼ lb. or less and to transmit its readings by means of electric contact to limit the movement of the motor plunger. The variations in pressure are transmitted to a pilot valve which controls the movement of the motor by means of electric magnets. One magnet controls the upward movement of the plunger and another the downward movement, the pilot valve normally being held in a neutral position where no pressure can be transmitted to the motor or cylinder. The motor travels by stages. The plunger is moved step by step with a well-designed period of rest between stages of its travel. When a change of pressure takes ce, the plunger is moved rapidly to the next succeeding stage l comes to rest and so remains until the pressure changes.

ed Limit, Clock-Pendulum Precision

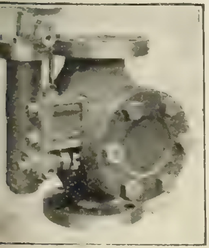
. E. Clock, Fidelity & Casualty Co., of New York, N. Y.
"Power," June 1, 1920



This is a device for the control of steam engines and is connected to any reciprocating part of the engine. There are two pendulums, one being positively driven and moved through a fixed arc; the other, or weighted pendulum, is in line and swings with the positively driven arc until such time as the operation becomes fast enough to overcome the stabilizing spring, which tends to hold the weight pendulum firmly on two pins that project through the curved slots in the disk attached to the weight pendulum. As the positive driven pendulum moves to the right and starts upon the return stroke faster than that for which it is adjusted, a contact is made with electrical apparatus and by moving a lever and by working of the ious mechanisms, the pilot valve is opened, resulting in a flow water through the connection to the operating cylinder. This atches the automatic throttle valve and gives it a start, and throttle sleeve being released together with the piston effect of steam valve stem closes the throttle promptly.

gulator, Framasco Pump

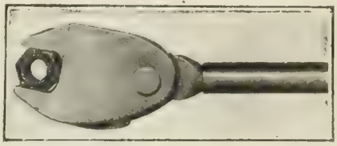
Edward Valve and Manufacturing Co., Chicago, Ill.
"Power," May 25, 1920



This pump regulator is designed to maintain a constant differential between the discharge pressure and the steam pressure, or a fixed pressure at the delivery end of the pump. One of the distinguishing features is the separation of the valve proper and the control cylinder, thus eliminating expansion and contraction troubles due to the high temperature of the steam. The regulator will operate either in a horizontal line or in any other position. It is said that with a normal pressure of 175 lb., an increase of less than 5 lb. will close the valve and stop the pump, or a decrease of 3 lb. will cause the valve to open in full.

Wrench, Adjustable Ratchet

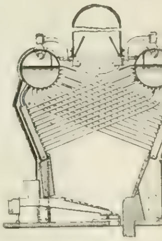
Allan-Diffenbaugh Wrench and Tool Co., 6250 South Halsted St., Chicago, Ill.
"Power," 1920



A self-adjusting wrench that will take the place of several sizes of open-end wrenches. To operate, simply place the jaws over the nut and pull on the handle—the harder the pull the harder the jaws will grip. To let go of the nut, simply release the handle, which releases the grip of the jaws and permits a ratchet action on the nut

Boiler, Burton Duplex Water-Tube

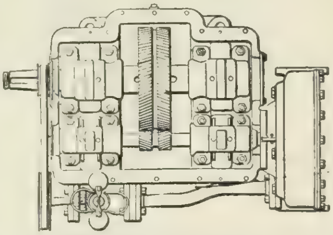
De Pere-Burton Co., De Pere, Wis.
"Power," May 11, 1920



This is a one pass boiler, provided with two cross-drums at opposite ends of the setting. The tubes lead obliquely upward across the path of the gases and enter their respective drums. A vertical row of tubes lead from the water leg at one side of the boiler and enter the drum at the other side. The next row of tubes connect the water leg at the right-hand side of the setting and the drum at the opposite side. Thus the rows of tubes alternate in the direction of their slope and cross over the combustion chamber. Most of the tubes are curved at one end. The tubes may be cleaned from within the drum, and instead of pulling them out through hand holes in the header they may be removed into the combustion chamber. Key caps are provided in the water leg opposite each tube.

Transmission Turbine Gear

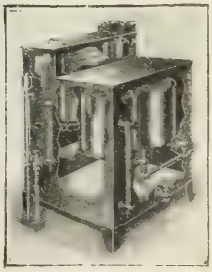
B. F. Sturtevant Co., Boston, Mass.
"Power," June 8, 1920



This turbo-transmission is designed for shaft and pump drive. It is self-contained and does away with turbine bearings and turbine packing. The turbine and pinion shaft is supported by two bearings in the gear casing, but the turbine proper overhangs the gear casing at one end. Two pinions are carried on the turbine shaft, and these connect with two large gears which are carried on the gear shaft and couple to the shaft or pump that is to be driven. It is built in two sizes, 25 and 50 hp. The speed is controlled by a throttling governor driven from the gear shaft.

Filter, New Wayne Gravity Oil

Wayne Oil Tank and Pump Co., Fort Wayne, Ind.
"Power," June 15, 1920



This filter handles continuously large volumes of oil. The water and much of the sediment are removed by a tray system, thus reducing the work of the filtering medium. Dirty oil passes through a screen to a heating compartment, then through a precipitating chamber and from there to filtering units from which it goes to the clean-oil compartment. The screen removes impurities from the oil and much of the remaining impurities are gathered and deposited on the trays. Water is separated from the oil as it passes over the heating coils. The final filtering is done by means of cloth filter units which remove the remaining slime and impurities that have not been precipitated. This type of filter is built for capacities ranging from 2 to 600 gal. per hour

Patented Aug. 20. 1918

New Publications

EFFICIENT BOILER MANAGEMENT. By Charles F. Wade. Published by Longmans, Green & Co., London and New York. Cloth, 6 x 9 in., 266 pages. Price $4.50.

The author, who has had considerable experience in this field abroad, aims to bridge the gap between the scientific discussion of chemistry, fuel analysis, etc., and the purely descriptive articles and pamphlets dealing with steam-making apparatus. The elementary scientific principles underlying the various subjects are taken up in the usual sequence. The treatment is pleasing and of utility value. In the way of illustrations the author has provided many, and while many, if not most of them, are catalog reproductions, the selection is good. The reader will be disappointed with the meagre text devoted to mechanical stokers and furnaces suited to various stokers and fuels. Perhaps the author is not to be criticized inasmuch as mechanical stokers of the multiple-retort type are not nearly so common in the British Isles as in America. It is presumed that he wrote for the English reader chiefly. In the United States engineers will want to follow the test code of the American Society of Mechanical Engineers instead of the forms given by the author; they are similar of course, but in view of the value of standard methods in testing reporting and comparing them the American Society's code should be used here. As efficient boiler room management these days is so much influenced by design and general arrangement of boiler house and equipment the American engineer will be disappointed to find that the author has barely touched on this important subject so interrelated with management.

Obituary

O. C. Woolsen, mechanical engineer, with offices in Newark and New York City, died at his home, 80 Broad St., Newark, N. J., on July 2, following a lingering illness. Mr. Woolsen contracted a cold which developed an asthmatic condition, causing his death. The news came as a shock to his many business acquaintances and friends both in Newark and New York. Mr. Woolsen was well known in engineering circles and for many years was a member of the American Society of Mechanical Engineers, the Newark Board of Trade and the New York Railroad Club. He is survived by two daughters, Helen Woolsen and Mrs. Charles Weigand, of Newark, and a son, O. C. Woolsen, Jr., who, at the time of his father's death, was at St. Paul, Minnesota.

Personals

S. H. Cleland has been appointed Eastern sales manager of the National Engineering Co., Chicago. He has opened temporary offices at 15 East Fortieth St., New York City.

H. F. Strickland has resigned as chief engineer of the Hydro-Electric Power Commission of Ontario. Mr. Strickland was connected with the commission for eight years.

Alexander Wilson, formerly chief electrical engineer of the Montreal Light, Heat and Power Co., has opened an office as consulting engineer in the Yorkshire Building, Montreal, Quebec.

W. C. Rott, formerly with several large steel companies, has joined the staff of Barton R. Shover, consulting electrical, iron and steel plant, and steam engineer, Oliver Building, Pittsburgh, Pa.

George M. Wisner, for the past thirteen years chief engineer of the sanitary district of Chicago, has resigned to enter business for himself. Mr. Wisner will continue to act as consulting engineer for the district board.

Prof. C. C. Williams, of the School of Engineering at the University of Kansas, will go to Europe this summer to study transportation problems there. He will visit England, Holland, France, Belgium, Italy and Switzerland.

Edwin A. Rogers has resigned his position as power plant engineer of the New Cornelia Copper Co., Ajo, Ariz., and has opened an office as consulting engineer, in San Francisco, Cal., specializing in fuel oil combustion and power-plant efficiency work.

Edward Blakeny, formerly in the engineering department of the American Telephone and Telegraph Co. and the Western Union Telegraph Co., is now a member of the technical staff of the research department of the Radio Corporation of America, New York City.

George P. Sonn, formerly with the National Conduit and Cable Co., Inc., and the National Brass and Copper Tube Co., Inc., as mechanical engineer, is now with the Machine Tool Engineering Co., Inc., Singer Building, New York City, as special sales representative.

Dr. C. O. Mailloux, past president of the American Institute of Electrical Engineers and president of the International Electrotechnical Commission, has been made an honorary member of the Société Française des Electriciens, the leading electrical society of France.

J. W. Dorsey, assistant professor of electrical engineering at the University of Manitoba, has incorporated a company under the name of the Dorsey Electrical Laboratories, Ltd. Professor Dorsey announced a few nights ago that he had discovered a new and cheaper way of transmitting electrical power.

Sam W. Smith, for many years sales manager of the Uehling Instrument Co., of New York, and formerly equipment engineer for the Southern New England Telephone Co., has joined the Smith Engineering and Supply Co., Boston. This concern will represent the Uehling Instrument Co. and the Adriance Bate Co., makers of the Bate flue cleaners, in New England.

Edward J. Cheney, secretary of the Standards Committee of the American Institute of Electrical Engineers, formerly connected with the General Electric Co. and recently chief of the Division of Light, Heat and Power of the Public Service Commission, Second District, Albany, N. Y., has opened an office at 61 Broadway, New York City, for a general engineering and consulting practice.

Society Affairs

The American Peat Society will hold its annual meeting at Madison, Wis., Sept. 2-4. A number of interesting papers will be presented at the meeting. A definite program has not been prepared as yet.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention at the Hotel Pennsylvania, New York City, Sept. 20-24. The program, as a whole, deals with the complete plant electrification from the ore pile to the finished product. A feature of the convention will be the display of the products of the representative electrical manufacturers.

The New York Section of the American Institute of Electrical Engineers is planning a series of joint meetings throughout the coming year with the Metropolitan Section of the American Society of Mechanical Engineers. Among the subjects selected for discussion at the meetings are marine engineering, enginering education, industrial installation, power generation, steam-railroad electrification and industrial relations. The first meeting will be held in October.

The National Electric Light Association has been invited to appoint a representative to serve on an advisory board which will co-operate with the engineering staff of the North Atlantic Seaboard Super Power Survey. L. P. Breckenridge, professor of mechanical engineering at Yale University, will head the Advisory Board and also represent the fuel-engineering profession. Other members of the Board already appointed are James H. McGraw, president of the McGraw-Hill Publishing Co., and E. G. Buckland, vice president New York, New Haven & Hartford Railroad.

Business Items

The Mexico (Mo.) Power Co. has purchased the municipal plant at Wellsville and is now furnishing current from the central plant in Mexico to that city.

The Adirondack Power and Light Corp is planning to construct a steam power plant in the Mohawk Valley, as an auxiliar to its various water power plants. The new plant, it is expected, will be located near Amsterdam, where several sites have been investigated.

The Southern Sierras Power Co., San Bernardino, Cal., is planning a $250,000 improvement to its steam plant. Work will begin at once. The improvement is an additional "frequency changer" to be installed by the Southern Sierras and Southern California Edison Co. jointly.

The Tonawanda Power Co., North Tonawanda, N. Y., has started work on the construction of an addition to its transformer station which will give the company equipment for the transmission of twice as much power as at present for industrial and lighting purposes.

The West Penn Power Co. has obtained possession of ten Pennsylvania corporations licensed to operate in Greene County. These concerns are: Mt. Morris Power Co., Aleppo Power Co., Center Power Co., Gilmore Power Co., Graysville Power Co., Jackson Power Co., Morris Power Co., Springfield Power Co., and the Wayne Power Co.

Trade Catalogs

Girtanner Standardized Steam Ash Conveyor is the title of a new 13-page catalog now ready for distribution by the Girtanner Engineering Corp., of New York. Illustrations and descriptions of the Girtanner line of ash conveyors are given. A copy of the catalog will be sent on request.

The Gas Combustion Co., Union Arcade, Pittsburgh, Pa., has ready for distribution a new 24-page catalog entitled "The Bradshaw Burner." Descriptions of the various types of burners are given, including standard and pressure types for boilers, standard types for stoves and standard pressure types for gas producers. An analysis of combustion chamber, stack and gas pressures is also contained in the catalog. A copy will be sent on request.

The Crescent Belt Fastener Co., of New York, has ready for distribution a new 6-page pamphlet, Form N. Y. 227, dealing with belt joints. A service chart which will enable the customer to determine the size of Crescent plates and rivets adapted to his use for any condition of work is given. Full description of the method of making joints is also outlined. A copy of the pamphlet can be obtained on request.

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., has published a new catalog 4-A-1, giving a complete list of distribution transformers with list prices. Distributed-shell, rectangular-core, and simple-shell construction with auxiliary apparatus has been outlined clearly. Single-phase, 25- and 60-cycle and three-phase 60-cycle transformers oil-insulated and self-cooled, with their voltage ratings, have been listed. The standardization of distribution transformers by various associations is discussed.

The Portable Machinery Co. of Passaic, N. J., has published a new 24-page catalog entitled "Portable Conveyors." By a number of illustrations the [illegible] conveyor handled by this company is shown in actual operation. The conveyor described in the booklet is designed to be moved and operated by one man. Its distinctive feature is the "feed end," which can be pushed and completely buried in the material to be conveyed, thus allowing the material to be scraped into the carrying belt instead of being lifted by shovel into a feed hopper. A copy will be sent on request.

The Metal and Thermit Corporation, New York, N. Y., has just issued the Third Edition of its Thermit Pipe Welding Pamphlet No. 16. In this new edition the subject of Thermit pipe welding has been revised and brought up to date. The new pamphlet describes and illustrates in detail how Thermit pipe welds are made and contains reports on successful tensile strength and vibration tests of Thermit pipe welds conducted by Stevens Institute. One of the features of the new pamphlet, not previously published in former editions, is a chart showing the comparatively low cost of a Thermit welded pipe as compared with the cost of installing compression flanges with bolts and gaskets, and of installing elbows with flanged connections.

Coal Situation No Better—No Worse

No reduction in prices of bituminous coal in the eastern states. Investigation under way in Baltimore. Car shortage still the prime factor in Illinois' high prices. Diversion of fuel to Michigan disturbs Midwest market. Desperate coal situation in Milwaukee leads to the appointment of a commission to appeal to the I. C. C.

The larger coal consumers in Boston have 30-days' supply according to a careful survey. In several industrial centers stocks have increased during the month, apparently owing to reduced consumption. The demand remains strong nevertheless and producers are in a position to exact high prices. Last week $12 and upward was paid for coal at first hand, these prices being f.o.b. mines in central Pennsylvania for July shipment.

New York—Comparatively little coal is being moved from the local docks for local consumption except on permit for use by a public utility corporation. The bituminous demand is lighter but the average price remains the same as last week, i.e., $14 to $15 at the piers with a couple of dollars added for loaded bottoms.

In spite of holiday curtailments in production and shipment, the anthracite situation is easier. The resumption of the regular towing service from Perth Amboy and a betterment in towing conditions in some of the other ports has brought more coal into the city. There has also been an improvement in the railway service and an increased car supply, resulting from the Interstate Commerce Commission order. The steam sizes are slightly easier. Current quotations for company coal per gross ton at the mines and f.o.b. Tidewater, lower ports, are as follows:

	Mine.	Tidewater.
Buckwheat	$4.00@$4.10	$5.75@$5.85
Rice	3.00@ 3.50	4.75@ 5.25
Barley	2.25@ 2.50	4.00@ 4.25
Boiler	2.50	4.25

Philadelphia—Despite the lifting of embargoes, receipts have not increased appreciably. A number of plants have curtailed production, which has eased the market considerably. Price variations are wide and there is hardly a market figure. Bituminous prices range from $10.50 to $12.50 for Pennsylvania coals, while Fairmont grades have been subject to greater variations, with quotations running from $8.50 to $12.75, a good average being $11.75.

The steam sizes of anthracite are in a fairly satisfactory position from the standpoint of coal men. High bituminous prices have increased the anthracite demand until buckwheat is difficult to obtain. Consumers with contracts are stocking up for winter.

Baltimore—Federal investigators from the Department of Justice are now in Baltimore asking questions of shippers and agents of bituminous. It is reported that the coal trade does not regard the investigation very seriously. Customers seem willing to accept coal at high prices, so that the operator does not have to quote, but merely asks what the consumer is willing to pay and then accepts the proffer. The market is highly competitive.

Milwaukee—At Senator Lenroot's suggestion a committee was named to go to Washington to appeal to the Interstate Commerce Commission for relief. The commission will be urged to place an embargo on exports. Docks in the northwest hold five million tons less than a year ago and unless reserve stocks can be accumulated before the close of Lake navigation, factories will shut down.

Chicago—The market continues to absorb whatever coal is offered and premiums are being paid for spot. Current prices for spot range from $5.25 to $6.50 f.o.b. mines, on central and northern Illinois coals, with no differential between the price of lump, screenings or mine run. The car shortage has resulted in a considerably stiffened market, even during last week.

St. Louis—All steam sizes of anthracite are in the greatest demand. The local trade has a fair supply, but no storage ahead, outside buyers paying $4.75 to $5.50 for steam and domestic sizes in the Standard field.

Birmingham—There is a bountiful supply of cars on the Southern and Frisco Lines, mines being furnished a 100 per cent supply. On the other hand, production has fallen off even from last week. The shortage of coal is acute throughout Southern territory, and industrial plants, railroads and public utilities have very small stocks. There is practically no spot coal, and in spite of a strong and active demand for domestic and steam grades, little new business can be accepted because of operating difficulties.

New Publications

PROPOSED WORK

N. H., Portsmouth—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for removing and reconstructing boiler and stokers.

Mass., Boston—The Boston & Maine R.R. Co., North Station, will soon award the contract for a 6 story, 125 x 135 ft. club building including a steam heating system. About $500,000.

Mass., Boston—Mowll & Rand, Archts., 50 Bromfield St., will soon award the contract for converting present store building into a theatre including a steam heating system on Washington and Essex Sts., for the Washington Essex Bldg. Trustees, 723 Scollar Bldg. About $1,500,000.

Mass., Cambridge—Monks & Johnson, Engrs., 99 Chauncey St., Boston, will soon ward the contract for a 1 story, 40 x 80 t. boiler house, etc., for the Carr Fastener o., 47 Ninth St. About $40,000.

Mass., Cambridge—John C. Spofford, rcht., 36 Bromfield St., Boston, will soon ward the contract for a 6 story, 100 x 100 t. manufacturing building including a team heating system on Main St., for the uffolk Engraving & Electrotyping Co., 394 tlantic Ave., Boston. About $225,000.

Mass., Danvers—The Comn. on Mental iseases, 36 State House St., Boston, plans o build a 1 story power plant at the State nsane Asylum here. About $250,000. Kindall, Taylor & Co., 93 Federal St., Boson, Archts. and Engrs.

Mass., Northbridge—The Bd. of Sewer omrs. plan to construct a sewerage system nd pumping station for the town. About $142,000. McClintock & Woodfall, 15 Court Sq., Boston, Engrs.

Mass., South Byfield—The Dummer Academy plans to construct a 3 story school building including a steam heating system. About $150,000.

Mass., Taunton—The Municipal Lighting Comn. plans to construct a 1 story electric light plant addition on West Water St.

N. Y., New York—The Andrew Friedman Foundation Home for Men and Women, 206 Bway., plans to build a home including a steam heating system on the Grand Concourse. About $1,500,000. H. A. Jacobs, 320 5th Ave., New York City, and J. H. Friedlander, 681 5th Ave., New York City, Archts.

N. Y., New York—Sommerfeld & Steckler, Archts. and Engrs., 31 Union Sq., will receive bids until August 2 for a 7 story, 50 x 50 ft. factory including a steam heating system, for the Rigaud Perfume Co., 75 Barron St.

N. Y., Warsaw—H. H. Charles is in the market for one 20-hp. portable gas engine with 40 ft. 10 in. belt and heavy well outfit with extra stem and bits.

N. J., New Brunswick—W. B. Wills, Inc., Archt. and Engr., 1181 Myrtle Ave., Brooklyn, plans to build a 1 story theatre including a steam heating system. About $350,000. Owner's name withheld.

Pa., Altoona—The Altoona Gymnasium Comn. will receive bids in August for a 2 story, 80 x 130 ft. gymnasium including a steam heating system, etc., on Lexington Ave. and 9th St. About $200,000. Jallade, Lindsay & Warren, 37 Liberty St., New York City, Archts.

Pa., Philadelphia—The Pennsylvania R.R., Bell Bldg., is in the market for a 220 volt d.c. motor.

D. C., Washington—The Dist. Comrs. will soon receive bids for a 2 story, 300 x 400 ft. psychopathic ward building in connection with the proposed hospital to be known as the Gallinger Hospital. Plans include a central power plant. About $1,500,000.

D. C., Washington—Marsh & Peter, Archts. and Engrs., 522 13th St., will soon award the contract for a 9 story newspaper building addition including a steam heating system for the Star Newspaper Co., 11th St. and Pennsylvania Ave.

Va., Ashland—The Ashland Ice Plant is in the market for one air compressor and one electric motor. C. B. Boschen, Pur. Agt.

Fla., Jacksonville—The Porter Judy Fruit Co., 442 West Bay St., has secured a permit for installing an 18 car capacity cold storage plant at its establishment here. About $40,000. B. W. Anderson, Supt.

Ala., Florence—The Chamber of Commerce plans to build a power plant here on Cypress Creek, for the city.

Ala., Mobile—G. B. Rogers, Archt. and Engr., Van Antwerp Bldg., will soon award the contract for installing a steam heating system in the proposed 15 story, 75 x 150 ft. office building on the Northwest corner of Dauphin and Conception Sts., for the Van Antwerp Drug Co., Van Antwerp Bldg. About $500,000.

Tenn., Smithville—The Corp. of Smithville voted upon $30,000 bonds to construct a transmission line from here to the Great Falls Power Co. at Rock Island.

O., Cleveland—The Bd. Educ., E. 6th St and Rockwell Ave., plans to build a 1 story junior high school including a steam heating system on Hopkins Ave. W. R. McCormack, Archt.

O., Cleveland—The Citizens Savings & Trust Co., East 9th St. and Euclid Ave., is having plans prepared for a 10 story, 80 x 150 ft. bank and office building including a steam heating system, at East 101st St. and Euclid Ave. About $500,000. Walker & Weeks, 1900 Euclid Ave., Archts.

O., Cleveland—The city received bids for furnishing and installing two 8,000,000 gal and one 1,000,000 gal motor driven vertical centrifugal pumps with motors, etc., from Dravo-Doyle Co., Diamond Bank Bldg., Pittsburgh, Pa., $20,750; Joseph Skeldon Eng. Co., 242 Water St., Toledo, $27,620. Noted June 29.

O., Cleveland—The Ohio Athletic Association, c/o E. T. Ferry, 2151 Scranton Rd., plans to build an 8 story commercial and club building including a steam heating system on Euclid Ave. and East 32nd St. About $400,000.

O., Cleveland—Parish & Bingham, 10600 Madison Ave., will soon award the contract for a 1 story, 30 x 50 ft. boiler plant. Two 250 hp. boilers will be installed in same. About $40,000. Ernest McGeorge, 1000 Euclid Ave., Archt. and Engr.

Ind., Portland—The Portland Oil & Refining Co. plans to build a refinery and is in the market for steam pumps, pipe, etc. H. J. McConoley, Secy. and Treas.

Mich., Detroit—The Bd. Educ., 50 B'way., will soon award the contract for a 2 story, 65 x 144 ft. addition to the Davidson School on Roman and Joseph Campau Aves., $195,000; a 2 story, 77 x 159 ft. school to be known as the George School on Russell and Superior Sts., $230,000; and a 2 story, 105 x 200 ft. school to be known as the Pattengill School on Northfield and Spokane Aves., $330,000. Separate contracts for installing steam heating systems in these schools will be let.

Mich., Port Huron—The City and County of St. Clair, c/o A. E. Stevenson, plans to build a 3 story city hall addition including a steam heating system on Huron Ave. About $320,000.

Mich., St. Clair—The city is having plans prepared for furnishing and installing a 300 hp. engine, 200 kva. direct connected generator, water meter, piping, etc. About $57,755. G. C. Champe, Toledo, O., Engr.

Mich., Wayne—F. L. Forman, Village Clk., will soon award the contract for furnishing and installing a motor driven centrifugal pump with a 1,000,000 gal. per day capacity in connection with the proposed filtration plant here.

Ill., Chicago—The Ajax Forge Co., 2503 Blue Island Ave., is in the market for one 500 ft. per min., 125 lb. pressure, belt drive air compressor.

Ill., Chicago—The Chicago Northern Masonic Association, c/o F. M. Glennon, 626 South State St., had plans prepared for a 2 story, 150 x 150 ft. masonic temple, including a steam heating system on Winthrop Ave. and Argyle St. About $300,000. Hyde & Brown, 8 South Dearborn St., Archts.

Ill., Chicago — Max Goldberg, Harper Theatre, 5236 Harper Ave., is having plans prepared for a 1 story, 135 x 150 ft. addition to the present theatre including a steam heating system. About $350,000. Z. E. Smith, 305 East 55th St., Archt.

Ill., Chicago—Hyde & Brown, Archts., 8 South Dearborn St., will receive bids until August 10 for a 3 story, 125 x 200 ft. masonic temple including a steam heating system on Cottage Grove Ave. and 61st St., for the Midway Masonic Temple Association. About $750,000.

Wis., Stratford—Frank J. Curtin, Village Clk., will soon award the contract for the construction of a well reservoir and an 18 x 30 ft. pumping station and for furnishing a 250 gal. power pump and a 20 hp. gasoline-kerosene engine. W. G. Kirchoffer, Madison, Engr.

Ia., Marshalltown — The C. A. Dunham Co., 343 South Dearborn St., Chicago, plans to build a 2 story, 40 x 150 ft. addition to present heating apparatus factory here. About $150,000.

Ia., Webster City—The Webster City Stock Co. is having plans prepared for a 6 story hotel and store building including a steam heating system. About $300,000. Proudfoot, Bird & Rawson, 810 Hubbell Bldg., Des Moines, Archts.

Minn., Minneapolis—The Bd. Educ. had plans prepared for a 4 story, 220 x 300 ft. senior high school, including a steam heating system on 20th Ave. and Quincy St. About $700,000. E. H. Enger, 3018 3rd Ave. S., Archt.

Minn., Minneapolis — The Bd. Educ. is having plans prepared for a 3 story junior high school, including a steam heating system, on 30th Ave. N. and Emerson Ave. About $600,000. E. H. Enger, 3018 3rd Ave. S., Archt.

Neb., Lincoln—The State Legislature of Lincoln plans to construct a 5 or 6 story capitol building including a steam heating system. About $7,000,000. Bertram G. Goodhue, 2 West 47th St., New York City, Archt. and Engr.

Mont., Polson—The Rocky Mountain Power Co. of Butte has filed an application at the office of the federal register of lands, for preliminary power permit to construct 5 dams in the Flathead River between northeast corner of the Bison range and point where river enters the lake near here.

Mo., Kansas City—The Kansas City Light & Power Co. plans to install 5 new substations in the down-town dist. between Oak and Wyandotte Sts. and 7th and 15th Sts. The stations will be equipped with automatic motor generator sets for converting a.c. to d.c. The first station will be located in the R. A. Long Bldg. on 10th and Grand Aves., and equipment will include one standard 1,500 kw. rotary. Estimated cost, $500,000.

Mo., Moberly—The city plans to construct a pumping plant, etc. About $250,000. Fuller & Beard, Chemical Bldg., St. Louis, Engrs.

Tex., Port Arthur—The Eastern Texas Electric Co. plans to build a generating station extension and install a 4,000 kw. turbo generator, two 665 hp. boilers with auxiliary equiment and pumps. About $600,000. Joseph Bowers, Supt. Stone & Webster Inc., 147 Milk St., Boston, Mass., Engrs.

Cal., Brawley—The city plans to build a 1 story, 60 x 80 ft. power plant along the water front. Two 100 hp. Diesel engines and two 100 hp. motors, two 850 g.p.m. centrifugal pumps will be installed in same. About $15,000. G. R. Wade, City Engr.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for the installation of a heating system in the structural shop here. Noted May 18.

Ont., Chatham—The city is having plans prepared for altering pumphouse, including the installation of electrical driven centrifugal pumps, etc. About $50,000. E. A. James Co., Ltd., 36 Toronto St., Toronto, Engr.

Ont., Hamilton—The city has voted upon $15,000 bonds to construct an electric light plant.

Ont., Port Arthur — The Kaministiquia Pulp & Paper Co. plans to construct a pulp mill. A hydro-electric plant will probably be installed in same. About $1,000,000. C. D. Howe, Engr.

CONTRACTS AWARDED

N. H., Portsmouth—The Portsmouth Hospital has awarded the contract for a 2 story, 30 x 150 ft. boiler house, laundry, etc., to H. A. Wood, 21 Brewster St., at $35,000. Noted June 29.

Mass., Belchertown — The Committee on Mental Diseases, 36 State House, Boston, has awarded the contract for installing a heating system in the proposed hospital buildings at the State Hospital here, to the Holyoke Valve & Hydrant Co., Race St., Holyoke, at $21,483. Noted July 6.

Mass., Boston — The New Boston Arena Co., c/o Frank & Wilcox, Archts., 294 Washington St., has awarded the contract for a 1 and 2 story auditorium building, including a steam heating plant on St. Botolph St., to the W. M. Bailey Co., 88 Broad St., at $800,000.

Mass., Fall River — The Osborn Mills, Montaup St., has awarded the contract for a two story sub-station, to Beattie & Cornell, 38 North Quarry St., at $25,000.

Mass., Malden—The Standard Oil Co. of New York, 26 B'way, New York City, has awarded the contract for a 1 story, 60 x 102 ft. warehouse and a 1 story, 60 x 132 ft. boiler house, to H. D. Best, 175 5th Ave., New York City.

Mass., Somerville (Boston P. O.)—The Great Atlantic & Pacific Tea Co., 451 D St., South Boston, has awarded the contract for a 5 story, 100 x 370 ft. warehouse including a steam heating system here, to the Turner Constr. Co., 178 Tremont St., Boston, at $650,000.

Conn., Hartford — The Hartford Auto Club Garage Co., 36 Race St., will build a 7 story, 117 x 150 ft. garage, etc., including a steam heating system on Hicks and South Ann Sts. About $500,000. Work will be done by day labor. C. F. Luce, 36 Pearl St., Archt.

N. Y., Long Island City—Stein Hall & Co., Inc., 61 B'way, New York City, has awarded the contract for a 4 story factory, including a steam heating system, on 6th and Jackson Aves., to the Turner Constr. Co., 244 Madison Ave. About $400,000.

N. Y., Oneida—The Standard Oil Co. of New York has awarded the contact for a 1 story, 23 x 60 ft. garage, 15 x 20 ft. boiler house, 12 x 16 ft. pump house, including steam heating system, to H. D. Best, 175 5th Ave., New York City, at $35,000.

N. Y., Syracuse—The Standard Oil Co. of New York, 26 B'way, New York City, has awarded the contract for a 2 story, 100 x 140 ft. warehouse, 1 story, 40 x 55 ft. tank house, 1 story, 36 x 90 ft. boiler and pump house and a 1 story, 60 x 120 ft. garage, to H. D. Best, 175 5th Ave., New York City.

N. J., Newark—The Peerless Baking Co., 713 South 14th St., has awarded the contract for a 2 story, 50 x 100 ft. factory and power house, on Nye Ave. and Clinton Pl., to the United Fireproofing Co., 8 West 40th St., New York City.

Tenn., Memphis—The Iten Biscuit Co., 1202-24 Capitol Ave., Omaha, Neb., has awarded the contract for an 8 story, 290 x 450 ft. biscuit factory, including a steam heating system here, to the Alexander Constr. Co., 388 North Front St. About $500,000.

Tenn., Nashville—The Waterworks Dept. has awarded the contract for two 20,000,000 gal. capacity high service pumps and two 20,000,000 gal. capacity low service pumps, to the Worthington Pump Co., at $180,950. Noted June 29.

O., Cleveland—The Eaton Axle Co., 10307 Euclid Ave., has awarded the contract for a 1 story, 62 x 123 ft. heat treating plant and boiler room at 831 East 140th St., to the Lundoff-Bicknell Co., 5716 Euclid Ave., at $50,000.

O., East Cleveland (Cleveland P. O.)—The Cleveland Electric Illuminating Co., Illuminating Bldg., Cleveland, has awarded the contract for a 1 story, 43 x 49 ft. electric sub-station addition at 16301 Euclid Ave., to F. E. Hauselman, 408 Illuminating Bldg., Cleveland, at $50,000.

Ill., Belleville—The Arcade Theatre Co. has awarded the contract for a 3 story, 80 x 175 ft. theatre, including a low pressure steam heating system, on Main and High Sts., to the Mullen Bldg. Corp. About $250,000.

Ill., Mt. Vernon — Swift & Co., United States Yards, Chicago, has awarded the contract for a 2 story warehouse and cold storage building, to Theo. Stark & Co., Cedar Rapids, Ia., at $165,000.

Ill., Rockford—The city has awarded the contract for furnishing and installing an air compressor, in connection with the proposed concrete reservoir on Stanley and Cedar Sts., to the Swords Bros. Co., 17th St., at $30,470.

Ia., Muscatine—E. M. Henle will build a 5 story, 120 x 140 ft. theatre and store building, including a steam heating system. About $527,000. Work will be done by day labor.

Kan., Paola—The city has awarded the contract for installing pumps, to the Williamson Pump & Machine Co., Kansas City, Mo., at $14,690.

Ont., Kitchener — The Paramount Theatres, Temple Bldg., has awarded the contract for a 1 and 2 story motion picture theatre, including a vacuum steam heating system with mechanical ventilation system, on Queen St., to B. H. Secord & Sons, 133 Nelson St., Brantford, at $300,000.

NEED COMPETENT MEN?
SEE THE SEARCHLIGHT SECTION
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POWER

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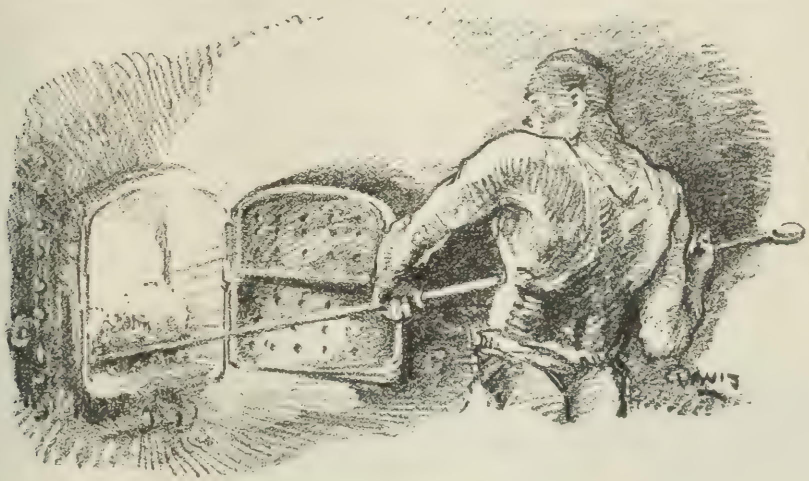


Clinkers

By Rufus T. Strohm

IN DAYS gone by we could depend on fuel companies to send the grade of coal required. We had a chance to pick and choose, and so the stuff we used to use worked pretty well when fired. But days like those will dawn no more, for War stuck in its bloody oar and knocked things arsy-versy, and what with walk-outs at the mines and tie-ups on the railroad lines nobody shows us mercy.

Although we uttered kick and threat and smashed the rules of etiquette with "damns" and "highty-tighties," the coal that we received of late is loaded down with bone and slate, and oodles of pyrites. We did our darndest with the stuff, but when we used just air enough for burning all the gases, the ashes fused to lumps of glue that soon grew soft and trickled through the grate bars like molasses.

In every air-space it congealed, till half the openings were sealed, preventing air admission; it froze in ledges, chunks and balls until the bridge and furnace walls were in a fierce condition. And when on sultry days and nights we hoped to set the plant to rights by putting in some quick work, the clinkers were so firmly stuck that we were wholly out of luck and ruined half the brickwork.

We gave them scads of heavy licks with hammers, sledges, bars and picks, we sawed and wrenched and chiseled; but though we twisted, gouged and pried from front to rear, from side to side, our efforts mostly fizzled. For when we'd finished our routine and got the furnace fairly clean of clinker, ash and rubble, the next fresh batch of coal we used was scarcely hot before it fused and brought the same old trouble.

I don't abhor the thought of Hell because it's peopled, so they tell, with liars, thieves and drinkers. The reason I'll fight shy of it is simply this—the brimstone pit has far too many clinkers!

Care and Maintenance of Fire-Protection Systems—I

BY C. H. JENKINS
Superintendent of Surveys, the Underwriters' Bureau of the Middle and Southern States

IN THE plans of a modern plant or building as much attention is given nowadays to the protection against fire as to any part of the equipment. The entire apparatus for this purpose usually is in charge of the power-plant engineer. The investment and business must be protected against destruction by fire. Automatic protection is the most desirable, and of such equipment the automatic sprinkler system has given the best results.

Briefly, the purpose is to place sprinkler heads on pipes filled at all times with water under pressure. The sprinkler is a brass casting with a nozzle opening ½ in. in diameter and a deflector to scatter the water. The opening is kept closed by a plug or valve held in place by a strut or combination of levers. The levers are held together by a soft-soldered link which melts at from 155 to 165 deg. F. In case of fire the heat melts the solder and the levers fall apart, releasing the valve, which is forced open by the water pressure, and the water, striking agains the deflector, is sprayed against anything within fiv or six feet on all sides of the head. The floor is we down in a circle ten to twelve feet in diameter.

Sprinklers have been improved and perfected unti they are now reliable devices. When they are correctl installed and properly maintained, they will extinguis the average fire or will at least hold it in check until further help arrives. Usually, a sprinkler in operation will create enough disturbance to attract attention.

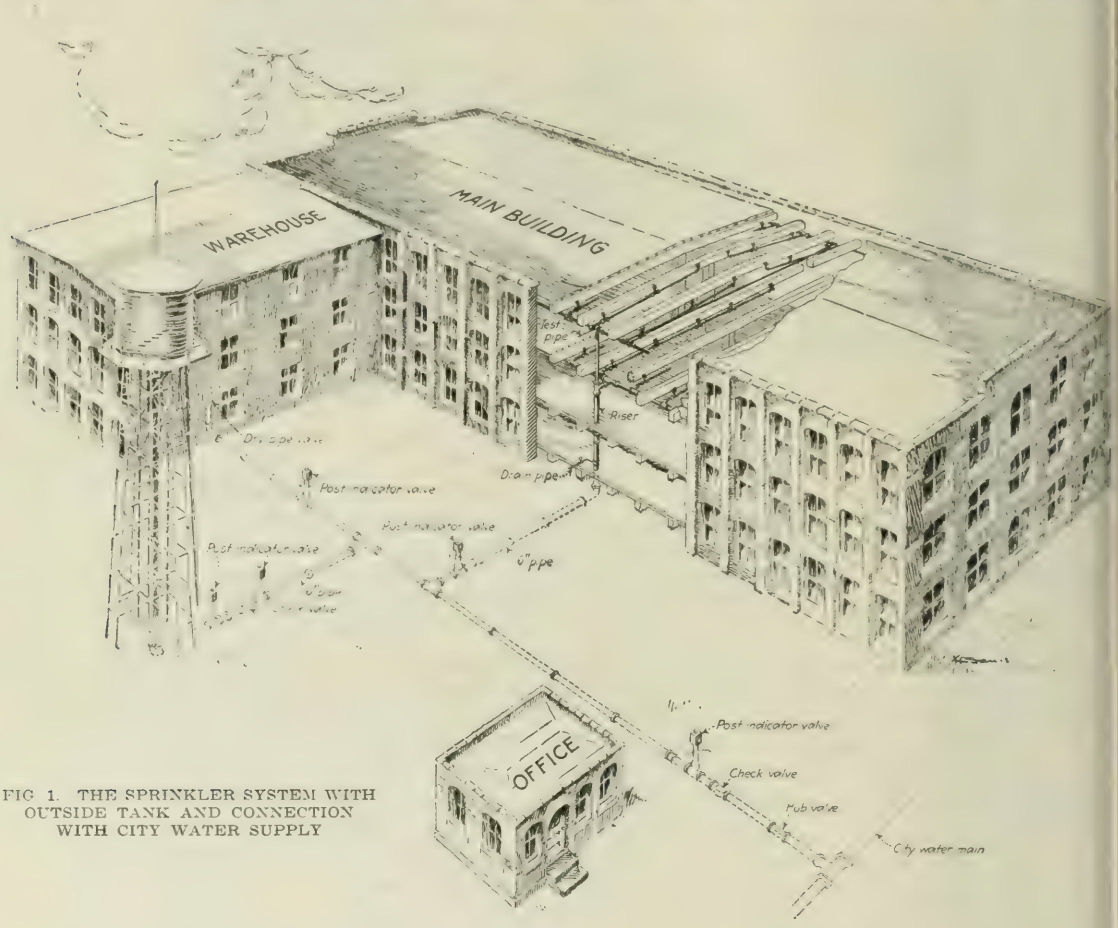


FIG. 1. THE SPRINKLER SYSTEM WITH OUTSIDE TANK AND CONNECTION WITH CITY WATER SUPPLY

The phrase "correctly installed" is used advisedly. Standard rules for the installation of automatic sprinklers have been published by the National Board of Fire Underwriters. They are the rules in general use today and are universally accepted as standard throughout the United States and Canada by both the installing companies and the insurance interests. Nevertheless there are, throughout the country, a number of equipments which might be called home-made imitations of sprinkler system. They have been installed sometimes by the owner, using his employees, and sometimes by local firms whose usual business is steamfitting or plumbing. In either case it too frequently happens that, owing to imperfect knowledge of the rules or requirements of installation, the equipment is faulty and does not allow the sprinklers to give full results. When an investment of this kind is undertaken, it is best practice to contract with a specialist in this line of work and thus obtain first-class standard equipment.

Given a system properly installed, we can expect good protection against fire, provided the equipment is well maintained. Maintenance is the vital necessity to insure full benefit from the investment. Strange as it may seem, good, first-class maintenance is not as common as it should be. Why a firm, otherwise efficient, should invest from ten to twenty thousand dollars in a means of fire protection and then leave the system to take care of itself is difficult to understand. The system is too often left in the care of someone who does not understand it and is not particularly interested in it. In either case the investment is apt to be nullified by the apparatus being out of service when the fire comes.

Engineers and the mechanical department are usually pretty busy people, and the fire-protection system, being in addition to the usual equipment, is likely to receive attention only when there is nothing else pressing. It might be well for those in charge to bear in mind that if the plant burns down, numbers of people will lose their jobs. A small amount of time spent in looking over the system at frequent intervals will guard against such contingency.

"UNSATISFACTORY" FIRES.

The National Fire Protection Association, which keeps as complete a record of fires as is possible, reports for the years 1897 to 1919 inclusive 1,017 "unsatisfactory" fires in properties equipped with sprinklers. Of that number 283, or 27.9 per cent, were due to the water being shut off part or all of the sprinkler equipment; that is, a valve in the pipe feeding water to the sprinklers was shut when the fire started. Obviously, if there is no water on the sprinklers they cannot extinguish fires.

Of the remaining cases 36 were due to portions of the piping system being allowed to freeze so that water could not pass through to the sprinklers when the heads opened. The others were due to miscellaneous causes. The large losses represented by these fires were due directly to unsatisfactory maintenance.

During the year 1919 one inspection department covering five states reports impairments of fire protection coming to its notice during the year as follows:

Valves Shut	Tanks Low or Empty	Pressure Tanks, Poor Condition	Dry Valves Out of Order	Alarm Valves Out of Order	Fire Pumps Poor Condition
438	329		66	109	46

Another department covering five other states reports the following:

Valves Shut	Tanks Low or Empty	Pressure Tanks Poor Condition	Dry Valves Out of Order	Alarm Valves Out of Order	Fire Pumps Poor Condition
323	41	31	56	613	60

These were all actual impairments found at the time of inspection by representatives of the two departments. Note the large number of valves found closed in both cases.

In 1917 a loss of about one million dollars occurred in a sprinklered property. The piping in one section had frozen, and the water has been shut off to make repairs. Repairs were made, but water was not turned on the sprinklers on account of very cold weather. It was Saturday afternoon and only a few hands were on the premises. A fire occurred in the section where the water was shut off, and the sprinklers being out of service, there was nothing to stop it. By the time it was discovered and help arrived, the fire was so well started that it could not be controlled. The greater part of the plant was destroyed.

In another instance a valve was shut for repairs and the fire started so near it that, when discovered, no one could reach the valve. The building burned down. These are but two of numerous similar cases. The lesson is clear. There must not be the least carelessness when repairs are being made to fire-protection apparatus.

When a large number of sprinklers are shut off, it is best practice to keep a man at the closed valve ready to turn it on. A man working near-by may be used for the same purpose. In any event the water should be turned into the pipes as soon as possible.

It often happens also that valves become closed for no reason that can be discovered. A case is recalled where, in a textile property, a sprinkler valve was found shut; no one had any idea how it became shut. The foreman of the room, however, found the explanation. The valve was of the ordinary type with handwheel to operate and located close to the outside wall, about five feet from the floor. The room was used for spinning yarn. The foreman noticed that when the spinning frame was running well, the girl operator would step back and, by reaching up and taking hold of the valve wheel, would hang part of her weight on it, supposedly to rest herself. The valve was so placed that she had always to approach it the same way and each time she gave the wheel a slight turn. In the course of time the valve became shut. An inspection of the system found it in that condition. Numerous cases like these have been found. The only safeguard is frequent and careful inspection of the apparatus to make sure that it is all in order.

Closed valves have been the cause of most large sprinklered-property losses.

The engineer, master mechanic or whoever has charge of such a system should conscientiously study it until familiar with it and its operation. He should at frequent stated intervals make a careful examination of the whole equipment.

THE SPRINKLER SYSTEM

Fig. 1 shows a sprinkler layout equipped with automatic sprinklers. A standard system includes complete equipment of sprinklers installed according to the standard rules, and two standard water supplies.

The supplies are called the primary and secondary supplies. The primary supply should be able to give a normal water pressure of 25 lb. *on the highest sprinklers*. It should also have capacity sufficient to supply at least ten opened sprinklers at a pressure of 12 to 15 lb. with water flowing. In properties of especially inflammable occupancy a greater capacity would be required. The secondary supply, usually either a gravity tank or pump, should have ample capacity to supplement the primary supply. Either should be capable of taking care of the system alone if the other, for any reason, is out of service; normally, they work together. The capacities and arrangement of the various supplies used will be dealt with later.

The system shown in Fig. 1 has a connection from the public water works, also a gravity tank on a trestle. These are connected to a 6-in. underground pipe in the yard. Branches run from this main feed pipe to each building, in each of which there is an outside valve to shut off the water when necesasry. The branches run to a central distributing point in each building, where an upright pipe or riser carries the water to each floor The distributing pipes branch out from the riser in each story. An alarm valve is sometimes inserted in each riser, which rings a gong when water passes through it. There may also be another gate valve inside at the base of the riser, but usually one valve is enough. The building called warehouse* is equipped with a so-called dry-pipe system, air being kept in the pipes to prevent freezing in cold weather.

TESTING A NEW SYSTEM

Before a system of this kind is turned over to an owner, it is the practice to test it out at high hydraulic pressure. It is usual to test inside pipe at 150 lb. per sq.in. for one hour, and outside pipe at the same pressure for two hours. These tests should reveal flaws in material, also poor workmanship.

When the system has been completed, the engineer or whoever is to have charge of it should make it a point to go over the installation with the sprinkler-company foreman. He should carefully examine it and understand it. The owner must, of necessity, leave the care of such apparatus to the mechanical department. It becomes part of the latter's duty, therefore, to learn what has been provided and how it should operate. On a new installation it would be well to make the following tests in company with the sprinkler foreman:

If there is any underground pipe, the hydrants, if any, should be opened and flushed out. The water flowing out should be carefully observed. If it is clear and flows in a strong stream, a clean well-laid pipe is indicated. Too often, however, considerable dirt, gravel and other foreign material find their way into underground pipe. If not washed out, they may later be carried up into the sprinkler pipes and perhaps obstruct them. If the streams contain dirt and gravel, let them run until the water comes clear.

There have been cases where gloves, parts of overalls, oakum, tools and other odds and ends have been left in the pipe and were washed out through hydrants. Sometimes they obstruct the flow and an unsatisfactory stream is obtained. In that case it is necessary to take the pipe apart until the obstruction is found. Poorly run lead joints sometimes deposit large pieces of lead inside the pipe, which form obstructions. The time to find defects of this kind is before the work has been accepted, and they can be found only by testing.

FLUSHING THE DRAINS

After flushing the hydrants, the drain at the bottom of each riser should be opened and flushed. There should be a 2-in. drain pipe and gate valve at the bottom of each riser. They can be used to make sure that a good flow of water is available up to that point. If there are no hydrants, they can be used for flushing out the main feed lines.

If drains are piped to a sewer or main drain line, care should be taken to allow for a good flow. Lines from sinks, washbowls and such other connections should contain checks, so that in testing, water will not back up and overflow. At this point on each riser there should be a pressure gage, and if alarm valves are installed in the risers, there should be two, one above and one below the alarm valve. The reason for using two gages is that alarm valves are built like check valves; that is, they allow water to flow upward but not down. If the pressure in the pipes below the alarm valve got low, the pressure above would remain the same, and one gage would not show the lowering of the pressure. In making the last-mentioned test, it would be well to note how much the flow of water, with the drain valve open, reduced the pressure, the gage under the alarm valve being the one to read.

TEST PIPE AT TOP SHOULD BE OPENED

In addition to these tests the test pipe at the top of each system should be opened. At the highest point of the piping there is provided a ¾-in. pipe with a ½-in. bushed opening. This gives a flow equivalent to one opened sprinkler. It is provided for testing purposes and should be arranged so that water can be discharged without doing damage. A good flow of water at this point will indicate that there is water all the way up through the piping. All these tests are necessary to show that the pipework is free from obstructions. Many peculiar things happen during these installations. Stones, pieces of wood and débris are washed up into the pipes, sometimes when the water is first turned on. There have been cases where the outside indicator post valves have been set up with the valves shut, but the indicating device reading open. Valves may be defective and the discs will slip off of the stem. The valve may appear to be open, but the discs still obstruct the waterway. Pipefitters sometimes use blank gaskets of metal to close the top of the riser so that water can be turned on the systems below; occasionally, these are forgotten and left in place.

After the flowing tests have been made, it would be well to close and then open wide each valve on the system.

The alarm valves, if any, can next be tested. This can be done by opening the test pipe at the top of the system or at the same time that the flowing test is made. The alarms should begin to ring when the flow starts and should stop when it is shut off.

The dry-pipe valve should be examined and thoroughly understood. This device is used when piping is placed in unheated or cold buildings where water in the pipes is likely to freeze. By means of a mechanical or differential valve a limited air pressure in the piping will hold back the water until the air pressure is released by the opening of a sprinkler. These valves are somewhat intricate and require study, although they are nothing that a mechanical man should not be able to understand after a reasonable explanation. Carelessness or lack of understanding may easily place them out of service. See that a diagram is posted at each dry-pipe valve, explaining it and showing how to set it up.

The pressure ratio for these valves is usually 5 or 8 to 1; that is, 1 lb. of air will hold back 5 to 8 lb.

r water. To allow for air leakage, it is usually cus-tmary to carry 35 to 40 lb. air for water pressures of 6 to 110 pounds.

VALVE SEATS SHOULD BE CLEAN

In setting up these valves, it is important to have e seats clean, free from dents or scratches and to otain a proper adjustment of the working parts. If ere are nuts or setscrews to tighten, as there some-imes are, do not force them up hard. A snug fit is l that is necessary. There should be about one pailful f water above the air valve to seal it. This is called e priming water; frequently it is forgotten, and as a sult the air leaks back through the main valve casing. ir piping should not leak more than 10 lb. per week. ometimes, when a system does not hold the air pres-ıre, water is left in it for awhile to rust the small aks. The practice is questionable if the leaks are of ıy size. The pipework should be well enough done to ıake the piping reasonably airtight.

After these tests and examinations have been made. ırther explanation should be sought if the system is ot understood.

SYSTEM SHOULD BE TESTED AT REGULAR STATED INTERVALS

After the system has been turned over to the owner, his routine of tests should be made at regular intervals. he fact that the system is in order when delivered by ne installing company is no guarantee that it will emain that way. City valves in the street sometimes re shut off by repairmen and left that way; obstruc-ions get over the outlets from tanks. One case is ecalled where because of salts in the water and sed-ment, which settled at a certain point, a 4-in. pipe ecame entirely stopped up. In another case, where a ooden tank leaked, someone poured a large amount of atmeal into it with the idea that it would find the leaks, well up and stop them. Just how this would have af-ected the piping is uncertain. It might have gotten into ome of the small pipes and, together with sediment, of hich there is usually a little in the pipes, have formed n obstruction. Luckily, it was discovered by inspection nd cleaned out.

After going over the piping, examine the water-upply sources. In Fig. 1 they are city water-works onnection and tank. The tank should be shut off while ne flowing test is made to show that the water from he city is in proper volume and at good pressure, then urned on again.

There are gate valves in connection from both water-orks and tank for shutting off the water; there are lso check valves in each connection. These checks llow the water to flow into the system, but not the ther way. The one in the water-works connection is o keep the tank water from running out into the water-orks system. The one in connection from the tank is to revent city water from rising up into the tank and verflowing it.

TANK SHOULD BE FULL AND FREE FROM LEAKS

Make sure the tank is full of water and free from eaks. See that a strong and safe ladder has been rovided for access to it. Make sure that the filling ipe is in order and that there is an arrangement for eating the water in cold weather to prevent freezing. ee that a telltale, for showing how much water is in he tank, has been provided and is working right.

Instead of a city water-works connection direct there may be a pump. If so, look over the steam and water connections, run the pump to capacity if possible, and be sure it is working satisfactorily. An idea seems to be held in many cases that the pump or public connection is put there to fill the tank from which the water is fed to the sprinklers. That is not so. The pump or water-works connection feeds to the same main pipe that the tank does, and the water goes directly to the sprinklers.

Fig. 1 shows outside underground piping in part. In city properties there often is no yard room for outside pipe; but the arrangement in such cases is no different, the main pipes simply being run inside, usually in the basement.

Where public water cannot be used and a pump is not desirable, a pressure tank can be used as a high-pressure supply. It should be kept two-thirds full of water, the remaining one-third being air under pressure. Usually, 75 lb. air pressure should be maintained. Where a pressure and gravity tank are used, they are usually on the roof. The connections from each are sometimes brought together in the top story and a main pipe drops down through the building, feeding the sprinklers at each floor.

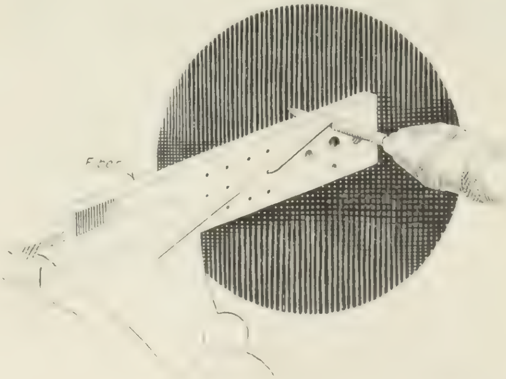
The supplies may vary, but the piping arrangement will be about as described.

(Part two of this article, dealing with supplies, will follow in an early issue.)

Handy Kink for Making Spiral Springs

BY J. W. FAGER

In making a "spring block" for small springs, I find that ¼-in. fiber works best. Take a piece of fiber about 2 x 6 in. and bore four or five holes in one end, ranging in size from ⅛ to ⅜ in. as in the figure. Near the large holes bore several small ones, say $\frac{1}{16}$ in. in diameter. By using nails or pieces of small rod, any size spring can be made, according to the size of the holes.



Put the block in a vise and thread the spring wire through the holes to give it tension. Take a nail the size of the spring you want to make, cut the head off and put it into the hole where it fits best. Wrap a few turns of the wire around the nail and grip the wire and nail in an ordinary brace, as in the figure. Then simply wind the wire around the nail until the desired length of spring is obtained.

Types of Direct-Current Motors—Series, Shunt and Compound

By B. A. Briggs

The three general types of direct-current motors, series, shunt and compound, are discussed and some of the important features of each type pointed out. It is shown that a compound motor is a combination of the shunt and series type, and the difference between a cumulative and differential connection is explained.

DIRECT-CURRENT motors may be divided into five general classes according to their electrical characteristics; namely, series, shunt and compound, interpole and compensating types. In all these types the armatures may be the same, the essential difference being in the field-pole windings and the way the latter are connected to the armature. The simplest type is the plain series motor, which derives its name from the fact that the armature and field windings are connected in series. Since the armature and field windings are connected in series, the latter passes all the armature current. Consequently, the wire in the field coils must be large enough to carry the total load current without excessive heating or voltage drop. For this reason the field coils of a series motor are usually wound with a comparatively small number of turns of relatively large-sized wire. The connections of a series motor to an ordinary type of manual starting box are shown in Fig. 1. It will be noticed that there is but one circuit through the starting box, armature and field windings, the armature and field windings being connected in series. Where motors of this type are of 3.5 hp. in size and above, they can generally be determined by inspection, by noting if the machine has only main poles, as in the figure, and if the field and armature leads are the same size. A test can be made with a lamp and circuit having machine voltage. If the motor is of the series type, the lamp should light up to full brilliancy when connected across either the field or armature terminals excepting in the case of very small machines.

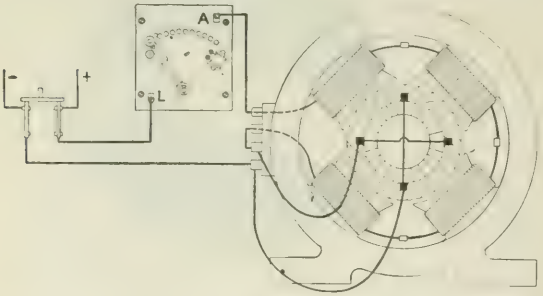


FIG. 1. CONNECTION DIAGRAM FOR SERIES MOTOR AND STARTING BOX

One of the serious disadvantages of a series motor is that it will race if its load is removed and will destroy itself unless disconnected from the line. If the load is changed on the motor, the speed will vary inversely—that is, if the load is increased the speed will decrease, and if the load is decreased the speed will increase—consequently, the motor is not adapted to constant-speed service. For this reason the motor is used to a very limited extent excepting in cases where it is continuously under the control of an operator; for example, on cranes and railway service. The motor has a characteristic that makes it well adapted to these two classes of service; namely, within certain limits its torque (turning effort) varies as the square of the current; that is, if the current taken from the line is increased by 2, the torque will be increased four times. Why this is so may be readily understood by a consideration of what happens in the motor when the value of the current is doubled in the motor's windings. For example, if the motor takes 10 amperes from the line, this current passes through both the armature and field windings and produces a certain number of lines of force per square inch in the field poles, which is reacted upon by the current passing through the armature conductors and causes the armature to develop a given turning effort. If the current was doubled in the armature, the lines of force remaining constant, the turning effort would be doubled. On the other hand, if the value of the current in the armature was maintained constant and the lines of force doubled in the field pole, the torque would also be doubled. Since the field and armature windings are connected in series, if the current is increased to 20 amperes, then the current will be doubled not only in the armature conductors, but also through the field coil. The latter will increase the lines of force from the field pole by 2. Consequently, when we have two times the current in the armature conductors acting upon two times the flux from the polepieces, this will give four times the turning effort developed by 10 amperes.

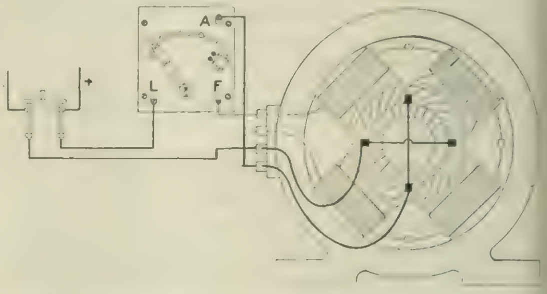
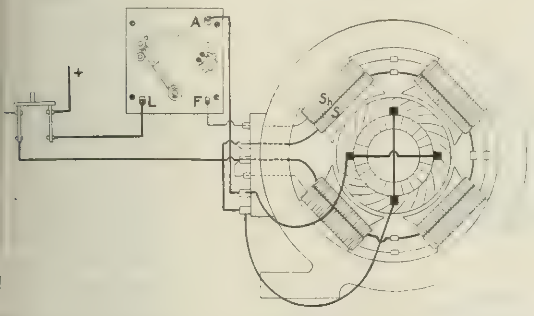


FIG. 2. CONNECTION DIAGRAM FOR SHUNT MOTOR AND STARTING BOX

Of course this holds true only up to the point where the magnetic circuit begins to approach saturation. Then the increase in torque for an increase in current is not so marked. This characteristic of the torque increasing as the square of the current, makes the motor well adapted to work that requires frequent tarting under heavy loads, as in railway and crane ork, and it is in these two applications that the series otor finds its greatest application.

The plain shunt type of motor is in general appearce very much like the series machine, and in the maller sizes it would be somewhat difficult to disnguish one from the other by a casual inspection. The hunt machine gets its name from having its field coils onnected in parallel, or in shunt as it is sometimes alled, with the armature. The connections for a simple unt-type motor and manual-type starting box are shown Fig. 2. Instead of one circuit, as in the series motor, here are two in the shunt machine; namely, one through he armature and another through the field winding.

The field coils, Fig. 2, are connected directly across he line, therefore, must be wound with a wire of comaratively small cross-section, so that the exciting curent will be maintained at a value consistent with high fficiency, and also to prevent the coils from overheatng. In this we find the most marked distinction beween the series- and the shunt-type machines. In the eries machine the field coils are wound with a comaratively small number of turns of large-sized wire, onsequently have a low resistance, while in the shunt nachine the field coils are wound with a large number f turns of comparatively small wire and have a high esistance. In large-sized machines, 3.5 hp. and up, he motors can be distinguished by the size of the field eads, they being smaller than the armature leads on he shunt machines and the same size on the series mahines. In the small machines, where the field and rmature leads are the same size on both types, one type nay be distinguished from the other by testing through he field coil with a lamp. When tested on the circuit f the machine's rated voltage a lamp connected in eries with the field coil of the shunt machine will glow limly, but on a series machine the lamp will light rightly.



IG. 3. CONNECTION DIAGRAM FOR COMPOUND MOTOR AND STARTING BOX

Since the field winding of a shunt motor is connected cross the line, the magnetic density in the field poles vill be practically constant irrespective of the load. herefore the torque of a shunt motor varies directly s the current in the armature, and not as the square f the current, as in the series machine. In other words, f the current through the armature of a shunt motor is ncreased by two, the torque is also increased two times. lso, since the strength of the field pole is practically onstant, the speed of the motor will be practically contant from no load to full load. In practice the variation s only about 5 to 10 per cent from no load to full load, the speed being higher at no load than at full load. Therefore, in a shunt motor we have a machine the torque of which varies directly as the current in the armature and whose speed is practically constant. These two features make this type of motor applicable to a large number of drives where the starting conditions are not severe and where a constant speed is required over a wide range of load.

There are many drives that require practically a constant speed after the motor has been accelerated and where a strong starting torque is required. In other words, a motor is required that has speed characteristics of a shunt machine and the torque characteristics of a series machine. To meet such requirements, what is known as a compound motor is used, which is nothing more nor less than a shunt machine with the addition of a low-resistance winding on the field pole, connected in series with the armature. The connections for a simple type of compound motor to be started by a manual-type starting box are shown in Fig. 3. It will be seen that the shunt winding, S_h, is connected across the line, the same as in Fig. 2, and the series winding S is connected in series with the armature, as in Fig. 1. The same starting box is used on both the shunt- and compound-wound motors.

Compound Motors for Elevator Service

When compound motors are used on elevator service, the controller is usually arranged so that the series winding is in circuit only while the motor is coming up to speed. After the load has been accelerated, the series winding is cut out of circuit automatically, thus converting the motor into a shunt machine during the running period. In this way the motor is made to act as a generator when the car is traveling in the down motion under heavy load to prevent the machine from racing. Cutting out the series winding during the running period also tends to make the motor run at a more constant speed under variable loads. Although a compound motor will not race as will a series machine under light loads, nevertheless its speed is not as constant under variable loads as a shunt machine. With the average compound motor the speed variations from no load to full load is in the neighborhood of 15 to 20 per cent. This, however, will depend upon the series ampere turns (turns × amperes) on the polepieces. The greater the number of ampere turns in the series winding the greater will be the starting torque, as also the variation of the motor speed.

There are two ways of connecting compound motors —so that the series and shunt-field windings have the same polarity, and also so that the two windings will have opposite polarities. Where the two sets of field coils are connected so as to have the same polarity, the machine is called a cumulative compound motor; that is, the resultant field strength is the cumulative effect produced by the two windings. When the two windings are so connected that they oppose, the machine is called a differential compound motor, since the resultant field strength is the difference between that produced by the shunt and the series field windings.

The simple series, shunt and compound types, of direct-current motors cover in a general way motors for use on direct-current circuits. There are a number of other types, but they are only modifications of the three types made. These modifications will be made the subjects of other articles.

Preliminaries to Cost Accounting in Refrigerating Plants

By PETER NEFF

Consulting Engineer, Canton, Ohio

THERE is probably no other industry in which so much responsibility for success or failure is placed upon the operating engineer as in refrigeration. That this responsibility may be met, the engineer must be alive to his duties, recognize the responsibility and take such steps as will increase his ability to produce a maximum of true efficiency.

The writer believes that the refrigerating industry affords opportunity for development that will make not alone for the good of the plant, but for the character and ability of the engineer, insuring him a career of which he may be proud.

PETER NEFF

Just a word to the plant owner and manager: When you find your engineer not only giving a full measure of faithful performance of duty, but combining study with experience and thus acquiring true education, and with this development of knowledge gradually improving the plant, give him encouragement and opportunity to broaden his viewpoint. Have him attend association meetings and visit modern plants; see that trade papers are put into his hands; and lastly, do not hold back substantial reward for actual accomplishments. Make him, as his position demands, more than a mere employee. I believe just as deeply in the converse of this, that an engineer who makes no effort to improve himself and the plant under his care, who neglects to study and take advantage of opportunities for improvement, who does not take an interest in knowing what the plant does—for one must first know what a plant is doing before he can compare it with subsequent results—should be relegated to the position of a second, who does simply what he is told, or he should be discharged. The conditions of business now demand that a plant continually improve.

Mr. Neff enjoys the distinction of being known to most professional and operating engineers in the refrigerating industry. His life's work has been the upbuilding of this industry. In this article he tells in a direct, pleasingly simple manner what he regards as important to the subject of cost finding in refrigerating plants. The subject is one on which world-wide attention is directed; engineering society committees are now working on it. Mr. Neff does not pretend that the article is scientific or abstruse; it deals with commonsense human and engineering fundamentals which must precede workable cost-accounting systems.

Someone has said that a little learning is a dangerous thing. It is not, unless wrongly applied. It is when a man with the little learning thinks himself fully equipped and then proceeds to apply this knowledge that it is dangerous. The little learning will simply be a stimulus to acquire more, will make him a seeker, will cause him to be cautious in what he undertakes and, lastly, will make him weigh carefully all that he is told and keep him from being carried away by strange and false doctrine.

The engineer must acquire the power to think, to analyze, to combine and coordinate theories with practical conditions as they have to be met. What may be a good thing in one plant may not be the best for another, but for that it is not to be condemned.

Some of us who have been through plant troubles and whose work has brought them for years in contact with various plants and their operation, while not always able to grasp in a brief visit all the conditions surrounding the operation of a particular plant, yet may be able, by discussing the trend of modern practice, to suggest general methods that can be made applicable to a particular case.

It is in that sort of work that help can be rendered to the engineer in charge. It is a process of education. Some have an idea that they must keep their knowledge to themselves. It is a strange thing, but the more one gives of knowledge the more he acquires. The engineer must have his heart in his work. He must be solicitous for the welfare of the plant, which means the success of the business for the owners, make the best of the equipment he has, think about the plant, "read up" on the questions involved, get a thorough understanding of what his plant is doing, and *possess this in a form that will be intelligible to the management.* He should ask for help if there are problems he is in doubt about or on which there is a difference of opinion; make suggestions and discuss them, giving reasons why this or that in his judgment should be done; put himself on record, have arguments for what he proposes; not try to do everything at once, but a little; compare results, and thus have a sure footing for the next step. The refrigerating industry is full of unsolved problems which are being worked upon. He should give his share of experience and knowledge. There is a pleasure that comes from striving and accomplishing, just as there comes with the pleasure a greater remuneration; for when business finds that a man can accomplish more, he will be sought. No education is real if it causes the slightest hint of neglect of one's appointed duties.

If one feels that all the time he should give to the plant under his care is the few hours set aside as so-called working hours, one will never get very far on the road to success.

This industry is growing faster than many realize, and there are offered exceptional opportunities to the man who is ambitious and competent.

I do not propose to give costs, but discuss how the engineer should and can acquire a knowledge of them and what is the basis. When one speaks of costs the subject is likely to be considered as simply dollars and cents. True, it can ultimately be reduced to this basis.

One must get a conception of the principles that underlie all refrigerating processes; these involve a knowledge of heat, the difference between sensible and latent heat, boiling points and how influenced by pressure, effects of superheating gases, transmission of heat from one substance to another. One must be able to visualize what is going on throughout the system.

WHAT THE LOG SHOULD TELL

A log must be honestly kept and studied; it will serve as a basis for much useful information relative to operation; in fact, it is essential. This log should not be burdensome; every facility should be had to take readings quickly and accurately. Often one finds thermometers placed where they cannot be easily read. There should be fixed thermometers for all important readings—good thermometers with graduations that are plainly visible. Refrigeration being a heat problem at every stage, it is useless to think that useful knowledge can be had without thermometers. Gages are needed; these are often neglected and the engineer does not know whether or not they are correct. In a log the fundamentals to be known are temperature of water to and from the condenser; of the liquid ammonia leaving the condenser and at the feed valve, or for convenience, as it leaves the receiver; of the suction gas as it leaves the evaporator and when it enters the compressor; the discharge leaving the compressor; whatever is cooled, be it brine, air, water, etc. Where brine is circulated for the use of cooling, its outgoing and returning temperature should be recorded, also, if possible, the quantity.

In many cases the medium is first cooled (precooled) by water, as is the case in a distilled-water plant. Here it is necessary to know the temperature of the water available for cooling as well as the temperature to which it is possible to reduce the medium. It is axiomatic that all possible cooling be done by natural means before applying mechanical, illustrated again by distilled water. The apparatus for cooling this with natural water should be such as to reduce it to practically the same temperature as the water available, otherwise there is an unnecessary extra load thrown on the machine. The same applies to the liquid ammonia. Here a large percentage of the work of the machine is used in cooling the ammonia from the temperature of the liquid at the feed valves to the temperature at which ammonia is boiling in the evaporator. Then if it is found that the temperature of the ammonia is higher at the feed valves than when it leaves the condenser, there is something that needs correction. These are emphatically cost problems.

THE GRAPHIC LOG WORTH WHILE

The temperature of the atmosphere must be recorded, also the pressures of the suction and discharge. I will not here touch on the question of power. Every engineer knows that a record of the power used is essential if one would know the costs of production.

There is much to be said in favor of the graphic log, as the eye will detect variations that might otherwise escape; but such a log requires considerable time, though it will repay one to plot them. It is most interesting when one year's run can be compared with another. There is much that could be said about the daily log and what it can be developed into, but we are here simply indicating its necessity for knowing what the plant is doing and making it possible to compare results when changes are made. With the ability to visualize what is taking place in a refrigerating system, one has the groundwork for a cost system.

A refrigerating plant is a manufactury of refrigeration that is disposed of in varying quantities. As there is but one commodity manufactured, everything must be based on some unit of this commodity. If one is making bricks, for example, one may take 1,000 bricks as the unit, and his costs will be so based, as well as the disposition he makes of them. At the end of a given period he will be a poor business man who will not know how many thousand bricks have been made and at what cost, and how many have been disposed of and at what figure per unit. If the number manufactured is considerably more than the amount sold or accounted for, he would be pretty sure to start an investigation. In the refrigerating industry we have been going along from the start with the ton of refrigeration as a standard of measure for the commodity. But we have guessed at the amount we made and guessed at the amount we disposed of. Not only that, but we have been accustomed to buying apparatus for the manufacture of refrigeration with a guarantee for its producing a certain number of tons, and we seldom know if it has fulfilled it. The ice manufacturer may say, "I weigh my ice and know exactly how much refrigeration is produced." The man who meters the brine and can calculate the tonnage disposed of may say he knows exactly his production. It is true they can tell something, but can they tell how many tons of refrigeration they are actually developing to make the ice or cool the brine? It is the same as if the brick manfacturer bought an apparatus to produce so many bricks, no matter if it broke up and made useless a large number besides the required toll of good ones. So in refrigeration, the ice man does not know whether he is developing 1.8 tons refrigeration per ton of ice produced or 2.5 tons.

ENGINEERING SOCIETIES BUSY ON STANDARDS

If we could measure the tons refrigeration we would have a basis for costs and also something that would enable one plant to compare its results with another. Furthermore, it would make the manufacturers more specific with their guarantees. We will see later how this affects them. Owners would be able to compare the working of their plant with that of another, and if one was making a ton of ice with an expenditure of 1.8 tons refrigeration, the other that might be consuming 2.5 would investigate why he suffered such a loss. And the engineer would be the one that he would turn to. We are being driven toward a solution of this problem faster than many imagine. In cold storage it is vital to a proper method of rate making. There is no need of going farther to emphasize the need—all know it is there. What are we going to do about it?

One influence that is making for a solution of the problem is the revision of the power-test codes of the American Society of Mechanical Engineers. The society insists that a method be promulgated for testing refrigerating machinery and has called in a number of engineers to solve the problem. It is perhaps not as difficult as it would appear from the time it has taken to get the methods worked out. The delay has been largely because the basic standards for the refrigerant were not accurately determined. But during the last few years considerable work has been done, at least on ammonia, so that we now have fairly accurate data for ammonia; data on other refrigerants are coming.

It is evident that if we know the temperature of the liquid at the feed valves, its specific and latent heat, the pressure and temperature of the evaporated gas, and the number of pounds of the gas evaporated, the amount of refrigeration can be determined. The weight of the liquid evaporated has been the hard task. Such tests as have been made have been by a careful weighing of the liquid on its way to the evaporator.

Through the development of the steam-flow meter there is coming a method of measuring the amount of gas evaporated. When this is accomplished, it will not be difficult to have a record of the volume and weight that a compressor or absorber handles in a given period. Tables can be made that, having the temperature of the liquid, the pressure in the evaporator, the temperature of the evaporated gas to the compressor, the measure of the volume of this gas, the period of time, the tonnage may be quickly calculated or read directly.

[Readers of this article by Mr. Neff will be pleased to learn here that in the new T-Wharf Plant of the Quincy Market Cold Storage & Warehouse Co., Boston, an orifice meter already has been installed for this very purpose—to measure the gas delivered by the compressor to the condenser. Although but recently installed, we learn that it is working satisfactorily in this service. Besides this meter, the plant is provided with venturi meters for water and brine, thermometers and all necessary indicating and recording gages.—Editor.]

This suggests something that will help bridge the gulf between present-day slip-shod methods and the more refined that are to come, something that will serve to educate, while at the same time giving fairly accurate results. It will also avoid the question of expense.

THE COMPRESSOR AS A FLOW METER

The method consists in using the compressor itself as the meter for measuring the amount of gas handled. If the compressor is indicated, the re-expansion loss can be expressed in terms of percentage of stroke, reducing the volume as swept by the piston in its travel. This re-expansion loss is dependent in the same compressor on the relation between the suction and discharge pressures. It is not a difficult matter to determine the loss at some predetermined relation of pressures, as for example 15 and 185 lb., which is commonly used; then by a chart the percentage of variation can be shown for any other combination of pressures. Having determined for an individual compressor the volume available for filling per stroke, it then becomes necessary to know the number of strokes in a given period; this can be found by the use of a revolution counter.

But another element and one not so easily handled is involved—the internal superheating of the gas. Superheating of a gas lessens its weight per cubic foot under a constant pressure. Compressor construction has to do largely with this loss. In practice the manufacturer allows for it in the size of his compressor when he guarantees a certain effective tonnage. Enough is now known about compressors to predict the loss involved, and there is no reason why the manufacturer should not be forced to produce evidence of what this loss is, for it is a loss in energy expended, and by the use of a flow-meter test this loss is determinable. If the manufacturer will then show what percentage of loss he allows for, due to the superheating of the gas on entering the compressor, one can correct for the difference in density of the gas as delivered in the suction line at the compressor and after it has entered the compressor.

If the volume available for filling is known for a given period and the pressure and temperature of the gas supplied to this volume, corrected for the increase of temperature due to internal superheating, the amount of liquid ammonia evaporated can be found and the tonnage determined. The temperature of the liquid at the feed valves being known, the amount of refrigeration consumed in cooling this to the temperature of the evaporator can be found. This is a loss that has to be borne by the machine, but it can often be considerably lessened if the loss is known and appreciated.

After the gas leaves the evaporator, any increase in temperature before reaching the compressor—in other words, superheating—can also be measured and usually corrected by insulation.

WHERE THERMOMETERS ARE NEEDED

Naturally, recording instruments are preferable in this work, but by averaging readings from fixed thermometers, as well as for the pressures, a fair degree of accuracy will be had. There is needed to try out this method a thermometer on the suction near the machine, one on liquid line to feed valves, a revolution counter, good gages on the suction and discharge lines, indicator diagrams of the compressor, and correction for internal superheating. Even without specially prepared tables, the data are available in the published tables of properties of the gas used for the refrigerant.

Now such a method, while not scientifically accurate, will help develop a knowledge of one's plant, will serve as a basis for a cost system; will enable the plant to be compared from time to time; and finally will awaken a desire to have and employ more accurate means, such as flow meters. When we do have a measure of the gas handled by a compressor, as will be the case with the flow meters, it will not be long till the variation in internal superheating loss will cause the manufacturers to take steps to make their compressors more efficient in this particular. And it will be a point on which their salesmen will be questioned and one that will be susceptible of verification after the plant is installed.

BASIS NECESSARY IN COST ACCOUNTING

Locating preventable losses in plants is one of the prime reasons for a cost system, and we can realize this only by having a basis; while this basis for the time being may not be all that we hope for, it can be corrected from time to time as our knowledge increases.

The ton refrigeration per day, like the kilowatt-hour, may come to mean something, and when spoken of will have a real significance; the fact that it may not be exactly as represented makes little difference if all use it in the same sense.

It would seem to me that the manufacturers of refrigeration apparatus should urge upon such bodies as the American Society of Refrigerating Engineers, that they issue tables and standards that can be used by all, that they be based on the latest available data and that they be arranged conveniently for the use of operating engineers. Then let the manufacturers assist in the distribution of this information.

In the meantime my suggestion to engineers is to make a start at analyzing plant conditions. Make an attempt to determine the amount of refrigeration that the machine is doing. Get your engineering association to secure the latest tables of data and familiarize yourselves with their use. Start a cost system that will show the amount used of any one thing per ton refrigeration per day. Accustom yourselves to thinking in terms of the ton refrigeration per day. At meetings of associations discuss daily logs in a practical way, the form of sheets which you use and the method employed in getting the quantities that go into the costs as items. There are a lot of these practical problems that should be discussed. A paper on them does little good. It is when you say something and someone argues it with you that you usually get something worth while.

The Ingersoll-Rand P-R Oil Engine

The Ingersoll-Rand Co. is building the Price heavy-oil engine in both horizontal and vertical designs. This engine falls into that class of internal-combustion engines termed solid-injection explosive oil engines, employing a compression of 200 lb. per sq.in. and requiring no ignition surface such as hot bulbs or hot plates. Ignition is by heat of compression only, with the exception that, on starting, an electric coil is employed during the first few explosions.

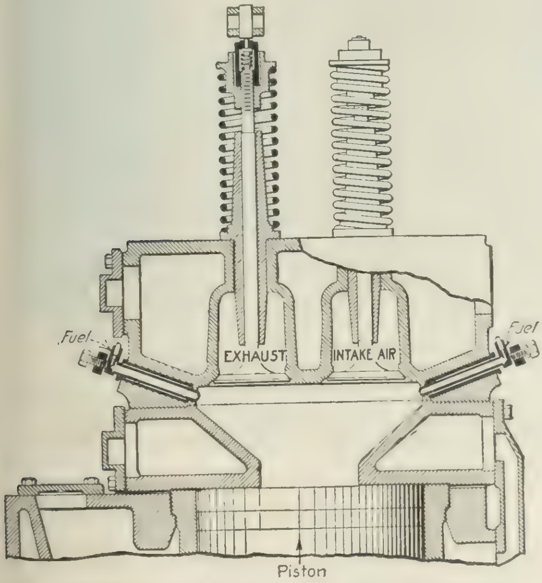


FIG. 1. INGERSOLL-RAND OIL ENGINE CYLINDER HEAD

The combustion chamber and atomizer are the parts where the design differs from other engines. As the cross-section, Fig. 1, shows, the head is composed of two castings; the lower part acts as the combustion chamber, while the upper casting carries the valves. The lower section, as may be seen from Figs. 1 and 2, has a constricted outlet leading to the cylinder.

The action of the engine is as follows: On the suction stroke the air is drawn into the cylinder and combustion chamber. On the compression stroke the fuel charge is injected through two nozzles, at about 33 deg. ahead of outer dead center, into the combustion chamber. The oil jets issuing from the two nozzles meet at the center of the cavity, creating such a turbulence that a complete mixing of the air and oil is assured. As the piston advances, the pressure and temperature of the cylinder contents increase to an extent that causes the oil to ignite when the piston forces the main air charge into the combustion chamber.

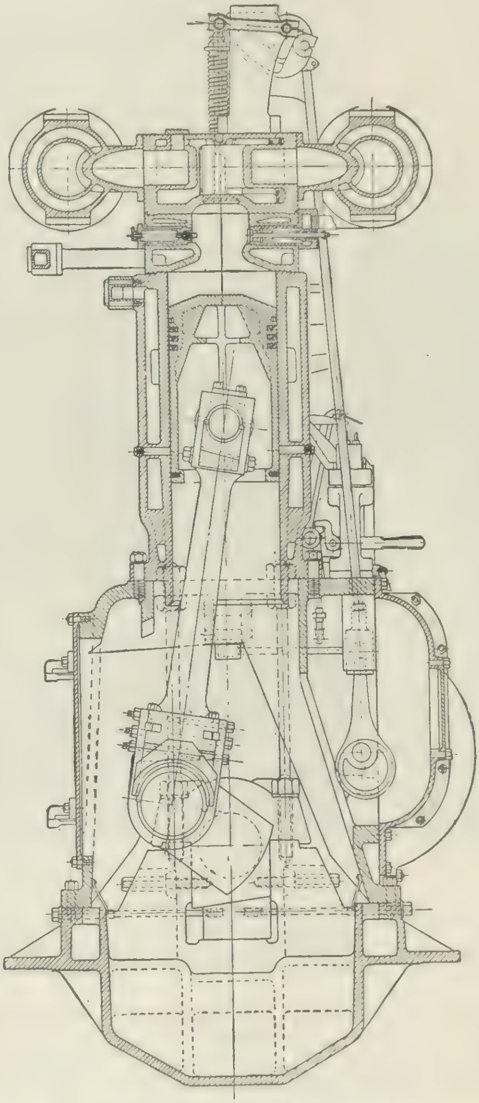


FIG. 2 VERTICAL SECTION OF P-R MARINE OIL ENGINE

A fuel pump is provided for each working cylinder. The pump plungers are actuated by cams on the camshaft, the governing being accomplished by the opening of a bypass valve on the pump discharge line. In Fig. 3 the pump is immediately to the left of the flywheel.

The marine engine is quite similar to the vertical stationary engine. The frame is of the inclosed box-section type; the valves are actuated through rockers and push rods by eccentrics on the camshaft. The lubrication of the bearings is accomplished by a combined force feed and splash system. The reversal is rather unique. The timing of the admission and exhaust valves is such that when running ahead one set of valves act as the exhaust, while on going astern the same set of valves are the suction valves and the admission valves now become the exhaust valves. Reversal is accomplished by means of air through a distributor somewhat similar to the starting rig on certain two-cycle hot-bulb oil engines. Since the fuel-pump plunger starts on its outward stroke 35 deg. ahead of dead center and returns at 35 deg. after dead center, it does not require any shifting of the fuel-pump cam to reverse. This is the simplest reversing rig employed on four-cycle oil engines.

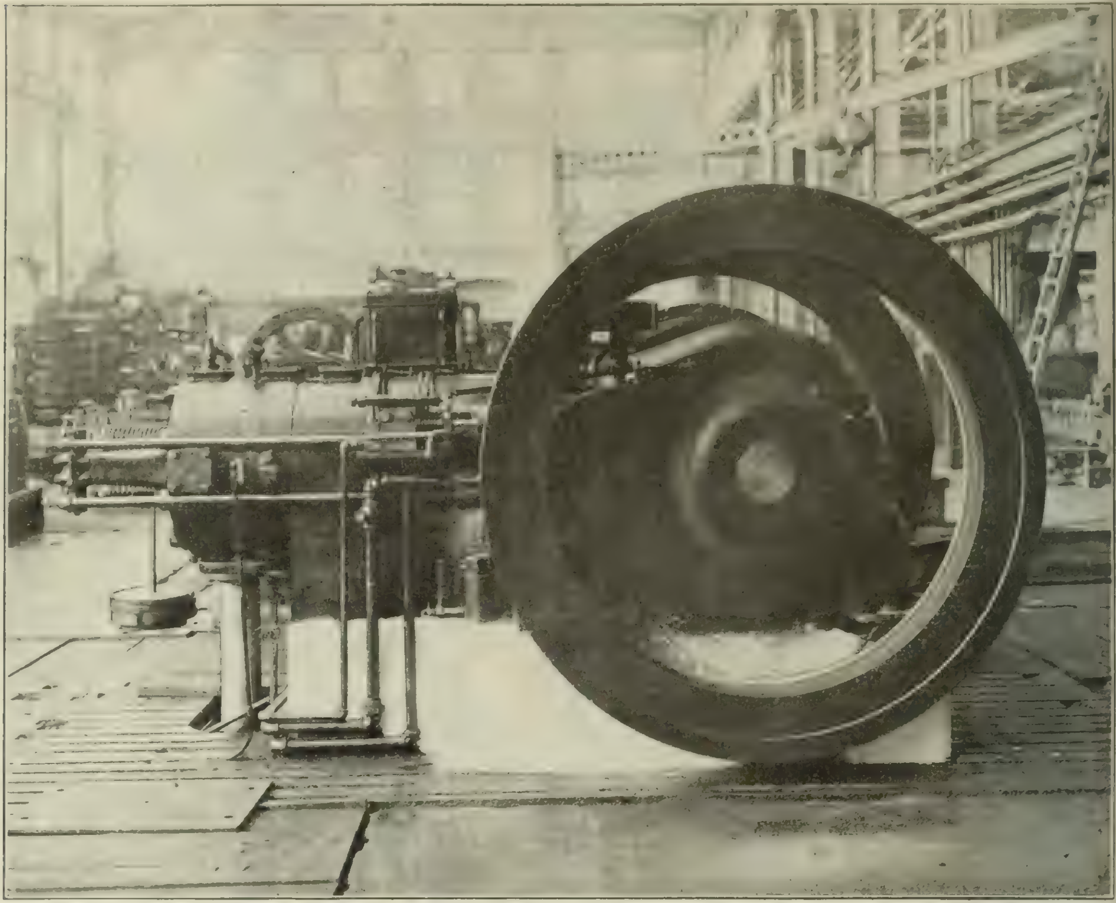


FIG. 3. INGERSOLL-RAND HORIZONTAL OIL ENGINE

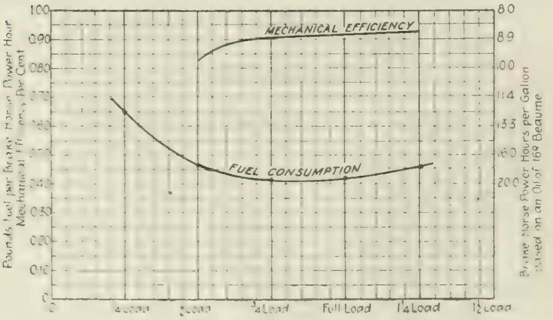


FIG. 4. EFFICIENCY AND FUEL CONSUMPTION CURVES

Fig. 3 is a view of the horizontal P-R engine, which is built in sizes up to 100 hp. The fuel cosumptions for various loads appear in Fig. 4. The thermal efficiency based on indicated horsepower is aproximately 33 per cent at full load; the high mechanical efficiency brings the efficiency based on brake horsepower up to 31 per cent, which is quite excellent even for Diesel engines.

The report of the Department of Commerce, Bureau of Foreign and Domestic Commerce, gives domestic exports of pumps, pumping machinery, refrigerating machinery and air-compressing machinery from the United States by countries for the month of May as valued at $1,964,047. Of these, pumps and pumping machinery come first with a total of $1,155,128, air-compressing machinery second, with a total of $553,808 and refrigerating machinery third, with a total of $255,111.

H. A. Kidder

New Head of the Department of Motive Power, Interborough Rapid Transit Company

H. A. Kidder, formerly electrical superintendent in the motive-power department of the Interborough Rapid Transit Co., and New York Railways Co., of New York, has been appointed assistant superintendent of motive power of both companies. The appointment is made pending final severance of the relations of W. S. Finlay, Jr., with those organizations in the near future, at which time Mr. Kidder will become superintendent of the department.

Mr. Kidder began his career with the companies mentioned as assistant electrical superintendent in 1906, prior to which he was connected with the General Electric Co. in its railway engineering department, and in the following year became electrical superintendent in charge of all electrical operating equipment.

The Interborough Rapid Transit Co. operates all the elevated lines and most of the subway lines in New York City, also most of the surface-car lines. The power department of this company has long been famous, and Mr. Finlay's predecessor, the late Henry G. Stott, attained eminence in his long period of service there. The large reciprocating engine made its last stand in this company's 74th Street Station when Edwin Reynolds, of the Allis-Chalmers Co., designed and installed for this station the Manhattan type engines, each of 7,500 hp. The first of the new type of cross-compound turbines were installed here, of 30,000 kw. capacity, followed by another unit of the same type of 60,000 kw. The reciprocating engine, low pressure turbine units in the company's 59th Street Station were among the first of the kind and are still in service, giving an economy of performance that is perhaps not materially surpassed by any steam prime mover anywhere.

Electric-Elevator Machinery—Worm Gears and Their Lubrication

By M. A. MYERS
Electrical Engineer, The Maintenance Company, New York City.

Elevator reduction gears may be either of the worm-and-gear, spur-gear or herringbone type. Lubrication of the gears is a very important factor in the operation of elevator machinery, and castor oil is recommended as best for this purpose. How to remove the worm from an elevator worm reduction gear is also discussed.

TO DRIVE the standard drum-type elevator, a comparatively high-speed motor is used. Since the speed of the winding drum must necessarily be slow, some type of reduction gear is necessary. This speed reduction is generally made through the medium of a worm and gear, although spur gears have in the past been used to considerable extent, and in some cases in modern machines herringhone gears are employed. In some installations of large-capacity elevator machines a combination worm and gear and spur gear has been used. No parts of the elevator machine have received more attention and had more study devoted to them than those parts in the gear case. These parts consist of a worm and wormwheel, thrust bearings and worm-shaft bearings. In the modern machines these parts are inclosed in a cast-iron case, Fig. 1, which forms part of the elevator machine frame. In Fig. 2 is shown a worm gear, with the top half of the gear case and the cover from the handhole removed to expose the parts. The following problem will indicate the principal reason for the worm-gear speed reduction in elevator machines:

Assume a car travel of 150 ft., at a speed of 150 ft. per min. If the drum is 3 ft. in diameter at the grooves, its circumference will be 9.4 ft. In other words, one revolution of the drum will produce a car motion of 9.4 ft. and 16 revolutions of the drum will be required for the car travel of 150 feet. Using an elevator motor running at a speed of 800 r.p.m., which is about the highest advisable for an elevator worm, then with a reduction from 800 to 16 r.p.m., a ratio of 50 to 1 is the result. Ordinary spur gears are too noisy, and too disposed to vibration, even when inclosed and operating in oil. Neither are they as safe for elevator purposes. Furthermore, the foregoing reduction cannot be made in one step with spur gears, since it would require impracticable gear diameters and impossible frames. In the case cited, for example, if a 3-in. pinion were possible on the motor shaft, a 150-in. gearwheel would be required on the drum shaft, consequently a gear train would be necessary to reduce the speed at the motor to that of the drum. Ordinary spur-gear elevators are to be found even at this date, but most are relics. Herringbone-gear machines and gearless machines are occasionally installed, but these will be the subject of a future article.

A well designed worm-gear reduction is a reliable piece of machinery, requiring little attention, other than to be kept well oiled. The worm and worm shaft are machined from a solid forging, or at least should be. Fig. 3 shows a worm shaft of a modern elevator machine; *A* and *D* are the shaft bearings; *C* the worm and *B* the ball-thrust bearings. The thrust bearings will be discussed more fully in the next article. Worms are in use that are keyed and pinned to the worm shafts, but this cannot be considered a safe practice. The worm may have a single thread, as in Fig. 3, in which case one revolution will move the wormwheel one tooth; or double thread, known as double-cut worms, which for one revolution moves the wormwheel two teeth. Right-hand cut worms are the rule, although left-hand cut worms are to be found in use. Whether right or left cut, the operation, wear, etc., of the worm gear are practically identical. The worm bearings may or may not be babbitted, as cast iron makes a good bearing material for the steel shaft as long as it is properly oiled. If the bearings are not babbitted, they may be bored out when they wear, and babbitted. Holes *E* and *F*, Fig. 3, are provided to allow the gear oil to reach the shaft easily, and *C* is the stuffing box gland to hold the packing and prevent oil leaking along the worm shaft.

The Hindley (spool) worm and gear, as shown in Fig. 4, differ from the ordinary worm and gear in that the worm is curved to conform with the circumference of the wormwheel. The advantages claimed for this construction are that the worm for its entire length is in complete mesh with the wormwheel teeth; friction and wear are distributed over a greater number of teeth—in other words, the wearing surface is increased; reduction of pressure per square inch of wearing surface between worm and wormwheel teeth, thereby reducing the tendency of lubrication to squeeze out from between the worm and gear teeth; all of which results in a reduction in power loss. The disadvantages are as follows: Difficulty in cutting the worm and gear, requiring special machinery; probable delay in obtaining replacements, and expense of replacements; the necessity of keeping the worm accurately cen-

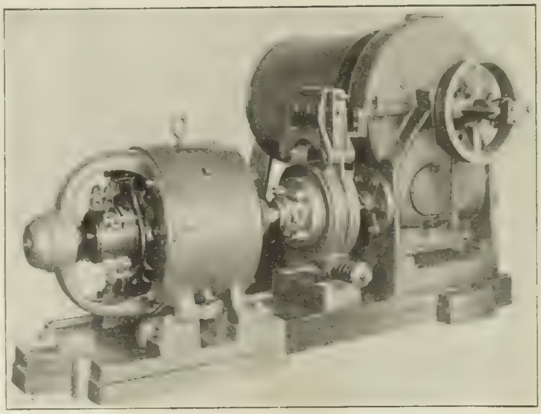


FIG. 1. ELECTRIC ELEVATOR MACHINE

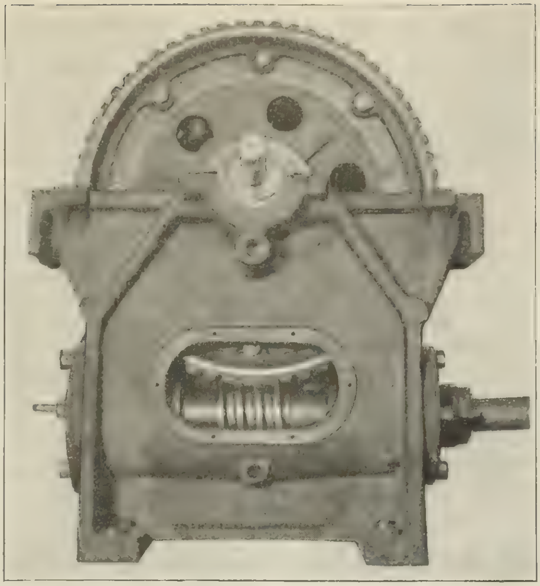


FIG. 2. WORM AND GEAR ASSEMBLED

ered with the wormwheel, which position is usually marked by the manufacturers by prick-punch marks on both worm and gear. Obviously, if the worm moves endwise, the increasing diameter will cause it to bind on the wormwheel in proportion to the movement. A slight wearing of the thrust bearings will allow this end motion, and the friction increase may be very great. If unnoticed at the start, cutting is liable to become so severe as to destroy both worm and gear. To make accurate adjustments for centers, the oil should be removed and the lower gear case handhole opened in order to view the work. The wormwheel, Fig. 6, is of bronze, the teeth being cut in a bronze ring, or rim wheel, provided with a short web and ears for bolting to a cast-iron spider. Fig. 2 shows the assembly, with the handhole cover and the gear-case top removed. Here the method of bolting the rim wheel to the spider is clearly indicated. The nuts on the bolts have setscrews to prevent loosening.

The factor to be most emphasized in connection with the operation and maintenance of a worm gear is the oil. Because of the high pressure between the worm and wormwheel teeth and in the thrust bearings, an oil of high viscosity and incompressibility (oiliness) should be used—in other words, a lubricant that will not allow itself to be squeezed out from between the rubbing surfaces. The best oil for this purpose is castor oil. A mixture of about 60 to 65 per cent castor oil, with the balance a good grade of cylinder oil, is excellent. The cylinder oil, in addition to reducing the cost of the product, is said to prevent the castor oil from becoming too viscous under certain conditions.

Castor oil has been so difficult or impossible to obtain during the recent strenuous times, that many substitute "gear oils" sprang into existence, giving various degrees of satisfaction. While the castor-oil market is now easier, it is still so expensive that many elevator users will not consider its use. It is the writer's belief, if those who pay the repair and the electric-current bills were brought to realize the saving to be effected in wear and tear on the machinery and in current consumption, a larger number of them would insist upon a fair percentage of castor oil in their elevator gear cases. If the stuffing boxes and bearings are kept in good condition, a good castor-oil mixture will long outlast ordinary oil, not only in lubricating qualities, but in non-leakage qualities, as it will not lose its viscosity on warming up or leak out of the gear case as readily.

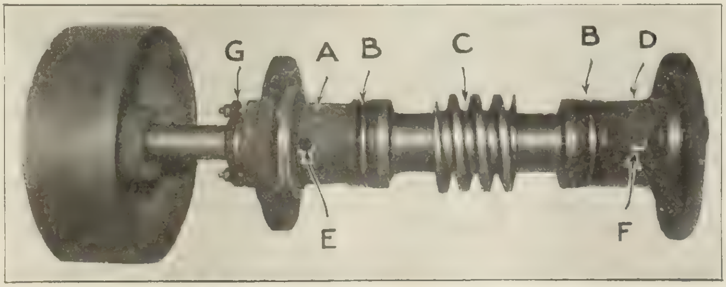


FIG 3 WORM SHAFT AND BEARINGS

The level of oil in the gear case should be kept high enough to completely immerse the worm, but no higher, or oil will be caused to leak out around the drum-shaft bearing. Sufficient oil will be indicated when the spaces between the wormwheel teeth are well lubricated, as they rotate beneath the handhole in the gear-case top. Where thrust bearings are in a housing or bonnet by themselves, oil should be introduced into the bonnet when the machine is first started, after which enough lubricant will usually find its way over from the gear case proper.

Powdered sulphur is sometimes mixed with the gear oil as a polishing agent when the gears are new or when roughened for any reason. If not more than a half pound per gallon of oil is used, it may be left indefinitely, as it will gradually work out of the oil and be deposited at the bottom of the gear case. For more aggravated cases of roughening, a molasses-like mixture of white lead, sulphur and machine oil may be introduced into the gear case. This should be cleaned out after its purpose is accomplished. When possible, it is advisable to operate a new worm-gear reduction unloaded for a period, to

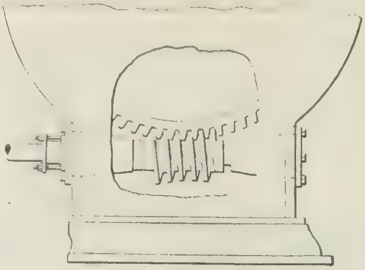


FIG. 4. HINDLEY WORM AND GEAR

wear the worm and wormwheel to each other, previous to subjecting them to load stresses.

The wormwheel bearings must be kept well oiled. Ordinarily, enough oil leaks through from the gear case to keep these bearings lubricated, but this does not necessarily follow. The speed of this shaft is so low that but little oil is needed, and it is likely to be neglected. It is necessary to keep these bearings and the worm-shaft bearings in particularly good condition, in order to keep the worm and wormwheel in correct mesh. When wear is found, these bearings should be promptly rebabbitted.

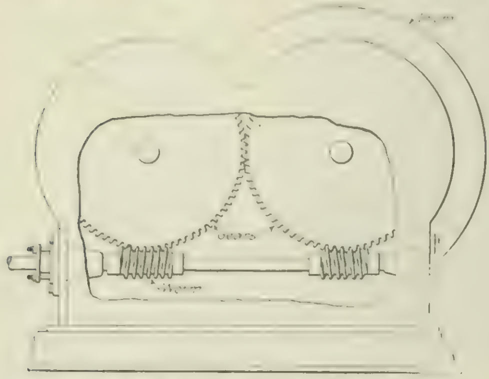


FIG. 5. TANDEM WORM AND GEARS

When the worm is to be taken out for repairs, it is usually necessary to remove it from the front end of the gear case, as the back end will probably be too close to a wall or other obstruction to remove the shaft that way. The counterweights must be landed as explained in the article on "Brake Adjustments," June 29th issue, or the drum blocked, or the car and drum-counterweight cables securely clamped together. The motor is then uncoupled and swung out of the way, after which the brake and brake wheel are removed, the worm-shaft bearing unbolted, and the worm screwed out.

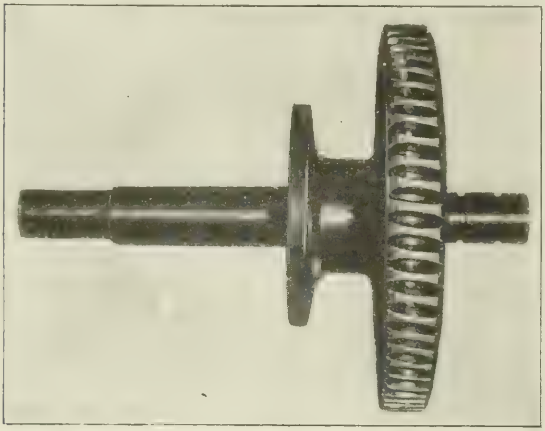


FIG. 6. WORM WHEEL AND SHAFT

When there is a solid brake pulley to be removed from the shaft, it is advisable to use a "puller" rather than to have recourse to hammering. The latter method may cause alignment troubles or possible distortion of the brake pulley and its attendant difficulties. For identical reasons the brake pulley should be pressed on rather than hammered.

To remove a Hindley (spool) worm which, because of its curvature, obviously cannot be screwed out like an ordinary worm, it is probable that removing both gear-case heads will allow the worm to drop sufficiently to be drawn out. Otherwise it will be necessary to jack up the wormwheel. To remove the worm shaft from a tandem-geared machine, Fig. 5, a similar procedure may be pursued. If dropping the heads does not give sufficient clearance to draw out the worm, it will probably give enough clearance between the worm and the wormwheel teeth to allow the so-called idler gear to be raised up on its companion gear, out of mesh with the worm, thereby allowing the worm shaft to be screwed out. There are cases, however, where both gear wheels must be jacked up to allow removal of the worm.

Improving Power-Plant Operation

By J. C. Moran

Many engineers often make a fuss about economy in some parts of their plant while much larger wastes are allowed to exist in other places. In one case that recently came to my attention, the engineer in a large packing plant died and a new man was hired to take his place.

The former engineer had been a bug on boiler and engine efficiency, and everything around the plant was kept spick and span. To the casual observer the plant was the last word in cleanliness and efficiency. The engines were indicated every week, CO_2 analyses were made once or twice every day, an exact record was kept of the amount of water evaporated and of the amount of coal burned, the firemen were well coached and knew their business, and the boilers were kept in fine condition, both on the inside and the outside. The settings were kept airtight, and the individual dampers on each boiler were adjusted so as to maintain the proper draft pressure for every load.

The plant had four boilers of a total capacity of 600 hp., and the coal consumption averaged about 20 tons per 24 hours when the plant was running at normal capacity. There were four firemen, two on each shift.

TRAPS A SOURCE OF UNSUSPECTED WASTE

After the new man had been on the job for a few days, he found that a number of the coils and cooking vats were bled directly to the sewer through a hand-operated valve on the end of the coils or at the outlet from the vats. Generally, the workmen would leave this valve pretty well open and as a result the steam was blowing through constantly, especially when the coils were doing little work and very little condensation accumulated in them.

After considerable argument with the superintendent he finally received permission to buy thermostatic traps for all the coils and vats that were not already provided. These were bought and installed as soon as possible.

While doing some of the work in this connection one day he found that the bypass on one of the traps already installed was wide open. This led to an investigation of the rest of the traps around the plant. To his surprise he found that this condition was the rule instead of the exception with practically all of the traps in the plant.

He got one of the steamfitters to go over every trap in the place and supervised the work himself. There was not a trap in the whole outfit that had a tight valve; in some the floats were collapsed, in others the trunnions on the tilt traps were packed so tight that it was impossible for the trap to move; and in others there was so much lost motion in the operating mechanism that it failed to operate. As a consequence the workmen opened the bypasses and let the steam whistle through, as the simplest method out of the trouble. The condensation in all cases went to the sewer.

While the traps were overhauled and the new ones installed, he connected all the drains to a common return line and connected this to the heater. When all the new traps were installed and the old ones overhauled, they found that the coal consumption had dropped from 20 tons every 24 hours to 17.5 tons. He called the superintendent's attention to this improvement, and the next week he found an extra five-spot in his pay envelope.

Valve and Flange Leaks Stopped

The new engineer did not stop at this. He next turned his attention to the valves around the plant, of which there was a large number. Starting in the boiler room he found that there was hardly a valve in the place that would shut tight; the stems were nearly all in need of packing and were blowing clouds of steam through the stuffing boxes. While going over the valves he also attended to all the leaks in the piping and flange joints and had those covered where the old covering had worn off. In many cases there had never been any covering before, and these pipes were all covered.

He found standard valves on high-pressure lines and cheap valves of the poorest grade on some of the hardest services. Wherever the conditions demanded, he bought the best valves he could get and threw out the old ones. Every valve was gone over, the discs of disc valves were renewed, the gates refitted on gate valves, and seats reground on the globe valves, wherever it was cheaper to repair the old valves than to buy new ones. The stems were repacked on nearly every plant, and every precaution was taken to insure that every valve was tight and would remain so for some time to come. When the job was finished, the coal consumption had dropped to 16 tons.

Pumps a Fruitful Field for Improvement

A large number of pumps were used in the plant for pumping water, oil and lard. The new engineer next turned his attention to these and found them in about the same shape as the steam traps and stop valves. The pumps were in a number of cases located at a distance from the boiler room, and a number of the steam lines were uncovered. The valves in some of the pumps were gone altogether, in others the valve seats were badly worn or scored; the plungers and pistons on the water end were badly in need of packing and in a few instances the steam ends were also in need of new piston rings and refitting of the steam valves, particularly in the simplex pumps with auxiliary valves.

The water-valve seats on all the pumps that required it were reseated with a new machine bought for the purpose. The pistons and plungers were repacked with suitable packing, and the steam ends of those that needed it were sent to a machine shop and refitted. New rods were installed in a number of cases, the old ones being so badly worn that it was impossible to keep them tight. Furthermore, the rods wedged in the stuffing box at each end of the stroke so much in many instances that it almost stopped the pump. Valves with seating rings at the outside circumference and at the center were installed in the power-house pumps and in a number of the others. In the rest new valves of the common disc type were installed, and when the job was finished the coal consumption had dropped to a little over 14 tons.

By means of some more changes in the refrigerating plant, substituting exhaust steam in some cases for processes where live steam had been used before, changes in the motors and lining up of the lineshafts and hoisting gear on the killing floor, the coal consumption was finally cut to a little over 12 tons every 24 hours. At the same time the output of the packing plant was considerably increased over that at the time when the new man first took charge of the plant. In this case the attention to the little things resulted in a saving of approximately $40 per day, or about 40 per cent of the original fuel cost. In addition, in case of necessity the load could be carried on two boilers, and the two firemen on each watch had a "cinch."

In another case the engineer arranged to heat his hot water for the building in the sump, where the condensation and drips from the oil separators, heater and other apparatus were discharged. He utilized the coil from an old closed heater and suspended this in the sump. The hot water for the building was passed through this improvised heater and raised the water temperature from 60 deg. to about 140 deg. and eliminated the necessity of carrying a back pressure on the engines to heat the water for this purpose. This had often to be kept up with live steam during the heating season, because the old water heater was so small that it would not properly do the work at atmospheric pressure, and a back pressure of about five pounds had to be carried both winter and summer. The net result was the saving of nearly a half ton of coal per day during the summer months.

Coal Saved by Overhauling Shafting

In another case a saving of two tons of coal out of a total of 26 per day was made by simply overhauling the lineshafting, adjusting the bearings and putting on heavier belts, that could be run slack and without slipping under the heaviest loads. In another case the simple changing of the belts reduced the coal consumption half a ton per day out of a total of about 10 tons.

In another plant where all but a small lighting unit and a fire pump was shut down over night, a saving of half a ton of coal out of a total of eight every 24 hours was accomplished by a few changes in the piping system so that practically the entire piping system was shut down over night. This eliminated all the condensation losses, leaks through valves and traps and waste from other causes.

In one case a saving of about two tons of coal out of a total of 25 tons per 24 hours was accomplished by installing three friction clutches on an extensive system of lineshafting. The plant was run 24 hours per day, and during a large part of the night the greater proportion of the line shafting was run idle because there was no means to cut it out of service. The friction clutches permitted the various sections of the shafting to be cut out when not in use and eliminated the large friction loss which resulted from the long lines of shafting running idle a large portion of the time.

Pulverized Fuel for Peak-Load Service in Railway Power Plants*

By O. M. Rau

THE Philadelphia Rapid Transit Co. has experienced all the troubles incident to these conditions (burning various coals on the same stokers and grates), as well as the necessity of providing for increased capacity to take care of the growth of its system, which led to a careful study of the problem, and it was found that by purchasing high-load-factor power and generating only peak power, the lowest combined costs would result.

The power costs are approximately 10 per cent of the operating expenses of a traction system, as against 90 per cent for a power company, and therefore are rarely given the careful consideration accorded by the latter.

The combined loads of a traction system and the local electric lighting and power company (less the peaks of the former) will usually increase the economy of the power company's generating system so that the production cost per kilowatt-hour is materially lowered. If this benefit is reflected in the price of power purchased by the traction company, it is apparent that a plant taking care of the traction load only would operate under a disadvantage as compared to a plant carrying the combined loads, and could not produce the power at so low a cost.

With few exceptions power-generating plants operated by traction companies do not produce a kilowatt hour at less than 2¼ lb. of coal, while many of the power plants of the large central stations, particularly when they carry the combined traction and power load of a city, reach a figure as low as 1½ lb. per kilowatt-hour.

TRACTION PLANTS AS PEAK LOAD STATIONS

It is therefore apparent that if the power companies will recognize the value of securing a selected block of the transit companies' load, and adjust the rate so that the price of this power is based on actual producion cost, it would be difficult for the traction company to produce this power at its own plants at such cost. This will leave the existing plants of the traction company to be used as peak-load stations, and as stand-by capacity in case of serious interruptions to the power company's system.

This principle has been applied to the generating system of the Philadelphia Rapid Transit Co. and has resulted in a considerable amount of coal being used for banking, in addition to which the necessity for rapidly bringing the boilers up to proper rating suggested a change in firing, and naturally, oil was considered as the proper fuel under these conditions. Investigation soon developed that the cost of oil (with due allowance for its advantages) at the present prices was prohibitive, and resulted in an extensive investigation as to the possibilities of pulverized fuel. This fuel has all the advantages of oil and is not dependent on a selected grade of coal. These qualifications make a particularly attractive fuel under existing operating conditions.

Before the war, when coal contracts on specifications were possible, and selected coal, particularly suited for the furnace equipment was obtainable at a satisfactory price, there was no corresponding advantage to offset the additional cost of pulverizing the coal. This situation has changed. The cost of coal has increased to such an extent that every opportunity to reduce this item of expense must be taken advantage of, and particularly does this apply to the public utilities, which have been unable to add the increased cost of production to their price of service.

The work now in progress by the Philadelphia Rapid Transit Co. consists in equipping its Mt. Vernon power plant, having a rated capacity of 10,000 kw., with a complete milling and burning installation. The plant consists of 20 hand-fired water-tube boilers of 375 hp. each, and five 1,500-kw. d.-c. direct-connected cross-compound engines with two 800-kw. d.-c. exhaust steam turbines. This plant uses anthracite coal to avoid the smoke nuisance. During normal times buckwheat coal such as used by this plant sold for not more than $3 per ton delivered, and while the economy was not equal to that of the large turbine plant, the production cost per kilowatt-hour, taking into account transmission and conversion losses and investment in substation, made the cost of the output from this plant compare favorably with power from any other source.

PULVERIZED FUEL ADOPTED

With the increasing cost of material and labor, it soon became apparent that this plant would have to be abandoned or improvements made to reduce operating expenses. The labor cost became excessive, and automatic stokers were contemplated, but with the increasing price of anthracite fuel this improvement was not considered economical, and it became evident that the most efficient use of this plant would be for peak-load service, which means its operation from three to four hours on the morning and evening peak.

Under these conditions of operation the cost of banking fires, as before noted, became of considerable importance, and consideration was given to the use of pulverized fuel, with the result that this method of firing was adopted.

The installation will consist of a six-ton per hour milling plant installed in duplicate to give continuous service; a weighing and conveying system, so that accurate records can be kept of the amount of coal delivered to each boiler; and a furnace equipment consisting of feeders and burners. This equipment is being installed by the Quigley Furnace Specialties Co.

This plant is designed to burn anthracite culm or "river coal." The company controls a supply of 2,000,000 tons, and it will no doubt be the principal supply of fuel for this plant, although other grades or bituminous coal can be utilized equally as efficiently. River coal will be received by rail at one of the storage yards, delivered by trolley to the receiving hopper at the plant, and conveyed to a 100-ton bin over the drier, the latter being of extra large capacity to take care of any excess moisture, although specifications limit this to 8 per cent. From the drier the coal is conveyed to the dry-coal bins above the pulverizers and thence by screw feeds to two high-side Raymond mills capable of reducing three tons of dried coal per hour to a powder having a fineness of 95 per cent through a 150-mesh seive. These mills are of the air-separation type and therefore convey the powder as fast as pulverized to the elevated pulverized-fuel bins, from which the fuel feeds by gravity to the conveying tank. This tank is balanced on a scale and equipped with a compressed-air conveying system, so that the pulverized fuel, after being weighed, can be conveyed in any quantity up to the capacity of the tank to the boiler hoppers, of which there is one in front of each boiler, connected with a valve on the conveying line. The fuel, after being weighed, can be delivered to any one of these hoppers.

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*From a paper before the Pennsylvania State Railway Association.

The feeding and burning equipment consists of two screw feeders attached to the bottom of each boiler hopper. The pulverized fuel falls into the feeder by gravity, controlled by an adjustable gate, and is fed into the burners where it mixes with the required amount of primary air to carry the pulverized coal into the mixing chamber where the necessary auxiliary air for proper combustion is added as the fuel enters the furnace.

CAN USE CHEAP COALS

This installation will allow the use of any of the cheaper grades of coal or mine refuse from the anthracite districts, or from the soft-coal fields. The labor cost in the boiler room will be considerably below that required for automatic stokers, while the maintenance expense of the burning equipment will be low. It is estimated that furnace maintenance will compare favorably with either hand or stoker firing. The principal items of expense will be in the milling plant. These, however, should be a direct charge to the fuel expense.

The installation of this plant is not yet entirely finished, and therefore no operating data are available at this time. It is estimated, however, that the cost of fuel delivered in the boiler room, including operating expenses, maintenance and fixed charges will not exceed $3.50 per ton, as compared with $5.40, the cost during 1919, which figure would no doubt be considerably higher during 1920.

The saving of fuel during banking periods, according to careful estimates, will amount to not less than 3,000 tons per annum. Experience with boilers fired with pulverized fuel indicates that the heat losses during nonoperating period are slight. The steam pressure during a 24-hour shutdown of a boiler fired with pulverized fuel recorded a drop of 5 per cent. This is primarily accounted for by the fact that the furnace can be completely sealed, allowing no air to circulate through the boiler. The total saving to be effected by this installation, it is claimed, will pay for the improvements within two years.

Arca Pressure and Temperature Regulator

A regulator that operates in a different manner from other instruments designed for like purposes is a Swedish invention known as the Arca Regulator, which is being marketed in this country by the American Galco, Inc., Grand Central Palace, New York City.

This regulator depends for its operation upon water under a reasonably constant pressure, between 15 and 90 lb. Unlike most other regulators it operates a globe valve of the usual type by means of a sprocket and chain. The valve is opened in one direction by a piston sliding in a cylinder to which the water is admitted by means of a special piston valve. The valve is closed by a weight when the water is released from the cylinder. Fig. 1 shows the piping and application of the regulator, when used to control the flow of steam and the pressure through a pipe, or a vessel, etc.

A relay *A* is connected to the pipe or vessel in which the pressure is to be kept constant and operates on the slightest variations, and on account of the use of a globe valve and a motive piston of long travel, very smooth operation is obtained.

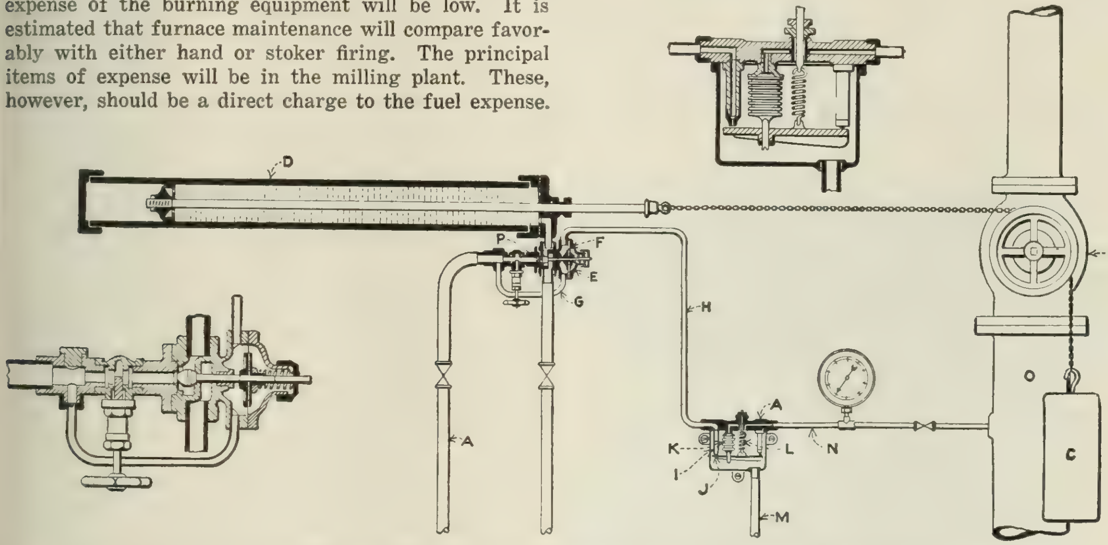


FIG. 1. APPLICATION OF THE ARCA REGULATOR WHEN USED TO CONTROL THE FLOW OF STEAM

The relay, which is the heart, so to speak, of the regulator, is extremely sensitive, and produces close regulation no matter what the fluctuations are on the high-pressure side or the variation in the demand of steam on the low-pressure, or regulated, side.

The globe valve *B* is controlled by a sprocket and a chain supporting a weight at one end. The other end is fastened to a piston operating in the cylinder *D*. Water under at least 15 lb. pressure, moves the piston and sprocket in one direction. When the discharge in the membrane valve *E* is opened, the weight moves the piston in the opposite direction, forcing the water out of the cylinder, and at the same time turns the sprocket of the valve *B*. The valve *E* is moved in one direction by a spring acting on one side of the diaphragm *F* and in the opposite direction by the water under pressure passing through on the other side of the diaphragm.

The water flows through pipe *G*, the diaphragm chamber and the pipe *H*, discharges through the nozzle *I* of the relay. The discharge of the nozzle is controlled by the disk or cup *J*, on a lever that is forced away from the nozzle by the pressure inside a metal bellows *K* or toward the nozzle by a spring *L*. The waste water from the nozzle runs off through pipe *M*. The inside of the metal bellows communicates through the pipe *N* with the low-pressure pipe *O*, where the pressure is to be controlled.

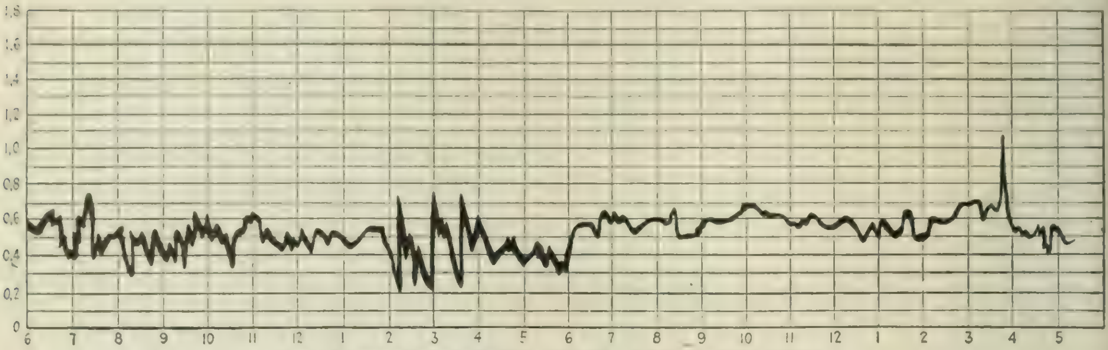


FIG. 2. STEAM-PRESSURE CHART, HAND REGULATION

The action of the regulator is as follows: If the pressure should drop in the low-pressure pipe *O*, the spring will move the arm and disk *J*, toward the nozzle , thus reducing the flow of water from the nozzles. his will cause the pressure to build up under the iaphragm *F*, thereby moving the valve piston *P* and dmitting water to the cylinder. The cylinder piston will be pushed in or toward the left and the weight will be lifted and at the same time the valve *B* is opened. The movement continues until the pressure is reestablished in the low-pressure system.

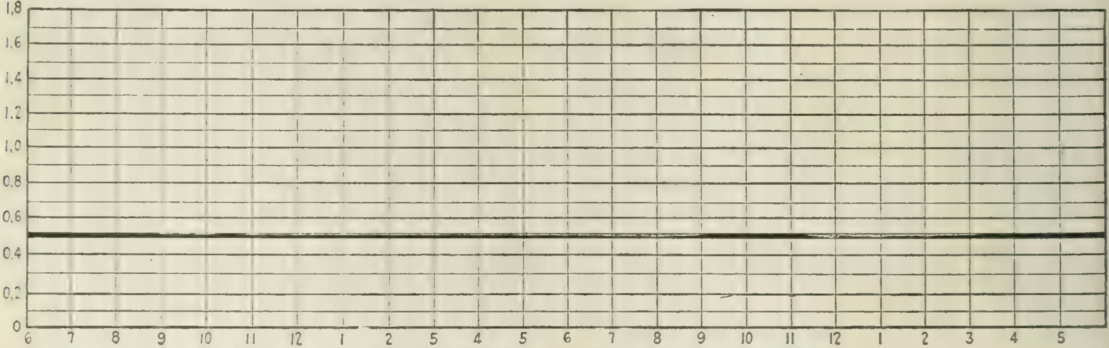


FIG. 3. STEAM-PRESSURE CHART, ARCA REGULATION

In case the pressure in the pipe *O* should rise, the pressure in the bellows *K* will increase and the lever *J* will be forced away from the nozzle *I*. The water will then flow out more freely, causing a pressure drop under the diaphragm *F*. The spring on the diaphragm will therefore move the valve piston *P* and connect the cylinder *D* with the discharge pipe *R*. The weight will immediately drop and move the cylinder piston, forcing the water out of the cylinder and closing the valve *B*. By adjusting the tension of the spring opposing the action of the bellows, the low pressure may be maintained at any point.

Valves are located in the various pipe lines for the purpose of regulating the speed of the action. The regulator is suitable in any case where a reducing valve or regulator is required. Figs. 2 and 3 show steam-pressure regulation charts of paper-machine driers. Fig. 2 shows the variations due to hand regulation. Fig. 3 was produced with the regulator controlling the steam delivery.

The regulator is also adaptable for controlling the temperature of drying chambers, hot-water tanks, etc., by using a different design of relay from that shown in Fig. 1. This relay, Fig. 4, consists of a nozzle *A* and a glass tube *D* incased in a tube *C*. The connection *E* connects to the space above the diaphragm of the membrane valve *E*, Fig. 1, and is for discharging whatever water passes through the nozzle *A*. This inclosed tube is so sensitive to changes in temperature that the regulator can be made to operate by merely applying the hand to the tube casing.

Its operation is as follows: With an increase in temperature above a predetermined point the brass is elongated more than the glass rod and this brings the lever *B* nearer to the nozzle seat. This action suppresses the flow of water, building up a higher pressure on the diaphragm in the membrane valve, thereby moving the valve piston and admitting water to the cylinder. The cylinder piston will be pushed in and the weight will be lifted, at the same time partly closing the main valve in the pipe that is supplying steam for the heating.

When the temperature has become stable, the discharge of water from the nozzle *A*, Fig. 4, is increased and the movement of the cylinder piston plunger is stopped and remains in that position until another change in temperature takes place.

If the temperature drops, the nozzle opening is increased, which reduces the pressure on the diaphragm in the membrane valve and connects the port in the cylinder *C* with the water outlet pipe (Fig. 1), letting water out of the cylinder. This action makes it possible for the counterweight to act, pulling out the piston in the cylinder *C*, at the same time opening the valve *B*.

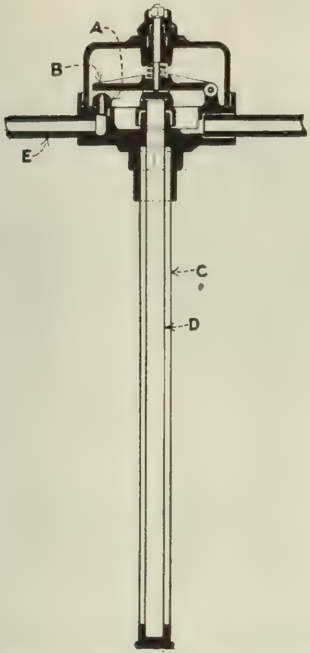


FIG. 4. SECTION THROUGH TEMPERATURE RELAY

Very low air and gas pressure is controlled in a similar manner, acting on a diaphragm of large area compared with that of the nozzle outlet, thus controlling the discharge of water through it and in so doing regulating the travel of the regulator piston. Thus the air admitted to, say, a boiler furnace could be controlled by either reducing or increasing the speed of the fan.

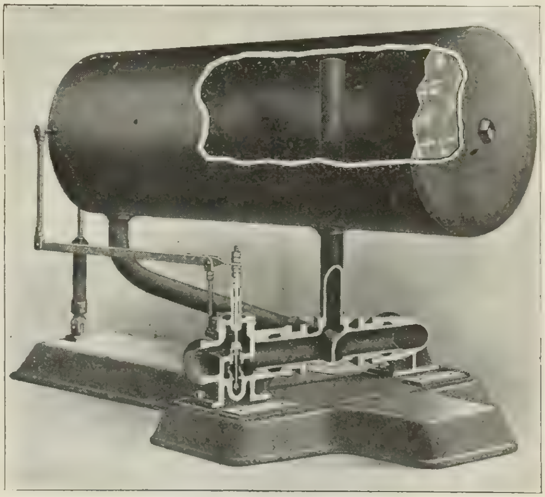
It would seem that this device is suitable for controlling any apparatus that depends upon a difference in either pressure or temperature, as for instance, the speed of a stoker drive, also forced-draft fans, etc., as well as the dampers of hand-fired boilers.

Ellis Tilting Steam Trap

A tilting steam trap of simple design has been perfected by the Ellis Drier Co., of Chicago. It was originally developed for use with the company's grain-drying equipment and proved so satisfactory that it is now being offered for general use as a direct-return, lifting, vacuum or separating trap. The principles of operation are much the same as in other traps of this type. Water of condensation runs into the receiver tank through the trunnion, shown in the accompanying illustration, the tank being in a horizontal position while filling. When sufficient water enters the tank to counterbalance the weight, placed in this case within the tank between a double head, the tank tilts, opening the valve shown, allowing steam to enter the receiver through the vertical pipe and forcing the condensation out of the trap. As soon as the water is discharged, the counterweight brings the tank back to the horizontal position.

A distinguishing feature simplifying the mechanism is the placing of the counterweight within the tank head. This is done at the factory, and as there is neither external lever nor sliding weight, the new arrangement prevents tampering with the adjustment, which might interfere with the proper operation of the tap. It is claimed also that the new location of the counterweight produces rapid tilting action. When the trap begins to tilt, the center of gravity of the counterweight moves forward as it swings through its arc. This shortens the counterweight level arm, which in conjunction with a longer leverage at the other end of the trap accelerates the tilting. With the tank returning to the horizontal position, the opposite action takes place. The center of gravity of the counterweight moves outward, lengthening the lever arm and causing the receiver to swing quickly to place. This rapid action increases to some extent the capacity of the trap.

Other features are a shock absorber consisting of two tempered springs, shown at the left of the illustration and a relief valve attached to and below the steam valve. It is always open when the trap is filling and, as it moves with the steam valve, is closed when the latter is open. The tank is made up of a special iron to resist corrosion. It has welded seams and before shipment is tested under a hydraulic pressure of 450 lb. The ends of the trunnions are faced and turn in removable brass bushings to eliminate binding should the trap get out of level. The trunnion is made of manganese bronze, nickel-plated, so that the glands may be pulled tight and still allow turning with a minimum of friction. The construction is substantial and the operation rapid.



ELLIS TILTING TRAP

The trap is made in seven sizes for working pressures up to 175 lb. and for capacities ranging from 1,800 to 18,000 lb. of water discharged to the boiler per hour.

Employer's Duty Concerning Boilers

The United States District Court for the Eastern District of Virginia in a recent hearing on a boiler-explosion case, defined the duty of an employer who operates a steam boiler to inspect it regularly and keep it in safe condition. Failure to do this renders him liable for resulting injury to an employee.

The claimant in this case was awarded damages for injury sustained as the result of a tube of a dredge boiler blowing out. The fireman on the dredge had been told by the fireman on the preceding shift that the boiler was leaking. He immediately advised the chief engineer and an investigation was started. The former opened the furnace door to point to the leak, which was at once seen to be a serious one, and an explosion almost instantly occurred, blowing the tube out and seriously scalding the fireman.

The court decided that the employer did not fulfill his duty by merely furnishing a reasonably safe place in which to work, but contended that his duty involved proper inspection and maintenance to the end that the boiler would remain in a reasonably safe condition.

Induction Motors Operating at 18,000 R.P.M.

A new application of the high-speed induction motor to certain classes of machine drive has been made possible by the development of an induction frequency changer by the General Electric Co. This device generates power at frequencies that will produce speeds of 18,000 r.p.m. or higher, and as a result high-speed induction motors can be directly applied to various types of machines, eliminating belts or gears with their disadvantages.

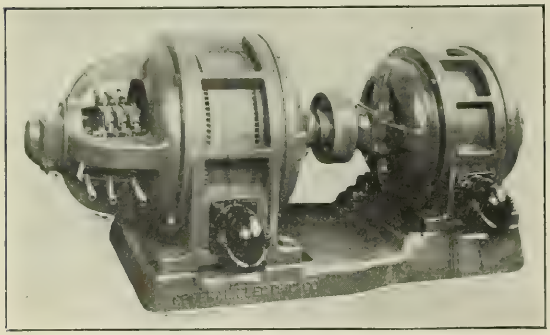


FIG. 1. FREQUENCY-CHANGER SET

The frequency changer, shown in Fig. 1, consists of a wound-rotor type induction motor, the stator of which is connected electrically to an alternating-current source of power. By rotating the machine in a direction opposite to that in which it would run as a motor, frequencies are generated in the rotor equal to that of the exciting circuit plus that due to the reversed rotation of the rotor.

Practically all the energy taken from the commercial circuit is transformed into high-frequency energy, the over-all efficiency being approximately 90 per cent. Where direct current only is available, an inverted rotary converter can be used both as a motor to drive the frequency changer and supply the excitation for the stator. The high-frequency supplied by this device being always three-phase secures uniformity as well as economy and simplifies both the motors and the frequency changers. The most economical sets are those having driving motors directly connected to the frequency changers, as in Fig. 1.

The high-speed motors used in connection with these frequency changers are constructed the same as the small standard squirrel-cage motors, having rotors of the cast-alloy type, Fig. 2, and are very compact. In the construction of the rotor the punchings are held securely in place and the slots completely filled with cast alloy. In the stator the windings are thoroughly impregnated with moisture-proof insulating compound which acts further to prevent movement of wires and unites the end turns into a solid mass which readily dissipates the heat that is generated in the interior of the winding.

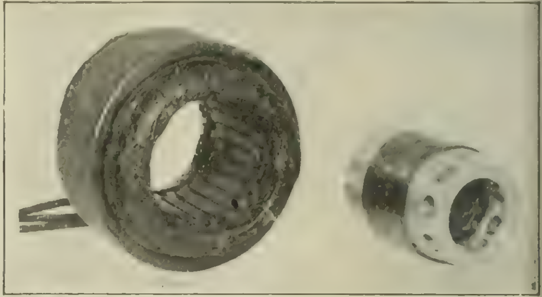


FIG. 2. STATOR AND ROTOR OF 1-HP., 12,000 R.P.M. INDUCTION MOTOR

The standard motors are two-pole and wound in two series, the first rated normally at 120 cycles 220 volts, the second at 200 cycles 110 volts, to operate at a range of from 200 to 300 cycles. The operating voltage of the motors must vary in proportion to the speed and frequency, but this change is accomplished automatically by the frequency changer. The normal slip is from 5 to 7 per cent, but where the load is such that the starting torque is the factor in determining the size of the motor, it can be increased by increasing the slip to 8 or 10 per cent, although such changes are objectionable if the motor must carry full load. Successful applications have been made with speeds ranging from 7,200 to 12,000 revolutions per minute.

* * *

An investigation of the activities of associations of producers of soft coal in the matter of exchanging reports of prices on sales is being undertaken by the Department of Justice. In connection with this investigation a letter was sent to all secretaries of local associations calling attention to the recent decision of the United States District Court at Memphis, Tenn., condemning the interchange of reports as to prices received on actual sales as practiced by the members of the so-called "Open Competition Plan" of the American Hardwood Manufacturers Association.

* * *

The area of grate surface is important, as it is one of the determining factors for proper combustion. The ratio of grate area to the boiler-heating surface will vary from 1 to 35 to 1 to 65, depending on the nature of the fuel and the manner in which it is fired.

EDITORIALS

Coal

IT TOOK the war and its after effects to bring home to the common people the extent to which the civilized world has come to be dependent upon fuel. They have suffered from the scarcity and want of it not so much in actual discomfort from cold in their homes, although this has been near enough to awaken apprehension and to require especial effort and urgency for its avoidance, as from the interruption to their employment, the deprivation of conveniences, the confusion and delay in transportation and the soaring price not only of fuel itself, but of everything into the production and transportation of which fuel enters. The man who, in thinking of fuel, had never got beyond his own cookstove or furnace, has been impressed in a most convincing way of its social-economic importance. It is as though a community, suddenly made conscious of the possibilities and evils of a drought, was just beginning to realize the importance and necessity of organizing its water supply upon a permanent, safe and systematic basis.

The well-being of the people is too intimately dependent upon a cheap and dependable supply of fuel to longer leave its procurement and distribution to the erratic machination of those whose acknowledged aim is to exact profit from rather than to expedite its handling. Any fair-minded person is willing to see the capitalist receive a fair interest on the money that he has actually and necessarily invested, but we are not altogether without sympathy with those who resent the inclusion in their coal bill of interest on the money paid for vast coal tracts to keep them out of the hands of possible competitors and preëmpt them for exploitation in the distant future.

Any fair-minded person wants to see labor involved in mining the coal and in its preparation, transportation and distribution generously requited, and he wants to see the man with the initiative and enterprise and ability to organize and conduct this production and distribution make a fair profit. He knows that the bulk of the discovered coal of the country is in the hands of a combination and that he has to pay for what he needs of it a whole lot more than it costs to mine and transport it. He is not fooled by the statement of kept-lady accountants that most of the coal companies are run at a loss and few make more than a very moderate profit, and he chafes under the impotency of a Government which permits such exploitation of a common resource.

When coal was necessary for the national defense, the Government saw that it was mined, and notwithstanding all the inspired cussing which the Government administration of the railroads got, it distributed the coal (and tons of slate and stuff that was sold at coal prices) at a time when mobilization and mass production were putting a greater stress upon the railroads than ever before.

Nationalization of national resources is looming big on the horizon. If the coal producers are not able and willing to organize their industry so as to produce a dependable supply and get it to the people at necessary cost plus a fair profit, the people will do it themselves. And it is up to the "private ownership" that took on so grievously about the maladministration of the railroads by the Government to demonstrate that it can do at least as well as the Government did under all the stress of unpreparedness and war conditions.

Engineering Articles

THE publication in the July issue of *Mechanical Engineering* of a paper by Messrs. Hampton, Leh and Helmick renews attention to the efforts of the American Society of Mechanical Engineers to encourage the younger engineers to prepare papers on engineering subjects. The society maintains a fund, contributed by one of its members, the income from which is used for prizes to be awarded each year for the best papers on mechanical-engineering subjects by junior members or by student members.

One of the most useful functions of the professional engineering societies is in affording an opportunity for the presentation and discussion of papers dealing with technical affairs. At the same time one of their great problems is to induce engineers to prepare papers measuring up to the standards set by the publication committees. The engineer, especially the one who is most capable of producing the highest-grade article, is often reluctant to put his ideas on paper. If the habit of writing is once acquired, however, it is likely to stick. In offering prizes to student and junior members the society hopes to aid in forming this habit among the younger engineers and so gradually build up a group of men always ready and able to present their ideas and experiences in a simple understandable style to the society and through the society to the engineering public.

Critics of the plan have argued that it would bring out a great mass of papers varying from the only passable to the really worthless. Undoubtedly, this is true. Probably the majority of the material submitted to the committee is poor—much of it very poor. It is also true that there is a great deal of stock, husk and cob grown in order to produce the grain on an ear of corn, but nobody suggests that as a reason against raising corn. It is also true that the stock and husks and even the cobs have some value, and in the same way the poorest of the papers submitted has some worth. The mere action of trying to set down his ideas is good training for the author, if nothing else.

While the prizes referred to can be given only to those connected with the society, there is a field for engineering articles, large or small, "high-brow" or "low-brow," that is open to everybody. That field is the engineering press. It is the great clearing house where ideas are exchanged between engineers, whether they belong to any society or not.

Every man who hopes to succeed must continue to learn more about his business, and one very good way to learn is to read. Before a thing can be read, however, somebody must write, and in a field as subject to change as modern engineering there is always something new to write about. It is the obvious duty of every engineer whose experience has furnished something new or interesting to write it for the benefit of other engineers. A few misspelled words or a little faulty grammar does not harm. It is the editor's job to look after that. The story, the idea, must come from the engineer, the man out on the job who has met and solved, or tried to solve the problem he writes about. There is money in it for the writer, putting a thing on paper is an education, and the thought of having added something to the general knowledge is a very pleasant sensation.

Try it.

Do Society Elections Foster Indifference?

OUR contemporary, *Engineering and Mining Journal*, in a recent editorial struck a pertinent note when it criticized the procedure of the Harvard Engineering Society in the election of its officers. Although a letter ballot is employed, a single ticket is prepared by the nominating committee and the membership, or at least those who take the trouble, exercise their prerogative of voting by registering approval of the committee's choice.

But why single out the Harvard Society, when the practice is followed also by several of our national engineering societies, including some that acclaim with pride that they are conducted along broad democratic lines?

In refutation it will be pointed out that any member has the option of writing on the ballot his choice for an office, but such scattered votes never mean anything and it is well known that the privilege is seldom exercised.

It is readily conceded that a nominating committee is essential in any large body and that such committees usually make an honest effort to put up a representative ticket. But the principle is wrong. Where a single ticket is nominated, it renders the ballot a farce and is equivalent to the members delegating their proxies to the committee, which might better be termed an election committee and much time and postage saved thereby.

Were the question put up to an open meeting in any of the societies, it is likely the members would insist on at least two candidates for every office regardless of whether there happened to be any issue at stake upon which the candidates represented opposite views.

Complaint is sometimes heard of a prevailing tendency for those in the saddle to commit the membership to various projects and assume that approval will be forthcoming. While it is always necessary that the initiative be taken by a few if progress is to be made, and equally true that a large percentage of the membership usually views the activities with indifference, still it is just such things as the single ticket that foster this indifference.

The strength and influence of a society is not measured by its numbers, but by the interest and activities of its members, and in these days when there is so much said about bringing the engineer to the front, it behooves the societies to use every means to attract and hold the interest of its members individually and collectively.

Send Us Copies of Your Log Sheets

THE high cost of everything that enters into the generation and transmission of power, particularly the prices of coal and the difficulty to get as much as wanted, whatever the grade, make record keeping of power input and output more vital than ever. Of course, writing down the weights of coal and water, the various meter and thermometer readings, the hours this pump and that engine were kept running do little real good if the log sheets are not made use of, if this day's or month's performance is not checked against yesterday's or last month's so that the trend of unit performance may be made known.

We have received many requests for copies of power-plant log sheets, such as daily reports, etc. Our reply to everybody making such request has been that in the first place we did not have any, and secondly, that a log sheet is really of best service when drawn up for the specific plant in which it is to be used. We have not changed our minds about this. But the demand for such sheets seems to warrant publishing a few so drawn up as to include all chief essentials, to apply generally to most plants and, above all, to be in such form as to encourage their use after being filled out.

That we may have the advantage of incorporating all the best features of many logs in the sheets that we hope to publish we are asking that our readers send a copy of each of their forms, that we may study them. These forms should come from all kinds of plants—steam, gas, water, electric and refrigeration. This is a simple, easy way for you to perform a service for your many fellow engineers. We hope for a hearty response to our request.

W. C. Albritton, of Savannah, Ga., is suffering from an attack of perpetuum mobile. It has been five years developing. He has got by the model stage and is undergoing that phase of the malady in which the victim is convinced that his idea will work if it can be tried out upon a large enough scale. The next stage is to unload stock, and its duration and virulence is dependent upon whether the inventor is really the victim of a delusion or just a simple crook. The collapse comes when the idea, if there is really one behind it, is given a fair trial, or when, impatient at his failure to make good, his disappointed stockholders proceed to run the victim out of town.

Elsewhere in this issue, Peter Neff, well-known refrigerating engineer, makes the suggestion that such bodies as the American Society of Refrigerating Engineers issue refrigeration tables and standards that can be used by all, based upon the latest available data. He adds that the manufacturers of refrigerating machinery might assist in the distribution of such literature. It surely would be greatly appreciated by engineers if there was one central source from which they might get such data.

In view of the fuel shortage, good news comes out of Wyoming and Montana. These two states are giving most encouraging yields of petroleum, where production so far is considerably higher per acre of tapped field than in the Mid-Continent and Appalachian regions.

CORRESPONDENCE

Why Not a License Law?

It seems to me that many boiler explosions could be avoided if proper laws were made and enforced. For instance, the laws of New York State, what few there are, are very slack as to the manufacturing and inspecting of steam boilers, and especially so in the qualification of operators. For example, a certain position was vacant that always had been and should have been filled by an engineer who had taken the civil-service examination. A time was set for this examination and at least four tried for it, but before the time for the appointment arrived politics stepped in and a man was appointed that had no practical experience in the engine or boiler room.

I think it the duty of every engineer to insist upon having a strong license law and try to live up to it. As a suggestion, why not appoint three practical experienced men to hold examinations in the largest cities of the state, say once or twice a year, and compel every man who wishes to handle a boiler in any way to obtain a license? Also pass a law making it a criminal offense to hire anyone that has not been examined and passed at least a 75 per cent examination.

Regarding the examination, there are many good operating engineers who are not college educated, and when they come before an examining board, they are unable to write out the simplest parts of their knowledge. Others can put more on paper than they really know. I therefore suggest that a verbal examination be given in connection with a written one.

Some manufacturers build boilers in any old way to carry any old pressure. Some years ago a boiler was desired for a sawmill. The owner went to a boilermaker of good reputation, but his price was too high, and as the purchaser would pay only a certain sum for a certain size of boiler, he was referred to a certain manufacturer who might build him a certain size boiler for a stated sum. This was agreed to and all other specifications were left out. The boiler was delivered and was put in use during the early part of December and was fired steadily until the later part of April, when it was dropped off at intervals of about one day a week during the summer.

In November I chanced to be in the boiler room one morning when there was about 20 lb. of steam. I called the owner's attention to water coming from around the head of a staybolt. He started to calk it, and the tool was driven through the sheet with the first tap. The fire was drawn, and on examination we found about twenty pits nearly through the sheet.

The only reason ever given as to why this boiler deteriorated as it had in eleven months was that soft rainwater was used, and that this had caused the pitting. But I have always thought that the sheets in that boiler were made of mighty poor material.

The Rockport explosion described in the Jan. 6 issue ought to be a lesson to both owner and operator. According to the information contained in the article, there is no doubt that an overpressure caused the accident, but had the safety valve been free to operate, this calamity would doubtless have been averted.

Syracuse, N. Y. M. E. WEBBER.

Water-Test Pressure on Handhole Gaskets

Regarding the answer to the question on "Water-Test Pressure on Handhole Gaskets," I wish to state that I have seen cases where full working pressure was pumped up on the boiler and the gaskets blew out when the boiler was put under steam. That, however, was due to a poorly designed handhole plate. This trouble is more often evident with cast-iron mud drums which do not have a true surface on the inside, and with pressed-steel handhole plates which do not provide wide enough gasket bearing. This trouble is overcome by substituting cast-iron plates with detachable bolts.

One objection to the pressed-steel handhole plates, such as I have used, at least, is that the ledge for the gasket to rest against is rounding and if the gasket makes a start it pushes out. With the cast-iron plates having a square ledge for the gasket to rest against, it can not blow out. E. G. HOPPE.

Cairo, Ill.

Steam-Turbine Has Record Run

In the article "Steam Turbine Has Record Run," page 809 of the May 18 issue of *Power*, it is stated that the machine made a world's record by continuously running 84 days, 11 hours, 36 minutes.

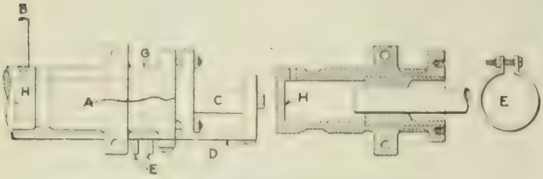
Records on a 1,000-kva. turbine generator at the power plant of the United States Coal and Coke Co., at Gary, W. Va., show that this unit ran 117 days, from June 18, 1919 to October 13, 1919, without a shutdown. During the run the output of the machine was 1,734,700 kw.-hr., or an average of 611 kw. per hour, the load ranging from 200 kw. to 1,300 kw.

The turbine is a single-flow reaction type, running 1,500 r.p.m. and connected to a common bus, serving a mine motor load. It was installed in 1906, and with the exception of two cases of trouble on the generating end and regular periods of inspection and minor repairs it has been in almost continuous service.

Gary, W. Va. E. WOODSON.

Making a Repair to a Cracked Hydraulic Cylinder

A crack about ten inches long developed in the cylinder on a retort press, the construction of which is shown in the illustration. The fluid, under 500 lb. pressure, is admitted through the pipe *B* and pushes the ram *C* outward. There is a similar ram in the other end of the cylinder (not shown), and the two are connected by the member *D*, which carries lugs *E*. The cylinders are separated by the wall *H*.



CRACKED PORTION OF CYLINDER BUSHED

The fracture is shown at *A*, and in due time it opened up to such an extent that the press was useless. The cylinder was removed, placed in a lathe and enough stock bored out to allow about an inch larger diameter than the stuffing box and deep enough to go to the end of the crack *A*.

A bushing was made, the cylinder heated good and hot and the bushing driven into place. When the cylinder was cool, the bushing was bored to a running fit to the ram and counterbored for the stuffing box.

A groove was then turned around the cylinder as shown at *G*, so as to allow room for a draw band under the member *D*. A draw band was made, shaped as shown at *E*, and, while hot, placed around the cylinder and drawn up as tight as possible.

There was a slight leakage at first on account of there being no material available to make the bushing quite long enough to cover the crack past the end, but it soon took up and the cylinder has been doing service for several months. A new one was ordered, but as long as the old one does at well as it has been doing, it is not likely that it will be put on. P. EARL.

Detroit, Mich.

Cleaning Apparatus for Generator Windings

In the June 1 issue of *Power* F. C. Williams described an apparatus made and used by him for cleaning the windings of motors and generators. I have seen a similar apparatus used around an automobile garage for cleaning parts, and while in charge of a large power plant the chief electrician at my suggestion made and used a similar device. In this particular plant large gas engines were the motive power and salt water was used for cooling the jackets and exhaust manifolds. It was impossible to keep the manifolds tight enough to prevent a small amount of salt vapor from escaping into the engine room, where it was drawn into the generators, and eventually there would be a deposit of salt all through the windings, and it was this deposit that the device was used to remove.

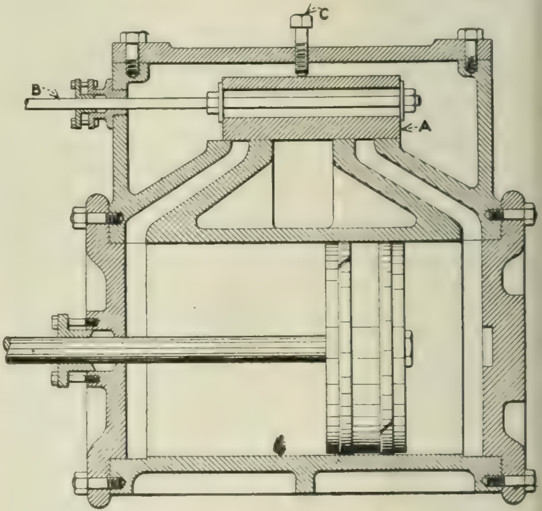
One machine had been cleaned successfully, and the electricians, three of them, were working on the second. They had it well soaked up and the work was progressing nicely when there was a loud roar and that generator and two of the men were a mass of flames, which resulted in three or four men being very seriously burned, and one probably crippled for life. The fire in the generator could not be extinguished until the gasoline had mostly burned out of the windings, and only the fact that the machine was bar-wound and mica-insulated saved it from being ruined. This should serve as a warning to anyone that contemplates the use of a device of this description to be sure that there is no open flame at any place in the building, before turning it on. The vapor thrown is almost as explosive as powder and it only needs a spark to set it off.

In this particular case there was, away over in the corner of the plant, an innocent little gas flame that every one had forgotten, used to keep an oil tank warm, but it got in its deadly work and the great wonder is that there was not loss of life and property. This is not meant to criticize Mr. Williams' device. It is efficient and will do the work, but every precaution should be used in regard to open lights or sparks in the same room. EARL PAGETT.

Cherryville, Kan.

Refacing a Slide-Valve Seat

A method of refacing the seat on which an ordinary slide valve operates is to make a steel block *A* the size of the valve and drill a hole through it in which to fit the valve stem *B*. One side of this block is cut like a file. It is then tempered and fitted to the rod *B*. Then fit lengthwise across the steam chest another iron plate 2 in. wide and ½ in. thick, having a screw hole in which to insert the screw bolt *C*. This plate is held in place by means of the steam-chest cover studs and nuts.



RIG FOR REFACING VALVE SEAT

With everything in place and a slight pressure exerted on the plate *A* by the screw *C*, move the plate *A* back and forth by means of the rod *B* until the seat is true. HAARBAND SINGH.

Lahore, India.

Trouble with a Loose Piston Head

An engineer located a pound in the high-pressure cylinder and upon examination found that the piston had worked loose on the rod, the piston having been forced on a taper, leaving a clearance between the face of the piston and the nut, as shown at *A*, Fig. 1. A washer was inserted between the face of the piston and the nut; the latter was then secured in place with a pin *B*.

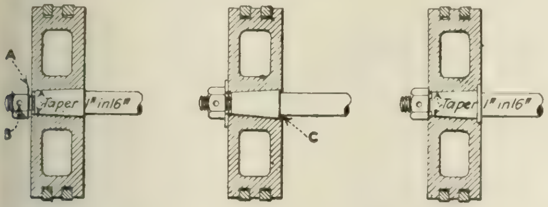


Fig. 1. Fig. 2. Fig. 3.

FIGS. 1 and 2. CONDITION OF OLD PISTON ROD. FIG. 3. A SUGGESTED IMPROVEMENT

All went well for a short time, and then the pounding suddenly developed again. An examination showed the piston had been forced onto the taper of the rod until the face of the piston overhung the end of the taper, as shown at *C*, Fig. 2. The situation was now serious, due to the close piston clearances. The makers were consulted, and they suggested that the cause was due to water in the cylinder. The piston was sent to the works, and after an examination it was decided to rebore it to a taper of 1 in. in 8 in. (the original taper being 1 in. in 16 in.) and to fit in a new piston rod. The piston was to be heated in a steam oven that was subjected to a pressure of 240 lb. per sq.in. and to be put on the rod in this heated condition and the nut screwed home. This was done, and after the piston had cooled down the nut was again tested for tightness and secured with a pin.

The engine has been in operation for some time and no further bother has been had with a loose piston.

The questions that arise are: Was the taper of 1 in. in 8 in. correct for this design of piston, seeing that the piston-rod taper has no shoulder for the head to press against? Was any material advantage gained by steam heating the piston head? Would it not have been better to have formed a shoulder at the end of the taper of the new piston rod to rest against, recessing the piston to suit, as shown as *D*, Fig. 3, leaving the bores, 1 in. in 16 in., intact? THOMAS W. AIREY.

Gainsborough, England.

Growth of Internal-Combustion Engine Horsepower

We read with considerable interest an article by Prof. L. W. W. Morrow in the June 8 issue, entitled "A Study of Power Development and Suggestions for Future Progress." We are inclined to believe, however, that the data presented in Fig. 3 referring to internal-combustion engines is not correct.

We do not know, of course, what sources of information the author had in preparing this chart, but according to it from the year 1913 to 1920 the horsepower of internal-combustion engines increased approximately 300,000, or an average of 45,000 hp. per year. This figure is certainly too small, as in one industry alone—the extraction of gasoline from natural gas by the compression process—more than this total horsepower is being added yearly.

There are other fields, such as blast-furnace operation, where large units are being added from time to time. For example, the Lackawanna Steel Co. has completed the installation of five Mesta gas blowing engines which alone would account for nearly half of the total horsepower allowed by Professor Morrow.

ALWIN SCHALLER, Gen. Mgr.,
Wellsville, N. Y. McEwen Bros.

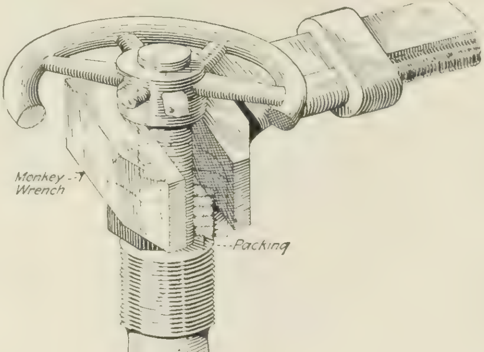
The information regarding the horsepower of internal-combustion engines installed was obtained from the United States Census of Manufactures, 1914-17, and current journals to October of last year, and therefore did not consider the installation mentioned. There is no question of the desirability of blast-furnace engine installations, and a large increase is to be expected in this industry. L. W. W. MORROW.

New Haven, Conn.

Valve-Stem Packing Kink

When packing a gate or a globe valve, using a packing nut that screws onto the neck of the valve bonnet, it is sometimes difficult to start the nut on, if it is well filled with packing. Of course this difficulty may be avoided by not filling the nut too full, but I prefer to stuff a goodly amount of packing into the nut so as to repack less frequently.

This difficulty may be avoided by opening an ordinary monkey wrench a little wider than the diameter of the valve stem, and placing it over the stem between the valve wheel and the packing nut, as shown. If the valve wheel is then turned until the nut is brought up to the threads on the valve bonnet, and the nut is turned at the same time, it will start on easily and there is plenty of packing around the stem.



SCREWING ON A PACKING NUT

In case the distance between the nut and the valve wheel is too great to permit the use of a monkey wrench, a piece of wood of the proper thickness may be used.

Arlington, Mass. JOHN D. EBERHARDT.

Industrial and Central-Station Plants

The article by Cornelius G. Weber, on "Interconnecting Industrial and Central-Station Plants," page 1049 of the June 29 issue of *Power*, as well as several recent articles on similar subjects, shows a growing tendency to recognize the value of the isolated plant to the community at large.

We have read during the last few years of the wonderful strides made by the modern central station in reducing its unit output cost in spite of the increased cost of coal, labor, supplies, etc. If we look at the reason for this, we find brilliant engineers who make this their life work; in fact, some large central station will usually bid quite high for the services of this type of engineer. Then, too, through the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, these same men keep in touch with one another, exchange ideas and publish records of their experiments for the benefit of all.

The poor isolated plants have no such interest shown them. Anyone, be he architect, consulting engineer or otherwise, is allowed to buy the apparatus and assemble it under one roof and call it a power plant. Perhaps it is; but ask the man who operates it what he thinks. Very likely the individual boilers, engines and pumps are the best in the market, but they do not fit together on the basis of over-all plant efficiency. And sometimes, where the plant itself is all right as far as the different apparatus working economically together is concerned, the plant as a whole does not fit the industrial factory for which it was built.

These facts are not new by any means, and only the economic necessity caused by the high cost of everything makes them a factor to be considered. The operating engineer has been preached to about "economy" in the plant. He should keep his boilers clean, inside and out, heat the feed water, indicate the engines, etc., which is all good advice; but when a plant is designed all wrong to start with, and no matter how hard the engineer works, he can attain only a half to three-quarters of the economy and efficiency he should —well, he is very likely to lose some of his enthusiasm and just keep the plant going and no more. This, it may be said, should not be the attitude of the engineer, but it is in many instances.

No right-thinking individual denies the fact that it is a good thing to have an engineers' license law to protect the rest of the community from the ignorant and careless handling of boilers and other power-plant apparatus by incompetent help. In fact, it is now advocated by certain engineers that the engineers' license law should also cover economy in plant operation, making it compulsory for every engineer to at least know the principles of economical power-plant operation, even if he does not practice them.

But going a step farther, it seems that it would be even more desirable to do something toward preventing the construction of poorly designed plants. Power plants that could not be made to attain the ordinary economy, no matter how operated, should never be built. Why not license the power-plant designers, or at least have their designs passed upon by a board of competent engineers, similar to the method that is used in getting building plans approved in large cities? This would institute several benefits: It would make the plant owner realize more clearly the importance of his own power plant, and incidentally raise his opinion of his engineering employees and probably their wages; the plant designer would have an increased incentive to see that the operating engineer was not only competent at the start, but kept his plant in shape at all times; and following the natural law of supply and demand, the higher wages would attract a more intelligent class of workers, to everyone's advantage.

Interconnecting the small isolated plants with the central station would take a large load off the minds of the isolated-plant engineers and has so many economic advantages that a fair-sized book could be written about it. But why is it not done? The answer is simply that the central stations will not hear of it. They are looking for all the business or nothing. Unless the Government steps in and forces this matter, it will probably never take place. There are many buildings so situated that, from their own isolated plant, they could supply light, heat and power to their neighbors, but this is blocked as a rule by local ordinances forbidding the running of steam pipe or electric conduit through building walls or across streets.

It would seem that the block plant, supplying light, heat and power to all the buildings in the block, or possibly in the vicinity, would be an ideal scheme if interconnected with the local central station; and its size would be such that competent help could be hired, to the mutual benefit of all concerned.

That the small isolated plant is doomed in the future, there is no doubt, but certainly the central station does not offer the best solution, when the steam requirements for heating and manufacturing purposes are taken into consideration.

The proposed plan of the Government to interconnect the various central stations and build new ones at the mines is a step in the right direction, but it hits only the high spots and does not take care of the small manufacturer, who needs steam served with his electricity. WARREN D. LEWIS.

New York City.

Water-Column Connections

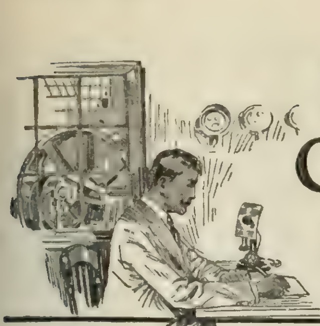
In a battery of boilers of which I have charge, the connections of the water columns are different. Some have the steam connection in the front head and others are connected at the top of the shell; some have the water connection at the bottom of the front head, and one has the connection near the top of the tubes, being placed there, no doubt, after careful calculations as to the weight of water at different temperatures and the weight of mixtures of steam and water.

The worst performer of the bunch was the one that had the connection nearest the top of the tubes. It was a high jumper—not merely one to three inches low, as Mr. Orr in a recent issue calculates it ought to be for the near-the-bottom connection, but six inches and more above the true level.

Many guesses were made as to the cause of its performance, and I made a few myself, my last being that it was due to the fact that the pipe forming the lower connection was exposed to the hot gases in the smoke box. Acting on this, we covered the pipe with insulating material and proved that the last guess was the correct one.

The steam formed in the pipe was carrying the water up into the water column, where there was room for separation to take place. R. MCLAREN.

Toronto, Ont., Canada.



INQUIRIES OF GENERAL INTEREST

Testing for Water and Dirt in Fuel Oil—What is a good method of determining the amount of water and dirt in fuel oil? W. T.

Mix a small quantity of the oil in a glass test tube with an equal quantity of gasoline and allow the mixture to stand in a warm place for 24 hours, when the dirt and water will settle to the bottom.

Blowdown of Safety Valve—Why does a safety valve remain open after the boiler pressure has dropped below the pressure at which the valve is set? W. E. G.

The valve remains open because the form of the valve is such that when it is raised from its seat the area of the valve that is acted upon by the escaping steam is greater than the area presented to pressure of the steam within the boiler when the valve is closed.

Protection of Steel Smoke Flue from Rusting—We have considerable trouble from interior rusting of sheet-steel smoke flues that connect boiler uptakes with the chimney. How can the corrosion be prevented? W. B. R.

The best protective covering for the purpose is a wash of portland cement and water mixed to a consistency of cold-water paint and applied with a stiff brush after the surfaces to be covered have been thoroughly scraped and cleaned.

Increasing Cushion on Duplex Pump—How can the amount of cushioning be increased on a duplex pump that is not provided with cushion-regulating valves? A. R. D.

The exhaust can be closed earlier, and thereby provide for a longer cushion, by turning off the diameter of the piston sufficiently to allow for a piston ring with an offset overlapping the piston. In this way a piston ring can be used that will be as wide as the piston, and a cushion can be obtained as long as the piston will permit.

Water Rate of Engine—What is meant by an engine running on 12 lb. of water per horsepower-hour? J. E.

The statement is intended to signify that the weight of steam consumed is 12 lb. per horsepower-hour, which would be the weight of steam generated from 12 lb. of water or the "water-rate." A statement of water rate is incomplete in expressing economy of a steam engine unless also the pressure and quality of steam supplied and the back pressure on the exhaust are specified or understood.

Material of Clean Tubes Unaffected by Forcing Boiler—What is the highest rate of transfer of heat that can be made through water tubes of a boiler without destroying the material? J. A. G.

The highest rate of heat transfer has never been known to destroy the metal when the tubes have been clean and kept covered with water. The rate required to burn out the tubes depends on the circulation and the kind and quantity of scale or other coating on the water side of the tubes. When new tubes have been burned out after very short use, the trouble has been traced to presence of oil.

Width for Machine Belt—What width of single leather belt would be suitable for transmission of 3¼ hp. to a machine that is provided with an iron receiving pulley 12 in. in diameter, to run 275 r.p.m.? W. L. F.

Each inch of good-quality single leather belt running on an iron pulley 30 in. in diameter and making 100 r.p.m., or 785 ft. per min., may be depended upon for transmission of 1 hp., and for the same stress of belt per inch of width, transmission of 3¼ hp. to a 12-in. pulley running 275 r.p.m. would require a belt width of

$$\frac{100 \times 30}{275 \times 12} \times 3\tfrac{1}{4} = 2.9, \text{ or practically 3 inches.}$$

Testing with Air Pressure—Is air pressure as reliable as hydrostatic pressure for testing the tightness of piping, boilers or other pressure containers? H. T.

When the test pressure can be held, testing with air pressure is fully as reliable an indication of strength and tightness as testing by hydrostatic pressure. Original testing by air pressure alone is dangerous, for in event of rupture of the pipe or vessel under test, the rapid expansion and high velocity of the escaping air and recoil of the vessel may have the effect of a destructive explosion. For the same reasons serious damage has frequently resulted in making hydrostatic tests of vessels that were partly filled with air. Tests of strength should first be made with hydrostatic pressure 50 per cent in excess of the allowable working pressure. As air is more searching of leaks, the joints of piping and containers for compressed air or gases may be more thoroughly tested by air pressure, but in cases where it is desirable to insure against an explosive effect, testing by air pressure should be preceded by a higher hydrostatic pressure.

Causes of Failure of Injector—What may be the cause of failure in operation of an injector? The tubes and parts are clean and show very little wear. W. H. A.

The trouble may be due to a leaky suction pipe. Plug the ends of the suction and overflow pipes. Then turn on the steam supply and the location of any leaks will be indicated by an escape of steam. The injector may be too hot to start, due to a leaking steam valve, or the feed water may be too hot. The suction pipe or strainer may be obstructed. Such obstructions usually can be removed by turning on steam after blocking the overflow and closing the delivery to the boiler. The delivery pipe may be choked or the check-valve may be faulty, either of which would be indicated by discharge at the overflow or inability to maintain the usual water level in the boiler. To test for these defects, place an accurate pressure gage on the delivery side of the injector and note whether it indicates pressure in excess of the boiler pressure. It may be that the steam supply pipe is choked or that the injector is supplied by wet steam, caused by foaming or priming of the boiler. The steam supplied should be taken from an independent connection out of the highest part of the boiler to insure dryness. On the other hand, superheated steam will not usually give results as satisfactory as dry saturated steam, as sufficient time may not be permitted for its condensation in the injector.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Interpretations of the A. S. M. E. Boiler Code

The following answers to requests for interpretations of the Boiler Code have been prepared by the Boiler Code Committee and approved by the Council of the American Society of Mechanical Engineers. The formal inquiry and reply are given together with explanatory references to the Code and illustrations where necessary for a better understanding of the interpretations as issued.

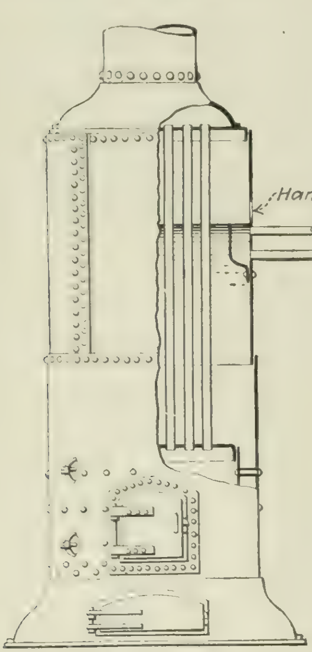
Case No. 253 (Previously Annulled)—Inquiry: Is it permissible under the requirements of the Boiler Code to use for boiler construction, tubes or flues that have been formed into the desired lengths by welding together at their ends, short lengths of such tubing by the electric pressure welding process, provided the metal upset at the weld is immediately rolled down to the proper thickness while under the heat of the weld?

Reply: It is the opinion of the committee that while there is no objection to the safe-ending of tubes for fire-tube boilers by a suitable welding process, the suggested method of making the tube from a number of small pieces would be an objectionable practice. The committee does not consider the practice of safe-ending of tubes to be suitable for water-tube boilers.

Case No. 268 (Reopened)—Inquiry: (*a*) Inasmuch as the discharge of feed water into vertical fire-tube boilers in accordance with the requirement of Par. 316 of the Boiler Code has caused serious difficulties from leaky tubes in the lower tube sheet, a reconsideration is requested of Case No. 145, in which the opinion of the Boiler Code Committee is given that the discharge of feed water in the water leg of a vertical fire-tube boiler is not permissible.

(*b*) In case it is ruled that such discharge of feed water into the water leg of a vertical fire-tube boiler is not allowed, is it permissible to protect the feed-water discharge through a feed-water pocket riveted within the shell at a point above the water leg, with handhole opening for cleaning?

Par. 316. Feed water shall not discharge in a boiler close to riveted joints in the shell or to furnace sheets.



CASE 268 ARRANGEMENT OF FEED INLET IN VERTICAL BOILER

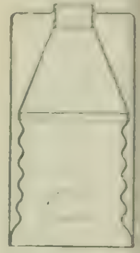
Reply: (*a*) It is the opinion of the committee that Par. 316 does not permit of discharging the feed water in the water leg of a vertical fire-tube boiler, and that difficulties with leaky tubes may be avoided by the use of an internal feed pipe which does not discharge into the water leg.

(*b*) It is the opinion of the committee that such a method of delivery of feed water to a vertical tubular boiler through an internal pocket or baffle above the water leg, with handhole opening for cleaning, is in full accordance with the requirements of the Boiler Code.

Case No. 275—Inquiry: Is autogenous welding permissible for the longitudinal joint of the firebox of a form of vertical boiler as shown in the illustration, where the furnace section is, after welding, heated and corrugated by rolls? The corrugations are rolled to a depth of 1½ in. on 8-in. centers, and the weld shows no fracture or distress after either corrugating or flanging.

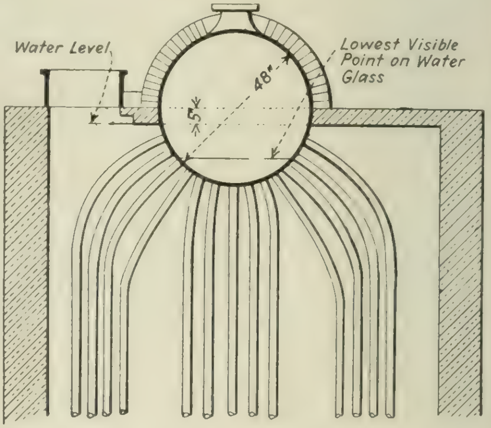
Reply: It is the opinion of the committee that the construction referred to, fully complies with the requirement of Par. 186 of the Boiler Code.

Par. 186. Welded Joints. The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 28,500 lb. per sq.in., with steel plates having a range in tensile strength of 45,000 to 55,000 lb. per sq.in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.



CASE 275. SPECIAL FIREBOX

Case No. 278—Inquiry: What would be considered the lowest permissible water level for a vertical water-tube boiler of the type shown in the illustration? Par. 430*v* of the Boiler Code to which reference is made in Par. 291 relative to the lowest permissible water level, leaves the location rather problematical, as there may be a difference in opinion as to what the lowest permissible water level may be.



CASE 278. SHOWING SPECIAL DESIGN OF WATER-TUBE BOILER

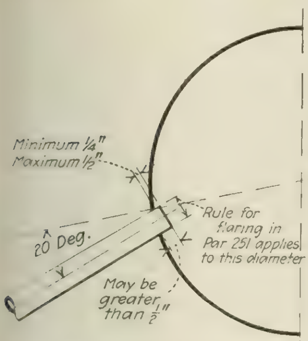
Par. 291 provides that each boiler shall have at least one water-gage glass, the lowest visible part of which shall be not less than 2 in. above the lowest permissible water level. The lowest permissible water level for various classes of boilers shall be the location for the fusible plug as given in Par. 430 of the Appendix.

Par. 430, after providing for the location of fusible plugs in various standard types of boilers, provides, "For other types and new designs, fusible plugs shall be placed at the lowest permissible water level, in the direct path of the products of combustion, as near the primary combustion chamber as possible.

Reply: It is the opinion of the committee that for a water-tube boiler of the design illustrated, a location for the lowest permissible water level such as referred to in Par. 430*i* would be a suitable and safe construction.

Par. 430*i*. In Stirling boilers, superheater type—(the location of the fusible plug) in the front drum, not less than 6 in. above the bottom of the drum, exposed to the products of combustion, and projecting through the sheet not less than 1 inch.

Case No. 283—Inquiry: In the construction of a water-tube boiler in which the tubes enter the tube sheet at an angle as great as 20 deg. from the normal, may the requirements of Par. 252 of the Boiler Code be fulfilled if the least projection of the tube be not less than ¼ in. and the maximum not more than ½ in.?



CASE 283. OBLIQUE TUBE IN WATER-TUBE BOILER

Par. 252 provides that the ends of all tubes, suspension tubes and nipples of water-tube boilers and superheaters shall project through the tube sheets or headers not less than ¼ in. nor more than ½ in. before flaring.

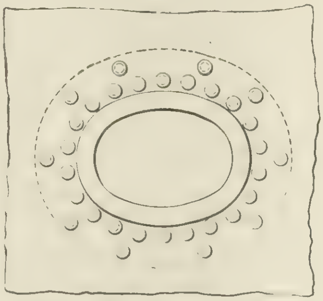
Reply: It is the opinion of the committee that Par. 252 applies to tubes which enter normally to the sheet and that where the tubes are at an angle, the least projection of the tube should be not less than ¼ in. or more than ½ in., which may result in the tube projecting more than ½ in. at other points. The rule given in Par. 251 for flaring should apply to the true diameter of the tube hole measured in a plane at right angles to the tube end and not to the maximum diameter of the elliptical opening in the tube sheet.

Par. 251 provides that the ends of all tubes, suspension tubes and nipples shall be flared not less than ⅛ in. over the diameter of the tube hole on all water-tube boilers and superheaters, or they may be flared not less than ⅛ in., rolled and beaded, or flared, rolled and welded.

Case No. 287—Inquiry: Is it permissible to burn off the edges of boiler plates and use them without any finish where sheared edges would be permitted by the rules in the Boiler Code?

Reply: The code does not prohibit the practice suggested.

Case No. 288—Inquiry: Where a manhole is applied to the head of a dome and an opening for access to the boiler is placed in the shell under the dome, is it necessary to reinforce this opening in accordance with the requirements of Par. 260?



CASE 288. REINFORCING RING FOR MANHOLE

Par. 260 provides that manhole frames on shells or drums when used, shall have the proper curvature, and on boilers over 48 in. in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in the illustration. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening.

Reply: It is the opinion of the committee that such an opening should be reinforced in accordance with the requirements of Par. 260. The reinforcing effect of the base of the dome may be included in calculating the reinforcement.

Case No. 291—Inquiry: In the case of a special arrangement of spacing of tube holes in the shells of the drums of a water-tube boiler with the pitch unequal in every second row, but shifting the adjoining rows to an exact stagger, as shown in the sketch, is it proper to calculate the efficiencies of ligaments under the requirements of Par. 192 or 193 of the Boiler Code?

Par. 192. When a shell or drum is drilled for tubes in a line parallel to the axis of the shell or drum, the efficiency of the ligament between the tube holes shall be determined as follows:

a When the pitch of the tube holes on every row is equal, the formula is:

$$\frac{p - d}{p} = \text{efficiency of ligament}$$

where p = pitch of tube holes in inches, and d = diameter of tube holes in inches.

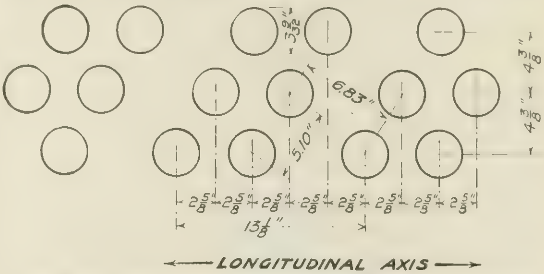
b Where the pitch of the tube holes on any one row is unequal the formula is:

$$\frac{p - nd}{p} = \text{efficiency of ligament}$$

where p = unit length of ligament in inches, n = number of tube holes in length p, and d = diameter of tube holes in inches. Example spacing shown in Fig. 1. Diameter of tube holes 3 ½ in.

$$\frac{p - nd}{p} = \frac{29.25 - 5 \times 3.281}{29.25} = 0.439, \text{ efficiency of ligament}$$

c. The strength of those ligaments between the tube holes which are subject to longitudinal stress shall be at least one-half the required strength of those ligaments which come between the tube holes which are subjected to a circumferential stress.

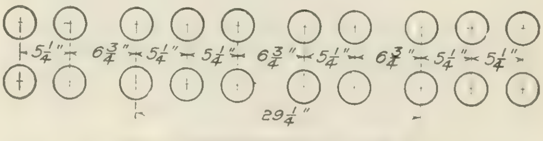


CASE 291. SPECIAL ARRANGEMENT OF TUBE HOLES IN WATER-TUBE BOILER

Par. 193. When a shell or drum is drilled for tube holes so as to form diagonal ligaments, the efficiency of these ligaments shall be that given by the diagram (diagram given in the Code is too large for reproduction here). In this diagram the abscissas are $\frac{p}{d}$ and the ordinates are $\frac{p'}{p}$, where p = longitudinal pitch of the tube holes in inches, p' = diagonal pitch of the tube holes in inches, and d = diameter of the tube holes in inches.

To use the diagram the values of $\frac{p}{d}$ and $\frac{p'}{p}$ are computed and the efficiency for the corresponding point is read off from the diagram. Should the point fall above the curve of equal efficiency for the diagonal and longitudinal ligaments, the longitudinal ligaments will be the weaker, in which case the efficiency is computed as in Par. 192.

Reply: It is the opinion of the committee that the efficiency of the tube sheet should be obtained by employing the method outlined in Pars. 192 and 193 of the Code for diagonal ligaments. All possible methods of failure should be assumed and the lowest value obtained through any one of the methods, should be used.



CASE 291. ARRANGEMENT OF TUBE HOLES TO ILLUSTRATE EXAMPLE IN PARAGRAPH 192 OF CODE

Case No. 292—Inquiry: In the case of a triple-riveted butt and double-strap joint with the pitch of rivets in the first and third rows one-half of that of the second row, as shown in the illustration, what is the proper method of determining the back pitch between the first, or inner, and second, or middle, rows of rivet holes?

Reply: It is the opinion of the committee that the back pitch required between the first, or inner, and the second, or middle, rows of rivet holes in such a design of joint shall be governed by the rules of Par. 182 for determining the back pitch between the second and third or outer rows of rivets.

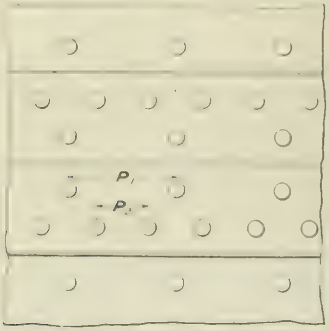
Par. 186. The distance between the center lines of any two adjacent rows of rivets, or the back pitch measured at right angles to the direction of the seam, shall have the following minimum values:

a. If $\frac{P}{D}$ is 4 or less, the minimum value shall be 2 D.

b. If $\frac{P}{D}$ is over 4, the minimum value shall be $2D + 0.1 (P - 4D)$

where P = pitch of rivets in outer row, where a rivet in the inner row comes midway between two rivets in the inner row, in inches; P = pitch of rivets in the outer row less pitch of rivets in the inner row, where two rivets in the inner row come between two rivets in the outer row, in inches (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced); D = diameter of rivets in inches.

In the illustration herewith the second value of P should be used; that is, $P = P_1 - P_2$.



CASE 293. LAYOUT OF RIVETS IN JOINT DESCRIBED IN INQUIRY

Case No. 294—Inquiry: Is it the intent of Par. 331 of the Boiler Code that at least one complete set of the four stamps specified for boiler plate in Par. 36 remain visible after the completion of the boiler, or if the slab or melt number is invisible, are the remaining markings sufficient to meet the Code requirements?

> Par. No. 36. Marking. *a.* Each plate shall be legibly stamped by the manufacturer with the melt or slab number, name of manufacturer, grade and the minimum tensile strength of the stipulated range as specified in Par. 28, in three places, two of which shall be located on diagonal corners about twelve inches from the edge, and one about the center of the plate, or at a point selected and designated by the purchaser so that the stamp shall be plainly visible when the boiler is completed.
>
> *b.* Each head shall be legibly stamped by the manufacturer in two places, about twelve inches from the edge, with the same marks in such a manner that the stamp is plainly visible when the boiler is completed.
>
> *c.* Each butt strap shall be legibly stamped by the manufacturer in two places on the center line about twelve inches from the end with the same marks.
>
> Par. No. 331. Stamping of Boilers. In laying out shell plates, furnace sheets and heads in the boiler shop, care shall be taken to leave at least one of the stamps, specified in Par. 36 of these rules, so located as to be plainly visible after the boiler is completed; except that the tube sheets of a vertical fire-tube boiler, and butt straps shall at least have a portion of such stamp visible sufficient for identification when the boiler is completed.

Reply: It is the opinion of the committee that all the information which the Code requires to be stamped on the plates at the mills must be obtainable from the finished drum structure for each plate. All four stamps need not be visible at a given point if the fragments from various sets can be pieced together so as to give the desired information.

Case No. 295—Inquiry: How may an inspector in the field know the range of tensile strength of boiler plate? Is it not customary for the boiler-plate manufacturer to state the range on the test sheets furnished to the purchaser?

Reply: Attention is called to the fact that the range for all classes of steel specified in the Code is 10,000 lb. per sq.in., and the tensile strength stamped on the plate indicates the minimum of this range, which minimum under the rules must not exceed 55,000 lb. per sq.in.

Case No. 296—Inquiry: Will a water-tube boiler of a type largely used in marine service, the heating surface of which is constructed mainly of iron pipe screwed into malleable iron and steel fittings, meet the requirements of the Boiler Code, if the pipe used is a special quality of redrawn lap-welded iron pipe of puddled stock and tested to 1,000 lb. hydraulic pressure?

Reply: There is nothing in the Boiler Code to cover the use of iron pipes for the tubes of such a boiler with screwed joints. Until such a time that the specifications for piping have been formulated, the Boiler Code Committee would consider that if the other requirements of the Boiler Code are met, special redrawn pipe not to exceed 1½-in. standard pipe size made from lap-welded iron of puddled stock and tested to 1,000 lb. hydraulic pressure, may be used for a working pressure not to exceed 200 lb. per sq.in., provided the wall thickness is at least 50 per cent greater than the wall thickness required by the Code for tubes of water-tube boilers.

Case No. 297—Inquiry: Will the requirements in the Boiler Code for automatic water gages be met under the terms of Par. 427*e*, if the shutoff valve in the upper fitting has a projection which pushes the ball away from the seat for a distance of ⅛ in., causing the ball to drop to a position considerably greater than ¼ in. away from its seat?

> Par. No. 427. Automatic shutoff valve on water gages, if permitted to be used, shall conform to the following requirements: (a) Check valve in upper and lower fittings must be of the solid non-ferrous ball type to avoid corrosion and the necessity for guides . . . (e) The shutoff valve in the upper fitting must have a projection which holds the ball at least ¼ in. away from its seat when the shut off valve is closed.

Reply: It is the opinion of the committee that the intent of the requirements of the Code will be met in the construction described.

Case No. 298—Inquiry: Is it permissible in the case of a forged-steel steam outlet riveted to the boiler shell to use a wrought-steel flange screwed to the outer end of the end-neck, the neck being properly threaded and peened over into a beveled part cut away from the flange?

Reply: It is the opinion of the committee that this method of forming a steam outlet connection meets the requirements of the rules in the Boiler Code.

Supply Lines for Gas Engines and Other Large Appliances

The piping code of the National Fire Protection Association, approved at the May, 1920, convention, includes the following recommendations regarding supply lines for gas engines. These rules will doubtless form a portion of the National Board of Fire Underwriters' insurance requirements and building piping.

The pipe to supply gas to a gas engine or other appliance of large consumption or high momentary demand shall, in every case, be carried back far enough independent of other piping, or other provision be made, to insure that the pressure at the other appliances is not disturbed by the operation of this appliance. Before the installation of the pipe for a gas engine is begun, consultation with the gas company is recommended, and the following precautions should be observed whenever practicable:

1. Every gas piping system should be of adequate size and so designed as to give as nearly equal distribution as possible, and in large installations a circulating system is recommended to give a more uniform pressure throughout.
2. Piping and connections shall be run as directly as possible.
3. Gas bags, if used to supply high momentary demand and maintain constant pressure, must be inclosed in a substantial gastight metal drum of approved construction, vented to the outer air through a pipe used for no other purpose, and the outer end have protected turned-down fitting to prevent clogging.
4. When not otherwise provided for, the regulator should be arranged with an automatic gas shutoff to prevent the flow of gas into the room in case the engine shuts down from any cause.

A perpetual right to the water-power resources of the Skagit River, Washington, as a source of power for municipal light and power purposes in Seattle has been given the city by the United States Government. The city is now engaged in the preliminary work on a project for the development of 50,000 hp., the cost of which is estimated at $7,000,000 and which it is believed will prove to be one of the best water-power projects in Washington, furnishing ample power for operation of street car lines, street lighting and an immense surplus for sale to private consumers.

Electric Power for Pumping[*]

BRIEFLY stated, the advantages commonly claimed for electric-motor-diven pumps are low operating expense, low first cost, compactness and simplicity, flexibility as to location, cleanliness, sturdiness and ease of control.

Operating expenses include such items as energy or fuel, attendance, supplies and the repairs necessary to maintain the machinery in operating condition. Most electric-motor-driven pumps require very little attention as there are no parts exposed to high temperatures and the lubrication is accomplished by ring oilers or other devices which require only occasional inspection. The pumps are frequently located in remote wellhouses and visited daily or weekly, as the case may be, for inspection; the operation being controlled either manually from the power house or central office, or automatically by a pressure-controlled switch. The great saving in labor costs constitutes one of the most important advantages of motor-driven pumps. In a small installation the energy costs are usually lower than the cost of the fuel that would be required by a steam plant. This is true despite the fact that coal is used to generate the electrical energy in the first place and that this energy must be carried over a transmission line and used in a motor. The reason for this is that with a steam plant considerable fuel is lost in getting up steam, banked fires, steam leakage and other boiler losses. Also direct-acting steam pumps commonly used in such plants take steam the full length of stroke and are very inefficient as compared with the large steam turbines commonly used in central power stations. With most types of motor-driven pumps supplies and maintenance expenses are lower than with steam pumps because of the greater simplicity of the pumping equipment.

DATA ON MOTOR-DRIVEN PUMPS IN THE STATE OF INDIANA COLLECTED ON INSPECTION TRIPS, 1919

Town	Population	Total Head	Annual Pumpage Million Gal	Annual Energy Consumption Kw.-Hr.	Kw.-Hr. per 1000 Gal	Kw.-hr per 1000 Gal per 100 Ft. Head	Total Annual Operating Cost Dollars	Operating Cost per 1000 Gal Cents	Operating Cost per 1000 Gal per 100 Ft. Head Cents
A	13,000	115	300*	383,300	1.28	1.11	14,603.58	4.86	4.23
B	10,000	484	478	1,565,000	3.28	0.68	15,174.11	3.20	0.66
C	8,700	212	422.4*	307,130	0.73	0.34	14,000	3.31	1.56
D	3,800	150	36*	52,800*	1.47	0.98	1,210.23	3.36	2.24
E	2,500	102	69.8	64,810	0.93	0.91	2,411.05	3.45	3.38
F	2,400	136	66.83	75,140	1.12	0.825	3,849.56	5.76	4.24
G	2,400	160	646.25*	129,250	0.20	0.125			
H	1,900	100	43.08	58,300*	1.35	1.35	1,494.51	3.50	3.50
I	1,600	120		98,455			6,263.60		
J	1,400	100	55.1	60,000*	1.09	1.09	1,634	2.97	2.97
K	1,400	132	18*	27,912	1.55	1.17	658.24	3.66	2.77
L	1,300	106	30*	8,230	0.27	0.25	263.30	0.88	0.83
M	1,200	148	43.12	100,000*	2.32	1.57	3,850	8.93	6.05
N	1,200	120		5,878			329.23		
O	1,100	137		5,888			333,55		
P	1,100	125	10.9*	26,740	2.45	1.96	1,835.14	16.83	13.5
Q	800	144	13*	3,770	0.29	0.20	515.20	3.96	2.75
R	600	145		13,330			805		

* Estimated

Average kw.-hr per 1000 gal.	1.31
Average kw.-hr. per 1000 gal. per 100 ft. head	0.90
Average operating cost per 1000 gal. in cents	4.97
Average operating cost per 1000 gal. per 100 ft. head in cents	3.74

The first cost of a plant is important because upon it the fixed charges—interest, depreciation, insurance and taxes—are dependent. These charges form an important item in the cost of service. The first cost of a motor-driven pumping plant is low because electric motors operate at high speed and therefore are small considering the power they develop. Also, they do not require a boiler plant and are more compact in construction than steam equipment. The building for housing the pumping plant is much smaller and costs a great deal less than one necessary to house a steam plant.

Where the water is pumped from widely separated deep wells, the advantage of flexibility becomes important, as a motor-driven pump can be placed at each well and controlled from a remote point either manually or automatically.

Probably the greatest objection urged against the electric motor is lack of reliability. This objection is based largely on the fact that the electric motor is not a prime mover, but is dependent for its energy supply over a transmission line from a central station. The electric motor itself, if properly applied, is the most reliable of all driving powers. This has been demonstrated many times in recent years in all sorts of service ranging in variety from clock mechanisms to battleships.

Even when the risks incident to transmission line or central-station breakdown are taken into account, electric drive compares favorably with a steam plant equipped with a single boiler and pump. Furthermore, electric-service interruptions are usually of only a few hours' duration at most and are therefore not of as great importance as the breakdown of a steam boiler. In some localities other difficulties, such as variable voltage or frequency or high cost of power service, arise. These difficulties are particularly likely to occur where the source of power supply is a small local plant.

The energy required by a motor-driven pump is usually expressed in kilowatt-hours per 1,000 gal. of water pumped. This is not a very satisfactory measure of performance as pumps work between wide ranges of suction lifts and discharge heads and therefore the energy requirements differ greatly. For large low-head pumps the energy required may be as low as 0.4 kw.-hr. per 1,000 gal., and for small high-head pumps it may be as high as 10 kw.-hr. per 1,000 gal. For average conditions in the small plants of the State of Indiana, 1.25 kw.-hr. per 1,000 gal. seems a fair figure. A better measure of performance is the amount of energy required to lift 1,000 gal. of water 100 ft. In an analysis of actual operating performances given in the table, both of these measures of performance are used.

The annual cost of energy for a given plant depends quite as much on the cost per kilowatt-hour as on the amount of energy used. Rates vary through a wide range, being dependent on the size, kind and location of the central power station. Also they may be affected by the nature and magnitude of the energy requirements of the load. They usually contain a charge more or less dependent on the aggregate horsepower of the customer's motors as well as an energy charge, these charges being graded in accordance with the magnitude of the customer's requirements.

For the plants visited, 25 in towns ranging from 500 to 25,000 population, the average cost per kilowatt-hour for the year 1918 varied from 0.8c. to 5c. The lower cost obtained in a fairly large town which received its energy supply from a hydro-electric plant transmission line, while the higher one prevailed in several towns receiving their energy from small local plants. An average for all the towns is about 3c. per kilowatt-hour. In several instances the power-company employees took care of the pumping plant, the attendance charges being included in the energy rate. In two towns the energy charge was based on the pumpage, as for example, 5c. per 1,000 gal. of water pumped. In the main this is neither a very fair nor a satisfactory method of paying for energy.

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[*] Abstract from Bulletin No. 4 (100 pages), "The Application of Electric Motive Power to Small Waterworks Plants in Indiana," by D. D. Ewing, professor of electric railway engineering, and G. C. Blalock, instructor of electric engineering, Purdue University. Published by Engineering Experimental Station, Purdue University, Lafayette, Ind.

Since the cost of electric energy ordinarily depends on the nature of the demand as well as on the actual amount of energy used, a study of the nature of the demand which a pumping station imposes on a power house is of interest. It costs much less per kilowatt-hour to furnish energy to a motor that runs steadily with a uniform load 24 hours per day than where it runs only a few hours per day. Also, energy used during periods when the power plant is not carrying its heaviest load—off-peak energy as it is usually called—can be purchased cheaper than used during the peak-load period of the day. The power demand of a water plant with a given pumpage will depend upon the kind of water system and the type of pumps used. Where the pressure of the mains is maintained directly by the pumps, the power input will be almost constant, while in those plants where the pumps operate only a few hours per day while filling a storage tank, the power demand will be intermittent in character and in general will be larger than with the other system.

The coal consumed in pumping water in small plants with steam pumps is about five times that necessary to generate the electrical energy required to pump the same amount of water with motor-driven pumps. The energy consumption in properly designed plants for conditions obtaining in the State of Indiana may be expected to vary from 0.5 to 3.0 kw.-hr. per 1,000 gal., 1.25 kw.-hr. per 1,000 gal. being a fair average. The corresponding energy consumption per 1,000 gal. per 100 ft. of head varies from about 0.2 to 2.0 kw.hr., with 1.0 as a fair average. The first cost of an electrically operated pumping plant is from 25 to 50 per cent of that of a steam pumping plant. The operating expenses for an electrically operated plant are less than 50 per cent of those for a steam-driven plant and are appreciably lower than those for an internal-combustion engine driven plant.

An Improved Form of Weir for Gaging in Open Channels

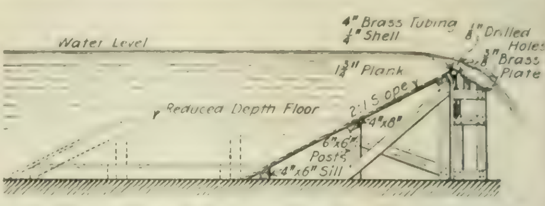
In a paper presented by Clemens Herschel before the American Society of Mechanical Engineers at the Spring Meeting in St. Louis, May 27, 1920, an improved form of weir for gaging in open channels is discussed and an account of experiments with this weir is given. The proposed form of weir is designed to eliminate the disturbances caused by the stream of water suddenly meeting a vertical obstruction and being torn by a sharp-edged crest. It was hoped, and the hope appears to have been realized, that such a construction would yield a formula much more simple than those at present used. The experiments made indicate that the discharge in cubic feet per second per foot in length of weir is represented by the straight line formula,

$$Q = 5.50d$$

where Q is the discharge and d is the difference of two observations of water height or pressure. One of these observations is taken upstream from the weir and is corrected, either automatically or by computation, for velocity of approach, and the other is taken at the crest of the weir.

The experiments described were made at the Hydraulic Laboratory of the Massachusetts Institute of Technology, using two weirs, one 10 ft. long and the other 3 ft. long. The flow of water was measured by a 30-in. venturi meter for experiments using more than about 8 cu.ft. per sec. and by a 16-in. venturi meter for smaller quantities. Variations of velocity of approach were obtained by introducing false bottoms, or "reduced depth floors," into the weir box to diminish its cross-sectional area.

The general design of the weir is shown in the illustration. The water is led gently up to the crest by a 2 to 1 slope. The crest itself is made in the form of the arc of a circle, and instead of bothering about air under the nappe, the nappe is supported on another 2 to 1 slope downstream from the crest. In this case the crest is made of a 4-in. diameter tube having a series of ⅛-in. holes so that the pressure of the water at the crest may be measured. Trial tests showed that best results were obtained when these holes were bored at right angles to the upstream slope of the weir. Connection from this tube with a hook-gage pail enabled the height of water over the crest or, more properly, the pressure due to the action of the water on the pizometer orifices, to be read. The height of the water upstream was read in a hook-gage pail having an orifice flush with the flume side, 13.9 ft. upstream from the weir crest and 1.68 ft. below it in elevation. For the same reasons that a vertical faced weir is objected to, end contractions were eliminated.



PROPOSED FORM OF WEIR FOR USE WITH SIMPLE FORMULA

A pitot-tube orifice pointing upstream was also arranged to measure the upstream head so as to automatically correct for the velocity of approach. Faulty apparatus and the limited time available rendered the readings on this device worthless so the readings of the regular hook gage were corrected by computations.

As a result of these experiments the author concludes that with a weir of the proposed shape the straight-line formula given may be used over the range of 0 to 9.55 cu.ft. per sec. per ft. of weir length and probably for greater quantities. Further experiments are suggested to determine the effect, if any, of changes in the radius of the crest, and the value of the pitot-tube orifice for obtaining the upstream head. The factor 5.50 used in the equation is also subject to further experimental investigation, especially to determine logical reasons for its value.

The Puget Sound Power and Light Co. has registered in the office of the county auditor a new mortgage covering approximately $25,000,000 of its assets made to the Boston Safe Deposit and Trust Co., of Boston, and at the same time registered a release of a mortgage covering about the same amount previously given to the Old Colony Trust Co., also of Boston. Each document was presented in printed form and embraced the description of the multitudinous holdings of the company, requiring over a hundred pages of closely printed matter. The series of transactions cited in the new mortgage cover the financial history of the company through its several reorganizations and recognition as an asset the $15,000,000 worth of municipal bonds received from the City of Seattle when that city acquired the part of the system which lies within its limits. One object of the mortgage was stated to be to secure the release of $14,301,000 of these utility bonds of the City of Seattle, now held in trust by the Boston Safe Deposit and Trust Co. The new designation of the company appears in the instrument as the Puget Sound Power and Light Co. The amount of filing fees collected on the two documents was $142.05.

Charles Freeman, original locator of the power site, whose rights were later acquired by the city of Seattle, Wash., has located two other power sites below the site which the city of Seattle is building upon, one of them capable of developing 20,000 hp. and the other one 10,000 hp. Mr. Freeman declines to state in whose interests he is acting or what he or his associates propose to do with the sites, beyond saying that they will be developed.

Official figures for British coal production in 1919 are 329,743,000 tons, as compared with 227,741,000 tons in 1918 and 284,412,000 tons in 1913.

Engineers in Westminster Abbey

I did not know that there was in Westminster Abbey a well-defined location for the tombs and monuments of scientists and engineers. We all know of Poets' Corner and of the Royal Chapels which contain the bones of many of England's kings and queens. But the engineers' and scientists' corner (an inadequate description for one spot in the quiet nave and in the north aisle) has not been celebrated in the descriptions of the abbey that have come to my hand. Consequently I was the happier at the discovery.

Against the screen of the choir stalls, looking in the nave is the monument of Sir Isaac Newton, while directly in front, well out in the center of the nave, are the tombs, under the pavement, of Telford and George Stephenson—Telford's marked by one of the small square pavement stones cut with his name; Stephenson's by a full length floor panel, a work of art in bronze. A statue of Telford stands elsewhere in the abbey. What a place for a last resting place! What a fitting home for the long sleep of these master engineers! Above them springs the wonderful Gothic nave, airy in its lightness, yet built of stone—a sight such as I have never seen. The master builders of a later age lie asleep beneath the work of the master builders of all time, masters who outrivaled those of ancient Egypt or Greece or Rome—the Gothic cathedral builders of the Thirteenth Century. Egypt built great temples and mighty pyramids. So did Greece and Rome. But structurally the forms were simple. With the high-flung naves and crossings and choirs of the Middle Ages came engineering problems of no mean order. Yet so well were the principles understood that wonderful grace and appearance of lightness were secured. Today, with all our advances, we do nothing to equal their master works.

But to return to the engineers in Westminster.

By the side of Newton, directly in front of the Newton monument, lies the body of the late Lord Kelvin, while twenty feet to the north, in the aisle, lie, side by side, the bodies of Herschel the astronomer and of Charles Darwin. Above these graves, casting on them a light mellowed by the art of the stained-glass worker, are a memorial window to Sir Benjamin Baker, the inscription recording two of his great works—the Forth Bridge and the Assuan Dam, and another to Lord Kelvin, "Engineer and Natural Philosopher," as the inscription has it. In this same north aisle are memorial windows, also, to Stephenson, Joseph Locke, designer of the Crewe Engine; Brunel, Trevithick, and Charles William Siemens.

The Siemens window looks down on a group of tablets to scientists—to Lister, the physician; Darwin; Hooker, the botanist; Adams, the astronomer, and Joule, the physicist. The Joule tablet bears this inscription: "This tablet is here placed near the graves of Newton, Herschel and Darwin by those who in many lands have united to perpetuate the memory of James Prescott Joule, F. R. S., of Manchester, in recognition of services rendered to science in establishing the law of the conservation of energy and determining the mechanical equivalent of heat."

In the central part of the nave and the north aisle are buried other great men with kinship to engineers. We find the tomb of Sir Charles Lyell, the geologist. It is covered by a brass-lettered slab bearing this tribute: "Throughout a long life he sought the means of deciphering the fragmentary records of the earth's history, in the patient investigation of the present order of nature, enlarging the present boundaries of knowledge and leaving on scientific thought an enduring influence." Out in the center of the nave, near the graves of Telford and Stephenson, are four graves placed with singular appropriateness under this great nave—mortal remains of four architects who played an important part in the revival of Gothic architecture. They are Sir Charles Barry, architect of the Houses of Parliament; Sir George Gilbert Scott, George Edmund Street and John Loughborough Pearson.

As I turned to leave this part of the abbey, after musing there an hour, I chanced to walk over the Telford inscription and my eye caught on the slab at Telford's feet the name of Livingstone—David Livingstone, the African explorer; and the thought struck me that he was in kindred company. He explored an unknown country; he extended the bounds of knowledge regarding a section of the earth's surface. So did Telford and Stephenson and Lyell explore the unknown; so did they and their great fellow engineers and scientists about them extend the bounds of knowledge. They, no less than he, were explorers of a dark continent and have placed humanity under tribute for all time.

Inquiry Into Coal Situation by Senate Committee

Charging that great quantities of American coal were being exported to European countries despite the embargo on fuel exports, James J. Storrow, State Fuel Administrator of Massachusetts, offered testimony at the opening of the inquiry of the Senate Committee on Reconstruction and Production, Tuesday, July 20, at the Engineering Societies Building. The hearing was conducted by Senator William M. Calder, the only member of the committee present.

Mr. Storrow declared that the coal embargo put into effect some time ago on order from the Interstate Commerce Commission was not being enforced and that the industries of the country would soon face paralysis unless measures were taken to stop the flow of American coal to Europe. Mr. Storrow said that the American market is overrun with European buyers who are offering such high prices for coal that no American buyers can outbid them. In Boston Harbor coal is being offered for from $20 to $21 per ton, while in the instance of one ship the price was $23.

Last April, the first month following the original lifting of all restrictions on coal exports by the fuel administration, there was shipped to Hampton Roads 1,900,000 tons of coal. Of this 1,300,000 tons was sent abroad and only 600,000 tons was distributed throughout this country, causing such a shortage that New England was forced to get along on half her normal coal supply.

The second session of the hearing was held Wednesday afternoon, July 21. John F. McGee, of Minneapolis, and State Fuel Administrator of Minnesota, appeared before the committee in response to a subpœna, for the purpose of giving information as to the conditions in the coal situation in the Northwest. Mr. McGee for some time has been in the City of Washington, keeping in close touch with developments.

In answer to questions put to him by the committee, Mr. McGee declared that the situation was becoming more acute in the Northwest each year and that while the demands of this territory for coal were increasing continually, less coal was being obtained with which to meet them. "In the past few years," said Mr. McGee, "a remarkable development has taken place in this section of the country. A vast number of power plants and industries have begun operations and it is necessary that they be supplied with coal." Mr. McGee was emphatic in his statements, laying the blame on car shortage at the mines. He said that at the present time the Northwest was facing a coal shortage totaling 6,000,000 tons compared to the same month last year and that American industries over the Canadian border from Minnesota were taking an additional 6,000,000 tons per annum. He declared, however, that the deficit could be made up if a sufficient number of cars were delivered to the mines and various other transportation difficulties were overcome.

William H. Groverman, of Minneapolis, who held the position during the war of District Representative of the United States Fuel Administration and who at the present time is secretary to the Northwest Coal Dock Operative Association, was next called upon and questioned regarding the situation in the Northwest. His testimony confirmed the statements made by Mr. McGee and he gave it as his opinion that the situation was becoming more serious each day and that unless something was soon done the industries in that section of the country would suffer seriously.

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*Excerpt from a letter written by E. J. Mehren, editor of *Engineering News-Record*, recording some impressions gained abroad.

Increase in Rates for Electricity

The Pacific Gas and Electric Co. has been authorized by the Railroad Commission to increase its rates for electricity by the addition of a 15 per cent emergency surcharge to apply on all bills rendered beginning with July 10, 1920, and ending with April 10, 1921, a period of nine months. Similar authority has also been granted the Great Western Power Co. The commission's decision adds to the standard rate schedules of both companies the surcharges that have been allowed on previous applications, the emergency percentage increase granted being imposed on the combined rates.

The effect will be a 15 per cent increase over the amounts that have been collected in recent months. In the case of the Pacific Gas and Electric Co. it is estimated that the new emergency rate will produce additional revenue of $2,200,000 for the year ending July 1, 1921.

The increase in rates applies to all territory served by the Pacific Gas and Electric Co., including that operated under lease from the Sierra & San Francisco Power Co. and the territory recently acquired through the purchase of the properties of the Northern California Power Co. In the case of the Great Western Power Co. the commission directs that company to bring to the level of its other rates its charges for municipal street lighting, street-railway power and power sold to other public utilities, which three classes of service were exempted when surcharges were fixed in July, 1918.

Councilmen William Hickman Moore and R. H. Thomson, of Seattle, Wash., conferred Tuesday, July 13, with officials of the Puget Sound Light and Power Co. to ascertain if the company would be able to furnish the city with power in case the lack of fuel oil should cause the municipal light and power plant at Lake Union to reduce materially the current it is furnishing to Seattle consumers. According to officials of the city light department, the supply of fuel oil on hand will suffice to operate the Lake Union plant only until the end of July. Negotiations are under way at the present time to obtain an oil tanker from the United States Shipping Board to transport oil to Seattle for the city's use. In the event that no relief can be obtained in that way, it has been proposed to obtain current from the traction company during the off-peak hours, so that the water in Cedar Lake, the source of the city's hydro-electric power at the Cedar Falls plant, may be conserved for use during the peak hours.

Personals

Howard C. Adams, formerly chief estimator for Tate-Jones & Co., Inc., has joined the George J. Hagan Co., of Pittsburgh, as engineer in their liquid fuel department.

W. S. Quigley, president of the Quigley Furnace Specialties Co., sailed for France on the Cunard liner "Imperator," on July 15. His trip is for the purpose of furthering the business relations of the Quigley organization in England, France, Belgium, Italy and Spain.

Charles W. Oakley, of Passaic, N. J., has accepted a position in Trenton, N. J., as supervising engineer of the G. R. Cook plants. Mr. Oakley will supervise the construction of a new plant and will devote much time to improving the efficiency of some of the old ones.

Timothy Healy was elected by the American Federation of Labor at the recent convention as one of the two delegates to represent the American labor movement at the British Trades Congress in London, England, next September. His many friends and associates, desirous of manifesting the esteem in which he is held, have arranged for a testimonial banquet to be held at the Yorkville Casino on Wednesday evening, Aug. 11.

P. C. Fordyce, has been appointed superintendent for the West Penn Power Co. at Waynesburg, Pa., succeeding W. T. McCormick who has been transferred temporarily to the securities sales department. Mr. Fordyce, who is a native of Waynesburg, has been with the West Penn for eight years in various capacities, having been located at Monongahela City, Butler, Kittanning and at the Pittsburgh office. He comes to his new position from the power sales department.

Society Affairs

The Michigan Section of the National Electric Light Association will hold its annual convention Aug. 24-26, at the Hotel Ottawa, Ottawa Beach, Michigan. It is expected that the consolidation of the Michigan Section with the Western Geographic Division will be arranged at that time.

The Grand Council Universal Craftsmen, Council of Engineers, will hold its annual convention at Springfield, Mass., Aug. 3-6, and in connection the annual exhibition of power-plant machinery, accessories and supplies will be conducted during the day and evening under the direction of the Craftsmen. The entertainment committee of the Council has planned many events and features of interest for the delegates and visitors.

The Public Relation Association of the National Electric Light Association at its first meeting in Chicago in July, which was for the purpose of organizing, discussed in a general way the work to be covered and postponed organization until Aug. 1, due to the fact that all geographic divisions were not represented. The work will be divided and subcommittees appointed at that time to handle every phase of public relations work.

The Report of the Ontario Branch of the Canadian Manufacturers' Association shows that serious consideration is being given to development of water power in Quebec sufficient to fill the needs of the manufacturers. A number of resolutions were adopted urging remedial measures to be at once conducted by the Hydro-Electric Power Commission and especially requesting that no more radical railway projects be entered upon until sufficient power is on hand to fill manufacturers' requirements.

Miscellaneous News

The Board of Directors of the Industrial Relations Body at their annual reorganization meeting at Atlantic City elected J. M. Larkin, of Pennsylvania, president; Mark M. Jones, vice-president; F. C. Parker, Chicago, Ill., secretary, and W. H. Winans, New York City, treasurer.

Premier Foster, of New Brunswick, has announced the appointment of the following to comprise the Hydro-Electric Commission for New Brunswick: Honorable C. W. Robinson, St. John, N. B.; C. O. Foss, St. John, and Ried MacManus. The commission will proceed immediately with the development of water power.

The Bureau of Standards, in following up the investigation of lead-covered cable failures in St. Louis, has sent out a number of inquiries to railway and power companies asking whether in their experience lead-covered cables fail more frequently when installed in fiber conduits than when installed in other types of conduit with particular reference to cables carrying power at 2,200 volts or higher.

The Radio Corporation of America is about to begin construction on the largest radio station in the world, on the north shore of Long Island near New York City. The project will be known as the New York Radio Central Station and will be able to simultaneously send and receive messages from five great nations of other continents. Preliminary engineering surveys have been completed, contracts for all construction material have been let, and a force of radio experts will immediately begin work.

The Division of Power Resources of the Geological Survey, in statistics covering the production of electric power and consumption of fuel by public-utility plants in the United States for the first four months of 1920, shows that New York State leads in hydro-electric output, the monthly total for that state reaching 268,736,000 kw.-hr. for April against 292,336,000 kw.-hr. produced by fuel. California ranks second by water power, with 219,475,000 kw.-hr. for April. Montana comes third with 100,008,000 kw.-hr. and Washington fourth, with 95,672,000 kw.-hr.

The Public Service Corporation of New Jersey has indefinitely postponed construction of the 200,000-kw. power station for which a twenty-five million dollar corporation had been planned. Prime factors in stopping the proposed construction are the extremely high prices of fuel, labor and cost of material. The company is having difficulty in obtaining fuel for present requirements, and it was pointed out that the operation of a power plant of the size contemplated would increase the amount of fuel consumed from 25 to 50 per cent. Under present conditions it would be impossible to obtain the necessary amount of fuel.

Trade Catalogs

The Hi-Voltage Equipment Co., Cleveland, Ohio, has ready for distribution a new 16-page catalog entitled "Hi-Voltage." It contains descriptions and illustrations of air-brake switches, horn-gap fuses, choke coils, etc. A copy of the catalog will be sent upon request.

"Portable Floor Cranes and Hoists" is the title of a new 34-page catalog now ready for distribution by the Canton Foundry & Machine Co., of Canton, Ohio. Complete descriptions of the portable floor cranes and hoists handled by this company are contained in the booklet, together with illustrations. A copy can be had on request.

"Power Machinery" is the title of a new 48-page catalog now ready for distribution by McGovern & Co., Inc., of New York. A complete classified list of power machinery, including air compressors, electric cables, condensers, cranes, compound and simple engines, feed-water heating, alternating-current and direct-connected generators, gas and oil engines, turbines, etc., is given. A copy of the booklet will be sent on request.

The Buffalo Forge Co., engineers and manufacturers, of Buffalo, N. Y., have published a new 51-page catalog entitled "Niagara Conoidal Fans." It contains tables of performances that should prove valuable to engineers and architects in making selections to meet any demands encountered in ordinary heating and ventilating practice. Complete descriptions, accompanied by illustrations of the various types of fans handled by this company, are also contained in the booklet. A copy will be sent on request.

Bituminous Coal on the Atlantic Seaboard

Soft coal is much in demand and now that buyers will pay a price more nearly competitive with export business, the coal comes forward, at $17 to $20, according to a recent payment for southern coal f.o.b. car at Boston, plus whatever charges accrue. Even the high volatiles are being readily absorbed and with the railroads still endeavoring to get a supply of fuel, there is no likelihood of a decline in prices. A reasonably large proportion of New England coal is coming in on contract. A few industrial plants are in serious difficulties.

Current quotations for bituminous at wholesale range about as follows:

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons........	$10.50@$11.75	$11.50@$13.00
F.o.b. Philadelphia, gross tons	13.60@ 15.00	14.75@ 16.50
F.o.b. New York, gross tons..	14.00@ 15.40	15.10@ 16.85

The improvement in car supply in parts of the Clearfield region and the conferences that have been held in New York by committees of railway executives and bituminous operators have led many to believe that the peak in prices has been reached. It was estimated that there were about four thousand cars of coal at the various loading docks on July 16, of which twenty-five hundred had been reported to the New York Tidewater Coal Exchange. Quotations at the mines on pools 1, 9 and 71 range from $13 to $14 with little being offered; pool 10, around $12.50; pools 11 and 18, $11.75 to $12.50, and pool 34, $11.75. Quotations, f.o.b. piers, range from $16 to $16.25 and from $17 to $17.25 alongside docks.

Despite reports of a better car supply, Philadelphia prices remain high. Pennsylvania steam coal sells at from $12.50 to $14 at mines, with a little tonnage of ordinary steam coal, mostly pool 18, offered around $12. The Westmoreland and Youghiogheny gas coals are reported to be selling anywhere from $13 to $15 a ton at the mines, with Fairmont coals somewhat lower, $12.50 at the mines being the average for all grades.

At Baltimore there is the greatest congestion of coal carrying vessels in the history of the ports. At or off the Curtis-Day pier are fifty-three ships to take on a total of about three hundred thousand tons of coal, while at the Canton pier are seven or eight vessels ready for fifty thousand tons. Loadings coastwise and for export by permit are being pushed and in the first part of July there was a total export loading of 150,000 tons, of which 135,000 was cargo coal. At tide, however, there is only some 2,000 cars of coal, with about the same number moving from the mines, so that all the coal in sight at this moment cannot load the waiting ships promptly. At the mines the usual procedure is for the purchasers to make their offers and the producers to accept the highest. Coal is selling at the present time, on which the consumer has not been billed and is trusting that he will be charged a fair price. Sales at the mines of best coal have been generally $11 to $13 per net ton.

New Construction

PROPOSED WORK

N. H., Portsmouth—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until Aug. 11 for removing and reconstructing boiler and stokers. Noted July 20.

Mass., Watertown—Lockwood, Greene & Co., Archts. and Engrs., 60 Federal St., Boston, will soon receive bids for a 1 story, 200 x 230 ft. foundry including a steam heating system for the Walker & Pratt Mfg. Co., 31 Union St., Boston.

Conn., Bristol—The School Comm. will receive bids until Aug. 3 for a 3 story high school including a steam heating system at Dunbar Meadows. About $750,000. Wilson Potter, 22 East 17th St., New York City, Archt.

Conn., Hartford—St. Francis Hospital will soon award the contract for a 3 story hospital including a hot water heating system on Woodland St. About $500,000. Sister Valencia, Superior.

Conn., Waterbury—The Connecticut Military Emergency Bd., State Armory, Hartford, will soon award the contract for a 4 story, 180 x 200 ft. armory including a steam heating system on Field St. About $400,000. Louis A. Walsh, 51 Leavenworth St., Archt.

Conn., Westport—E. T. Bedford, Greens Farms, will soon award the contract for a 2 story Y. M. C. A. building including a steam heating system on State St. About $250,000. W. B. Tubby, 81 Fulton St., New York City, Archt.

N. Y., Annandale—Stephens College plans to construct a college building including a steam heating system. About $600 000. Hoppin & Koen, 4 East 43rd St., New York City, Archts. and Engrs.

N. J., Garfield (Passaic P. O.)—The Bd. Educ. will receive bids about August 15 for a 2 story, 83 x 150 ft. school including a steam heating system on Lincoln Pl. About $225,000. A. L. Vegliante, Archt.

Pa., Philadelphia — Congress, Wash., D. C., appropriated $270,000 for the completion of the power plant including the installation of equipment at the Frankford Arsenal here and $88,000 for the installation of high tensioned electrical transmission lines from the power plant to the shops.

Pa., Philadelphia — The Temple University, 18th St. and Buttonwood Ave., is having plans prepared for a 6 story, 300 x 300 ft. college building including a steam heating system on Montgomery and Broad Sts. About $500,000. Philip H. Johnson, 1713 Sansom St., Archt. and Engr.

Pa., Scranton—The Bour Refractories Co., Laurel Line and Front St., plans to construct a 3 story, 90 x 200 ft. refractory including a steam heating system on Stafford Ave. About $300,000.

D. C., Washington — Congress appropriated $6,500 for the installation of new boiler tubes and mechanical stokers at the Columbia University for the Deaf.

Va., Richmond—A. G. Jones, 1418 East Main St., is having plans prepared for a 7 story, 70 x 150 ft. furniture warehouse including a steam heating system. About $400,000. Moores & Dunford, 38 South Dearborn St., Chicago, Archts.

Va., Richmond—The Transportation Motor Co., 1410 West Broad St., is in the market for a motor.

N. C., Four Oaks—The Ivanhoe Mfg. Co. plans to build mill 3 here. Plans include a warehouse and small heating plant. J. E. Sirrine, Greenville, S. C., Engr.

Miss., Magnolia—Jarvis A. Kramer plans to construct a 100 ton ice and cold storage plant.

La., New Orleans—The Packers' Architectural and Engineering Co., Archts. and Engrs., 431 South Dearborn St., Chicago, will soon award the contract for a 2 story, 100 x 198 ft. main building, 1 story, 57 x 67 ft. power house and a 2 story, 24 x 36 ft. reduction plant for the Arabi Packing Co. About $400,000.

Ky., Louisville—The Columbia Realty Co., c/o Arland W. Johnson, Archt., 469 5th Ave., New York City, plans to construct a theatre including a steam heating system. About $700,000.

O., Cleveland—St. Alexis Hospital plans to construct a 4 story hospital addition including a steam heating system on B'way and McBride Ave. About $450,000. C. A. Grasselli, Chn. of the Bldg. Comn. W. C. Jansen, Electric Bldg., Archt.

O., Cleveland—The Theodore Butcher Co., 2129 West 19th St., is in the market for a 20 hp. horizontal boiler (new or used).

O., Cleveland—The Walter Ice Co., c/o A. C. Bishop, Archt. and Engr., Guardian Bldg., is having plans prepared for the construction of a 1 story, 45 x 146 ft. ice plant on West 25th St. About $75,000.

O., East Cleveland (Cleveland P. O)—The East Cleveland Bd. Educ. will receive bids until July 30 for a 1 story, 48 x 66 ft. heating plant including two 300 hp. boilers. About $100,000. C. Ammerman, Clk. W. H. Nicklas, 1900 Euclid Ave., Cleveland, Archt.

O., Elyria—The Bd. Educ. plans to build a 2 story school including a steam heating system on Gulf St. About $250.000. R. S. Silsber, Lorain County Bank Bldg., Archt.

Ind., Fort Wayne -- The Jackson Township School, Allen Co., plans to install a 3 kw., 110 volt generator, driven by a gasoline or kerosene engine, a 500 gal. per hour pump, driven by a 1 hp., 110 volt motor, with automatic control and to maintain a pressure of 50 lbs per sq in. in a pressure tank, a 2 pipe modulation system of direct indirect steam heating and ventilating. Separate bids for installing lighting and power plant, heating and ventilating, etc., will be received. F. G. Fortney, 509-510 Bass Blk., Archt.

Ind., Indianapolis — The Bd. of School Trustees plans to install a steam heating system in the proposed 2 story school on Talbot Ave. Cost, $250,000. And in the proposed school on Martindale Ave. Cost $425,000.

Ind., Indianapolis—R. Hassler, 1435 Naomi St., is in the market for three 12,000 gal. capacity pumps, compressor and a blower to be installed in the proposed pump house at Hassler Polo Field.

Ind., Syracuse — The Wawassee Tire & Rubber Co., c/o R. L. Simmons, Archt., Elkhart, is having plans prepared for a 4 story, 175 x 175 ft. factory including 4 tubular boilers. About $600,000.

Mich., Bay City—The city is having preliminary plans prepared for the construction of a new filtration plant and reservoir and steam pumping system. About $[illegible],000. [illegible] Elms Sha[illegible] Co., 1223 Illuminating Bldg., Cleveland, O., Engrs.

Mich., Detroit—The Com. of Pub. Wks. will soon award the contract for furnishing and installing, six mile road pumps and motors including one 8 ft. and one 10 ft. vertical centrifugal motor driven pumps, one [illegible] hp. motor for 8 ft. pump and one [illegible] hp. motor for 10 ft. pump.

Mich., Mt. Pleasant—Congress, Wash., D. C., appropriated $46,000 for a power and heating plant at the Indian School here.

Ill., Breese—The city plans to construct a [illegible] volt 3 phase a.c. electric power line from here to Aviston including transformer stations, poles, etc. Fuller & Beard, Chemical Bldg., St. Louis, Mo., Engrs.

Ill., Chicago—Henshein & McLaren, Archts., 37 West Van Buren St., will soon award the contract for a 3 story, 11[illegible] x 170 ft. packing plant including a steam heating system on West 39th St. and Emerald Ave. for David Levi & Co., West 40th St. and Packers Ave. About $350,000.

Ill., Chicago—W. Kelly, c/o George C. Nimmons & Co., Archt., 122 South Michigan Ave., is having plans prepared for a 9 story, 75 x 100 ft. office building including a steam heating system at 546-48 South State St. About $500,000.

Wis., Florence—C. R. Johnson, Secy. Committee on Waterworks Improvements, will receive bids until Aug. 15 for furnishing 2 centrifugal motor driven pumps from 100 gal. to 500 gal. capacity, 2 operating panels equipped with automatic controllers, meter and oil switches, one electric siren and one small air compressor. W. G. Kirchoffer, 316 Vroman Blk., Engr.

Minn., Argyle—The city plans to build an extension to a high power transmission line from here to Crookston and install an electric light and power system. About $30,000. E. A. Brekke, City Clk.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, is having plans prepared for a 4 story administration building including a steam heating system on the State University campus, here. About $1,000,000. C. H. Johnston, 715 Capitol Bank Bldg., St. Paul, Archt.

Minn., St. Paul—The Bd. Educ., City Hall, received bids for installing heating and ventilating system in the proposed 3 story, 64 x 96 ft. school on Lafond and Avon Sts., from the Hankee Heating Co., 925 Merchants' Natl. Bank Bldg., $14,108; O'Neil Plumbing & Heating Co., 97 East 8th St., $19,993.

Minn., St. Paul—The Bd. Educ., City Hall, received bids for installing a steam heating system in the proposed 2 story, 60 x 128 ft. addition to school on Hamline St. between Jefferson and Lansing Sts., from The Hankee Heating Co., 925 Merchants' Natl. Bank Bldg., $14,814; O'Neil Plumbing & Heating Co., 97 East 8th St., $15,983

Kan., Lawrence—Congress, Wash., D. C., appropriated $20,000 for improving the heating and power plant at the Haskell Institute here.

Mont., Rockcreek—The state plans to construct a power plant to have a capacity of 20,000 kw. here.

Mont., Ronan—The state plans to construct a power plant on the Indian Reservation near here.

N. D., Fargo—E. G. Guthrie, Clk., will soon award the contract for a 2 story, 63 x 168 ft. junior high school, including a steam heating system for the Bd. Educ. About $110,000.

Mo., St. Louis—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., received bids for a boiler plant at the Marine Hospital here, from William Wilby, Selma, Ala., $1,000; Werner Hencke Plumbing Co., 2335 South Grand St., $1,095; Elliott & Barry Eng. Co., 1426 Olive St., $1,115. Noted July 7.

Tex., Brownwood—McCully & Co. is in the market for power equipment.

Tex., San Benito—The Cameron Co. Water Improvement Dist. will receive bids until July 29 for furnishing 1 [illegible] Semi-Diesel engine and centrifugal pump of sufficient capacity to deliver 10,000 gal. of water per min. discharging against a variable head up to 20 ft. Address F. S. Robertson, Genl. Mgr.

N. S., Halifax—The City Council voted $70,000 bonds to install a water meter system and new pumping station.

N. B., St. John—The York Cotton Mills will receive bids until August 1 for the electrification of its plant here and is in the market for equipment. Cost, over $100,000.

Ont., Kenora—The Lake of the Woods Pulp Mill Co. plans to develop the water power here. About $1,000,000.

Ont., London—The Columbia Handle Co. plans to install a steam plant and is in the market for engine, boiler and equipment. W. H. Braddon, Genl. Mgr.

Ont., London—George M. Reid, 391 Clarence St., will receive bids until August 21 for a 16 story, 100 x 180 ft. hotel including a steam heating system on Richmond St. About $1,500,000.

Ont., London—The Utilities Comrs are having plans prepared for a new power dam at Springbank. About $200,000. Equipment will be installed in same. E. V. Buchanan, Hydro Bldg., Genl. Mgr.

CONTRACTS AWARDED

Mass., Fall River—The New England Oil Co. will build 6 buildings, including a 24 x 40 ft. addition to boiler house along the Taunton River here. About $100,000. Work will be done by day labor.

Mass., Foxboro—The City has awarded the contract for the installation of central plant steam mains, etc., in the Foxboro State Hospital, to the Power Heating & Ventilating Co., 66 Travers St., Boston, at $13,055. Noted July 13.

Mass., Somerville—The Sturtevant & Haley Beef & Supply Co., 40 Fanueil Hall, Boston, has awarded the contract for the 2 story, 25 x 60 ft. refrigeration plant on Somerville Ave. to Harold H. Clark, 10 Dearborn Rd. About $20,000.

R. I., Cranston—The Narrangansett Finishing Co. has awarded the contract for a 1 story, 45 x 65 ft. boiler house addition to the C. I. Bigney Constr. Co., 357 Westminister St., Providence, at $30,000.

. **N. Y., Kings Park**—Lewis F. Pilcher, State Archt., has awarded the contract for the installation of heating, etc., at the Kings Park State Hospital, here, to W. B. Armstrong Co., 3 Fulton St., Albany, at $124,000 Noted June 1.

Pa., Scranton—Linder Bros. have awarded the contract for a 3 story, 90 x 160 ft. garment factory including a steam heating system and electric power on Capouse and Poplar Sts., to the E. A. Fuller Co., Dickson Ave., at $160,000. One hundred electric motors will be installed in same.

O., Cincinnati—The Union Gas & Electric Co., 4th and Plum Sts., has awarded the contract for a 1 story, 65 x 95 ft. electrical substation at 220 West 8th St. to the Foundation Co., Front and Rose Sts., at $40,000.

O., Cleveland—The Cleveland Electric Illuminating Co., Illuminating Bldg., has awarded the contract for a 2 story, 36 x 1[illegible] ft. substation addition at 1753 East 17th St. to F. E. Hauselman, 408 Illuminating Bldg., at $60,000.

Ind., Indianapolis—McCoy & Garten, 518 South Senate St., has awarded the contract for a 6 story, 81 x 190 ft. warehouse including boilers, etc., on South St., to the Bedford Stone & Constr. Co., Fletcher Savings & Trust Bldg., at $300,000.

Ind., Indianapolis—The Pioneer Brass Wks., 124 South Pennsylvania St., has awarded the contract for a 1 story, 200 x 300 ft. factory including boilers on 23rd St. and the Lake Erie Western R.R., to John G. Karstedt Constr. Co., 429 Lemcke Bldg. About $200,000.

Ill., Chicago—The Ajax Forge Co., 2503 Blue Island Ave., has awarded the contract for three 1 story buildings including a small boiler shop on Hoyne and Blue Island Aves., to Charles B. Johnson & Son, 111 West Washington St., at $300,000.

Wis., Colby—The Hoeppner-Bartlett Co., Eau Claire, will build a canning factory including a 2 story 42 x 166 ft. main building and a 20 x 56 ft. boiler house.

Wis., Madison—The State Bd. of Control has awarded the contract for a power house at the State Home for Women to the Immel Constr. Co., Fond du Lac, at $26,483.

Minn., Hallock—The village has awarded the contract for furnishing power plant equipment, to J. G. Robertson, University and Eustis Sts., St. Paul, at $24,46[illegible].

Minn., Kennedy—The Kennedy Electric Line Co., Inc., has awarded the contract for a 15 mi. transmission line from here to Hallock, to the Triumph Electrical Co., Minneapolis, at $10,724.

Minn., Minneapolis—The Lincoln Motor Sales Co., 219 Metropolitan Bank Bldg., has awarded the contract for installing a heating and ventilating system in the proposed 66 x 145 ft. sales and service building on 12th St. and Harmon Pl., to Charles Wilkins & Co., 21[illegible] South 7th St., at $16,640.

Minn., Minneapolis—The Northwestern Terminal Co., 121[illegible] Soo Line Bldg., has awarded the contract for installing a heating and electric system in the proposed 3 story, 100 x 200 ft. warehouse on Stinson Blvd. and B'way, to Harry C. Ridler, 3842 Pleasant Ave.

N. D., Grand Forks—The Industrial Comn. of North Dakota has awarded the contract for a reservoir, power house and plant including boilers, stokers, etc., to the Fegles Constr. Co., Minneapolis. Noted May 25.

Neb., Lincoln—The Bd. Educ. has awarded the contract for the installation of a heating system in the proposed Prescott School, to Phelps Underwood, at $77,545.

Wash., Seattle—The city has awarded the contract for the completion of the third unit to the Lake Union steam plant at Eastlake and Nelson Pl., to the Hurley Mason Co., Lowman Bldg. About $200,000.

Cal., San Diego—The Naval Pub. Wks. Office received only bid for refrigerating equipment and cold storage installation at the marine brigade post here, from the York Constr. Co. of Los Angeles, 308 Boyd St., Los Angeles, $34,500.

Que., La Tuque—The Brown Corp. Ltd. is in the market for 1 belt driven, forced draft fan, to have a 45,000 cu.ft. per min. capacity at 5 ft. pressure and one 12 x 15 ft. storage tank.

Ont., Toronto—The Grinnell Co., Ltd., has awarded the contract for a 1 story, 100 x 150 ft. foundry building including motors and a forced draft heating system, etc., to the Anglin Norcross Co. Ltd.

NEED COMPETENT MEN?

SEE THE SEARCHLIGHT SECTION

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POWER

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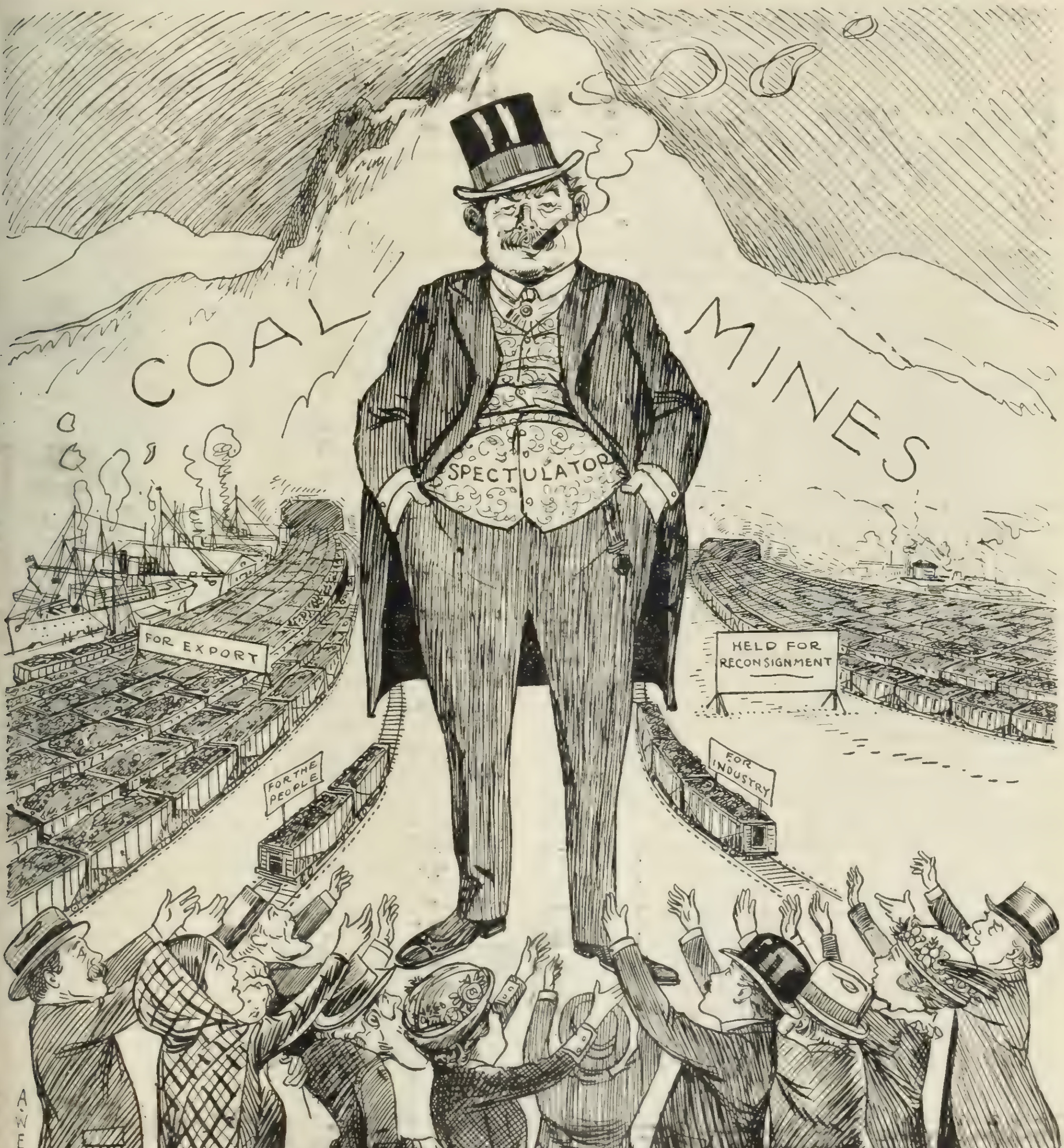


How Long Will This Condition Endure?

Connected Load Versus Generator Capacity

By FRASER JEFFREY

Electrical Engineer, Allis-Chalmers Manufacturing Company

Application of load in power plants having small power resources is a real problem—not a hit-and-miss proposition with troubles numerous and varied as an aftermath. There are limitations to field excitation, and the power factor of the load has a direct bearing, particularly during the starting periods of squirrel-cage induction motors.

SCATTERED throughout the country are many small isolated plants and central stations furnishing power to the local districts in their immediate vicinity. When these stations are located in a village or town, they usually supply street lighting and sometimes a connected power load for motor-driven ice machines and pumping units for town supply purposes. In addition to this there is a certain amount of industrial and private lighting load requiring electrical energy for the operation of this equipment.

In some of these plants the generating machinery consists of two prime movers so arranged that both units are run during the daytime when the maximum power-load condition prevails, and only one unit during the night to take care of the lighting and small power-load demand. In others of these stations only one prime mover is to be found, the daily 24-hour load factor being maintained as high as possible by operating the ice and pumping plants during the night, to balance up on the demand during the day.

There is always a temptation on the part of these small central stations, whether the equipment is driven by steam, gas engine or waterwheel, to accept contracts for delivering energy for operating a comparatively large number of induction motors which at times may be greatly underloaded or for operating induction motors relatively large as compared to the capacity of the generating equipment. Offhand it would appear to be a good thing to load up an otherwise underloaded equipment with a large number of motors or one or two big motors. However, the conditions are frequently not fully appreciated at the time these contracts are made. Everything runs along nicely until the new load is placed on the line, and the realization then comes that things are not as they should be. This condition of affairs applies not alone to the small central station, but to every other small plant such as might be found in any manufacturing concern generating electrical energy for its own immediate needs. It is a condition of affairs brought about through lack of a thorough understanding of some of the inherent characteristics of the prime mover, the electrical generating equipment, or the connected load in all of their essential points.

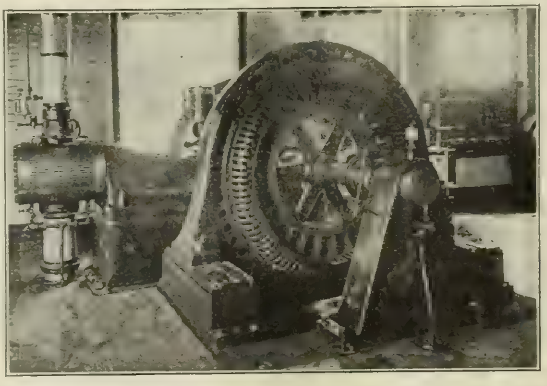


FIG. 1. STEAM-DRIVEN UNIT OF 100-KW. CAPACITY AT 80 PER CENT POWER FOCTOR

Consider a modern alternating-current system of generation such as is used in many small plants. A concrete example will show some of the inherent features of this type of equipment. Take, for example, a station having a single high-speed, direct-connected steam-driven unit similar to Fig. 1. The machine has a rating of 125 kva., maximum at 80 per cent power factor, 2,300 volts, 31.4 amperes, three-phase, 60 cycles, 257 r.p.m. Confining ourselves to the electrical end only of this equipment, the rating of the generator may be stated in a somewhat different manner. It might be said that the machine in question is capable of delivering 125 kva. (kilowatt-amperes) to a system requiring this amount of energy at 80 per cent power factor. In a three-phase alternator kva. $= \frac{EI \times 1.732}{1,000}$; in the machine under discussion, kva. $= \frac{2,300 \times 31.4 \times 1.732}{1,000} = 125$. Or it may be said that the machine will deliver 100 kw. of true energy at 80 per cent factor. The true power kw. (kilowatts) delivered by a three-phase generator is kw. $= \frac{EI \times P.F. \times 1.732}{1,000}$, where E equals the volts between terminals, I equals the current per terminal and $P.F.$ equals the power factor. In our problem kw. $= \frac{2,300 \times 31.4 \times 0.8 \times 1.732}{1,000} = 100$. Any alternating-current generator is capable of maintaining its voltage at normal speed and delivering an amount of wattless current (zero power factor) equal to the limit of its capacity, but represents zero energy or power. Under such conditions the engine would have to supply only the copper and iron losses in the generator, as it is delivering no true energy. It is therefore seen that in any alternating-current system the question of power factor cannot be overlooked.

Knowing the effect of power factor on the true power delivered, the limitations of an alternator can be best considered by referring to the curves in Fig. 2, showing the characteristics of the 125-kva. 80 per cent power factor 2,300 volt machine previously mentioned. If the terminals of the generator, when operated at its normal speed, are open-circuited and the fields excited with gradually increasing increments of direct current, then the terminal voltage for any given field excitation is shown by the no-load saturation curve A. If a 100 per cent power factor load of normal rating (31.4 ampere) is provided, more field excitation, 35 amperes, is required, as indicated by curve B, to maintain the terminal voltage of 2,300 than for no load. This is due to the impedence voltage drop in the armature and also the reactions of the load currents tending to shift the field magnetizing flux, so that it is not as effective under load conditions as it is under no-load conditions. Curve *C* shows the further increased demagnetization effect of an inductive full-load current of 31.4 amperes at 80 per cent power factor. A field current of 48.5 amperes is required to maintain normal voltage. If an inductive full-load current of 31.4 amperes at zero power factor is provided (by means of special tests and test machines), still more field excitation, 57.5 amperes, is required to maintain the terminal voltage, as shown by curve *D*. Therefore it can be seen that in order to maintain the terminal voltage under full-load conditions and normal speed with gradually decreasing power factors, increased field excitation is required.

It is evident that there must be some limit to the maximum excitation that the fields of the generator can safely carry. Referring to Fig. 2, it is found that if the current in the field coils is maintained at any given value until the temperatures become constant, the temperature rise in the field coils, by resistance expressed in per cent, is shown by curve *E*. For full voltage of 120 on the exciter, the fields heat up 18.8 per cent (by resistance) and the maximum field excitation possible with hot fields is 52 amperes. It is, therefore, not possible to carry full-load current at zero power factor on the machine under consideration, because the limitations of the fields are such that the normal terminal voltage of 2,300 cannot be maintained. The machine is designed to carry its full-load current of 31.4 amperes at 80 per cent power factor and requires 48.5 amperes excitation. The fields have a slight margin up to 52 amperes, which can be used in cases of emergency such as short periods of overloads, temporary loads at power factors less than 80 per cent, etc.

On the 125-kva. generator under discussion, when carrying its full load at 80 per cent power factor, the fields heat up 16 per cent (by resistance) or, in terms of temperature, rise above an ambient air temperature of 40 deg. C. (104 deg. F.), the temperature rise in degrees Centigrade equals $16 \div (100 \times 0.00364) = 44$, where 0.00364 is the temperature coefficient of copper at 40 deg. C. (104 deg. F.).

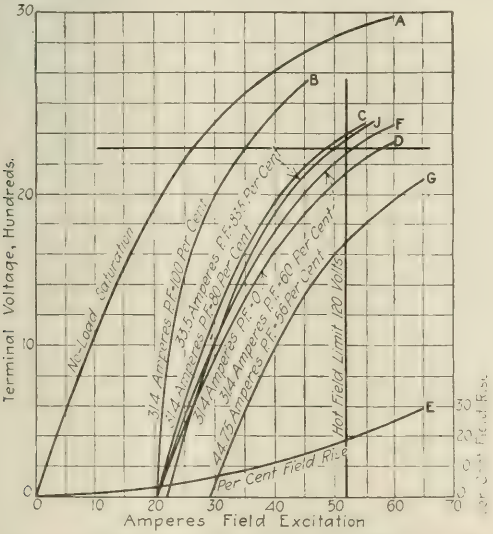


FIG. 2. CHARACTERISTIC CURVES OF THE 125-KVA. GENERATOR

To obtain the hot-spot correction according to the accepted rules of the American Institute of Electrical Engineers, a correction of 10 deg. C. (18 deg. F.) must be added to the value given, making a total temperature rise of $44 + 10 = 54$ deg. C. (129 deg. F.). This is not unreasonable and is within the generally accepted safe working temperature for this class of machine. Furthermore, the field margin is small, and even under maximum field conditions such as might be used temporarily, the greatest temperature rise possible is 18.8 per cent $= 51.5 + 10 = 61.5$ deg. C. (142.4 deg. F.).

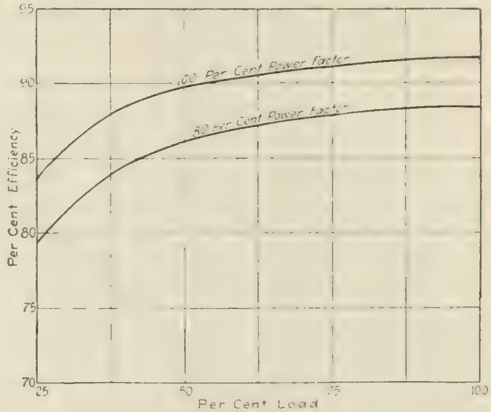


FIG. 3. EFFICIENCY CURVES, SHOWING EFFECT OF POWER FACTOR

It then follows that a knowledge not only of the amount of actual load, but also of the power factor, must be given careful consideration. In addition to this the speed regulation of the steam engine, gas engine or waterwheel driving the generator cannot be overlooked. The curves of Fig. 2 are based on the exact normal speed of 257 r.p.m. being maintained. Any falling off in the speed immediately reflects in a falling off in the terminal voltage unless the field excitation can be increased to make up the discrepancy.

The small power plant is liable to load up, or to slightly overload a generator with a number of induction motors having a fairly low power factor. If the motors are underloaded, as is often the case, the condition may be further aggravated by still lower power factors, so much so that the alternator is unable to hold up its terminal voltage, as shown by curve *F*, Fig. 2. Sometimes the exciter is speeded up to give a higher voltage and thus afford the greater excitation necessary to hold up the voltage. The point is often overlooked that by so doing, the heating in the fields may be increased to a dangerous extent.

Another direct effect of low power factor is a decided falling off in efficiency. This is natural because the increased field current necessary to sustain the terminal voltage incurs an added loss in the field copper itself. Inasmuch as the power output remains constant and the losses increase, the efficiency drops off. This is shown by Fig. 3, which gives the actual efficiency curves for the 125-kva. alternator whose characteristics are shown in Fig. 2.

Consideration has been given to the effect of inductive loads as might be obtained by using a number of induction motors which at times may be greatly underloaded. There is, however, another important point relative to the use of this type of motor, which offhand might not seem of any great consequence. It is a question that requires a knowledge of the starting phenomena of induction motors and can best be understood by a direct example.

Suppose that the 125-kva. alternator is carrying a load of only 70 kw. at 80 per cent power factor, or 87.5 kva. It might appear advisable to take on an additional load of a 40-hp. 2,300-volt induction motor of the squirrel-cage type. Combining this with the original load would give a total combined load on the generator of just about full load, or if the full-load efficiency of the induction motor is 92 per cent, the combined load would equal 70 + (40 × 0.746 ÷ 0.92) = 102.5 kw. of true power.

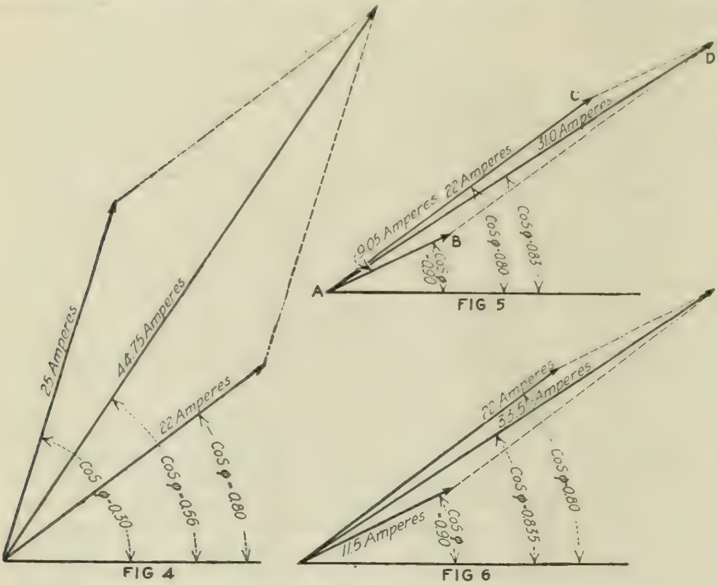


FIG 4 FIG 5 FIG 6

FIGS. 4, 5 AND 6. COMBINING LOADS VECTORIALLY TO OBTAIN RESULTANT LOAD

If the full-load power factor of the induction motor is 90 per cent, then its full-load current equals

$$\frac{40 \times 0.746}{2,300 \times 1.732 \times 0.92 \times 0.90} = 9.05 \text{ amperes, and}$$

may be represented to scale in magnitude and time phase relationship by the line *AB*, Fig. 5. Similarly, the line *AC* represents in like manner the 70 kw. at 80 per cent power factor equals $\frac{70 \times 1,000}{2,300 \times 1.732 \times 0.80}$ = the 22-ampere load. Combining these two vectorially, the resultant load is shown by the line *AD* and is 31 amperes or $\frac{2,300 \times 31 \times 1.732}{1,000} = 123.5$ kva., and the new power factor equals $\frac{102.5}{123.5} = 0.83$.

It will be noticed that the addition of the 40-hp. induction motor has raised the power factor of the whole system 3 per cent; that is, from 80 to 83 per cent. Apparently this is a good thing, but a study of the starting conditions of the squirrel-cage motor are necessary to determine all the effects the motor load has as regards the regulation of the alternator.

The usual method of starting a squirrel-cage induction motor is by means of a potential starter which impresses on the terminals of the stator winding a voltage less than normal in order to minimize the line disturbance that would be created by throwing the motor directly across the line. Incidentally, it is less of a shock to the motor and to the driven machine. After the motor is up to speed, the stator winding is connected directly across the line, as in diagram *B*, Fig. 7.

Assume that the 40-hp. motor in question, if thrown directly across the line, will draw a current of 59 amperes, or 6.5 times normal. While this is an unusual amount of current, it is characteristic of this type of machine. Another inherent feature is that the power factor is extremely low during the starting period, and in this particular case is 30 per cent, a fair average for this class of motor.

If starting by means of a potential starter, sketch *A*, Fig. 7, the torque conditions require the motor to be connected to the system on the 65 per cent tap, the current drawn by the motor (neglecting all line losses) equals 59 × 0.65 = 38.4 amperes, and the current drawn from the line is 59 × 0.65 × 0.65 = 25 amperes. This current has a power factor practically the same as the full short-circuit current of the motor. Combining it vectorially in Fig. 4, with the 22 amperes load at 80 per cent power factor on the generator, it is found that the resultant current has a value of 44.75 amperes at 56 per cent power factor. Referring back to Fig. 2, curve *G* shows the relation between terminal voltage and excitation required to maintain the generator voltage with this load at this particular power factor. It can be seen that even with full field, and assuming the ideal condition of constant engine speed, the generator voltage cannot be maintained. The fact must not be lost sight of that the starting period of the motor is more or less of a temporary condition. Under usual favorable conditions it should not exceed one minute. In the present case, if it were possible for the engine to maintain its speed, the generator voltage would drop, with full field excitation, to 1,690 volts, and the period of starting would be lengthened to possibly three or four minutes. The whole situation would undoubtedly be further aggravated by a considerable drop in the engine speed, tending to a still further drop in the line voltage. Although the motor would probably start and come up to speed provided the torque requirements were not too great, it is seen that a considerable disturbance is created on the line. This is enough to cause a distinct flickering of any lights as well as to create the liability of knocking out any other induction motors that might be on the system, because it must be remembered that the output and torque of these machines varies as the square of the impressed voltage.

To alleviate the conditions as much as possible, some type of automatic voltage regulator in the field of the alternator would be necessary, for it is self-evident that hand regulation of the field would not act rapidly enough to meet the conditions of a rapidly fluctuating load. Even the addition of such a device, while tending to maintain an even terminal voltage under erratic loads, would not prevent subnormal voltages in case the load demand should exceed the limitations of the field. A solution of this particular problem, provided the squirrel-cage motor cannot be started under light load or on a lower tap of the potential starter, can be found in the use of a slip-ring type induction motor. Unlike the squirrel-cage machine, which exerts a relatively small amount of torque with large currents at low power factor when starting, the slip-ring motor exerts a relatively large amount of torque with a minimum current at high power factor, under the same conditions. The torque, current and power-factor characteristics during starting are dependent on the control apparatus used. Ordinarily, standard control apparatus is made so that the motor exerts 125 per cent of normal torque with 125 per cent of normal full-load current and a power factor, under these conditions, corresponding to 125 per cent running load power factor.

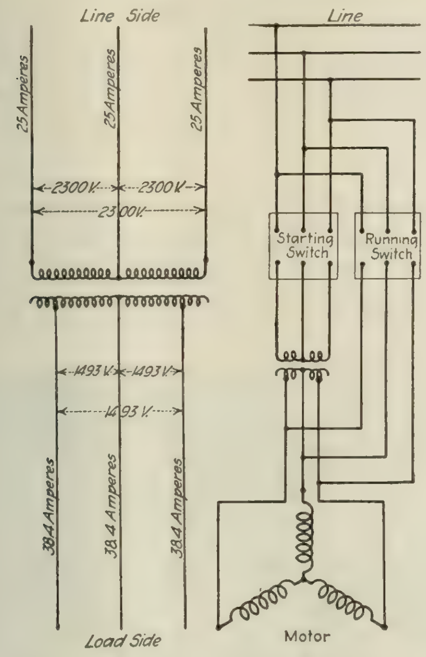


FIG. 7. MOTOR STARTING AND RUNNING CONNECTIONS

The resultant load current and power factor, assuming 125 per cent starting current at 90 per cent power factor, when replacing the squirrel-cage motor with the same size of slip-ring motor, is shown in Fig. 6. Transmitting this back to Fig. 2 curve *J* indicates that the generator will have no trouble in holding up its voltage provided the regulation of the engine is all that it should be.

Briefly summarizing, it may be stated that the examples and problems as given previously cover only the specific questions in point. Undoubtedly, problems entirely foreign to those cited may come up; different conditions may prevail; methods for relieving loads on squirrel-cage motors during starting might be used in some cases to get around the use of the slip-ring motor. Large plants with practically unlimited power resources encounter different problems from those of the small plant having small power capacity. A knowledge of their limitations is required for their successful operation. Application is not just a hit-and-miss proposition; it is coming to be more and more recognized as a very important subject.

Fuel Economy Outside the Boiler Room

By Rowland L. Tullis

A great deal has been written on the subject of economy in the boiler room, and much of it has no doubt been read, digested and put to good use by both operating and chief engineers. This is both fit and proper. It is absolutely necessary that the engineer do his best to produce steam as economically as possible, but it is a waste of human energy as well as mechanical energy for an engineer to produce economically and later allow it to go to waste or use it uneconomically. In too many cases this is exactly what happens. An example of this is shown in the case of the chief engineer of a large hotel who made such a mistake, and whose mistake was rectified by another who went outside the engine room to look for trouble.

The hotel had originally consisted of one four-story wooden wooden-framed building of about 160 rooms. Although the building could not be called modern in any respect, the management seemed to make money out of it and soon acquired a six-story building next door. Finally, they erected a thirteen-story, modern fireproof structure on the corner, making altogether a hotel of more than a thousand rooms. A large, modern hotel power plant was installed in the new building, designed to supply heat, light and power for the entire property, consequently the power plant in the old building was shut down, and the chief engineer was transferred to the new plant with an increase in salary.

This man was considered a competent and reliable engineer by his employers. He had been with them for many years, and they had been well satisfied with the service that he rendered. Two years ago he died and a new man was hired. As is usually the case, the hotel owners entertained some grave misgivings about the selection of a stranger to fill the old chief's place.

The new chief engineer was a man of long and varied experience and had come well recommended. Like every ambitious engineer taking a new position, he was on a constant lookout for a chance to better the service, decrease operating expenses or increase the economical operation of the plant. There is no doubt that he was looking for a chance to make a reputation for himself and thereby increase his monthly compensation.

First he made a careful survey of the boiler room, which contained four 250-hp. water-tube boilers. He found that the boilers were fired properly, that the settings were in almost perfect condition and that the draft was closely regulated. An evaporation test showed that the old chief had been evaporating as much water as was humanly possible with the grade of fuel that was burned. There was absolutely no chance to make a reputation for himself in the boiler room, so the new chief turned his attention to the engine room. He examined the engines, put his indicator to use, and even went so far as to take off the heads and examine the cylinders, pistons and rings, but he found nothing that would give him an opportunity to make improvements. He was about to give up in disgust as it was evident that the old chief had been wide awake. Finally he decided to go over all the steam traps and the heating system in the building in a last endeavor to find some place where he could make an appreciable saving in steam. He didn't have far to go until he began to find troubles and opportunities a-plenty.

As is usually the case in a hotel power plant, the exhaust lines and drain lines from the engines, steam separators and traps were run in tunnels or trenches beneath the engine-room floor, the trenches being covered with diamond-plate. The casual observer would never suspect that beneath this diamond-plate flooring was hidden a maze of pipe lines, valves and traps. Unless something went wrong the average engineer would never go to the trouble of lifting the plates to see what was under them.

The engines had steam jackets provided with drains at both ends. These led to traps which discharged into the exhaust line from the engines. The chief found the traps on all the drain lines in a bad state of repair. Consequently, live steam was blowing through into the exhaust line. A number of the traps were shut off entirely, the bypasses were open and steam was being wasted where it couldn't be seen and where it would be least expected. Similar trouble was found on the kitchen and laundry lines. Many of the traps were full of mud or sediment which had been carried over from the boilers when they carried over water. The chief saw to it that every trap in the building was thoroughly cleaned and overhauled, and valves and seats were ground or replaced with new, where necessary.

Next he discovered that they were using a great amount of live steam for heating purposes throughout the building in cold weather, although the exhaust from the engines should be sufficient under all conditions. A few days later he took an entire day to go over the heating system with the house plumber, who was thoroughly acquainted with all the details of the system. The heating system of the new twelve-story building was found to be almost perfect. It was a modern two-pipe vacuum system with an individual trap on each radiator; steam was supplied to the radiators at from four to five pounds pressure, and returns were cared for by a vacuum pump in the engine room. The house plumber explained that he seldom had any trouble with this section of the hotel, but complaints were pouring in every day about the old section. It was almost impossible to keep the rooms warm with the present arrangement of heating.

The oldest part of the hotel, consisting of about four hundred rooms, was divided into two separate buildings each with its individual heating system. One section of the old building was equipped with the single-pipe system; that is, the steam was supplied to the radiators and the condensation returned through the same line to the basement of the building, where it was received by a master trap and dumped back to the feed-water heater in the engine room. It was about a hundred yards from the basement of this building to the new engine room. The whole arrangement was obsolete and sluggish in action. Occasionaly, the master trap would refuse to work and the entire system would fill with condensation. Live steam would then be turned on, but would do no good as long as the condensation was in the system.

The heating system of the other section of the old building was even more obsolete in design and arrangement. There was a large hot-water heater of the horizontal-tubular type in the basement, and a small motor-driven centrifugal pump received hot water from this heater and circulated it through the radiators. The water was heated by a combination of live and exhaust steam, and the 1¼-in. live steam inlet was usually open.

After making a detailed survey of the situation, the chief made a lengthy report to the office and had a talk with the hotel owner. In a few words he put it squarely up to him that it would cost about two thousand dollars to remodel the heating system. Most of the old piping could be used, but return lines and traps would have to be supplied for all the radiators. The owner kicked a little at first on the expenditure, but the engineer was adamant and finally got what he was after. The two-pipe vacuum system was finally installed and put into operation. There is no further need of live steam, seldom does a complaint come from the old building and the chief showed a saving in fuel oil last year of over twelve thousand dollars. His yearly remuneration is now $3,500, while his predecessor received a scant $2,000.

Good Lighting in Power Stations

There used to be a time when a power station was considered naturally black inside and outside. Owners perhaps thought that coal-blackened firemen fitted better into a kindly atmosphere of blackness. But that day has gone by. Power stations should be as light as a factory or a dairy lunch room. This is not only for the appearance of the station, but because good lighting has proved economical in inciting efficient, cheerful, safe work by the men in the station. The importance of good lighting has been proved everywhere in factories and it is no less important in power stations. Good lighting pays dividends through contented men and neat scientific operation. That is why power-station engineers and directors arrange for it.

BOILER ROOM, LOOKING EAST

The photograph shows the interior of the boiler room of the New Bedford Gas and Edison Light Co.'s power station built by Stone & Webster. Here excellent lighting is incorporated into the design.

The Emmet Mercury Boiler

A Binary-Vapor Power Plant Using Mercury Vapor and Steam

A brief account of a plan to use mercury vapor and water vapor for the generation of power appeared in the March 31, 1914, issue of "Power." That article was an abstract of a paper presented before the American Institute of Electrical Engineers by the inventor, W. L. R. Emmet. Further development work has been done on the apparatus, although necessary war-time activities have interfered somewhat. In spite of such interference much experimental information has been acquired.

IT IS a well-known fact that the efficiency of any heat engine may be increased by increasing the temperature range through which it works. There are two ways to do this. One is to lower the temperature of the exhaust, and the other is to raise the temperature of the supply. The minimum exhaust temperature is, of course, limited by the temperature of the available cooling water. The temperature of the supply is limited by the temperature of combustion of the fuel, and in a steam engine is further limited by the properties of steam. At reasonably high temperatures the pressure of steam becomes too great for convenient commercial operation.

To overcome this difficulty, Mr. Emmet has designed a binary-vapor plant using mercury vapor and water vapor. Mercury boils and condenses exactly like water except that its density is much greater and its boiling temperature much higher. For example, at atmospheric pressure mercury boils at 677 deg. F. and condenses in a 28-in. vacuum at 455 deg. F. The corresponding temperatures for water would be 212 deg. F. and 101 deg. F. respectively. Briefly, Mr. Emmet's scheme is as follows: Mercury is boiled in a boiler similar in principle to, but differing greatly in detail from, an ordinary steam boiler, and the mercury vapor produced is used to run a turbine. The exhaust from the mercury turbine is condensed in a form of surface condenser, which is also a boiler. The heat given out by the condensing mercury vapor makes steam of the cooling water, and this steam may be used to drive another turbine or for any other purpose for which steam may be required. The chief difficulties seem to be the large amount of mercury needed and the danger of leaks, as the mercury vapor is very poisonous.

The illustration (see insert) represents diagrammatically the elements of Mr. Emmet's apparatus. The products of combustion from the furnace pass upward through part of the tubes which form the heating surface of the mercury boiler, and then forward among the remainder. These tubes are connected to the lower mercury chest, which might be called the mud drum in a steam boiler and to the mercury header corresponding to the steam drum in an ordinary boiler above. Mercury vapor at about 10 lb. gage pressure is collected in the header and passes through the pipe shown to the mercury turbine. Owing to the high density and low spouting velocity of the mercury vapor this turbine may be a single-stage machine, of reasonably low speed, and may have short buckets. The wheel may be placed inside the mercury condenser for simplicity.

The mercury condenser consists of a tank, as shown, supporting another tank marked "Steam Drum." A number of straight tubes extend from the bottom of the steam drum down into the condenser. The exhaust from the mercury turbine is condensed on the surface of these tubes, and as the boiling point of the mercury at 28 in. vacuum is 455 deg. F., steam may be generated inside the tubes. Circulation in the tubes is provided by smaller tubes inside them, leading from the steam drum, which corresponds to the upper drum of a water-tube boiler. The steam that is generated in this condenser-boiler is led through the pipes marked "To Superheater" through the superheater and finally through the steam main to wherever the steam is to be used. The steam condensate, whether from a steam turbine or engine, heating system or manufacturing process, is returned to the condensed steam receiver. From here it is pumped to the feed-water heater, which is really an economizer. This feed-water heater is shown in the illustration directly below the mercury condenser. From here the water returns to the steam boiler, thus completing its cycle.

The mercury condensate is drained from the bottom of the mercury condenser to the lower mercury header and thence to the mercury boiler. The high density of mercury renders a feed pump unnecessary, as by setting the condenser above the boiler the latter can be fed by gravity.

The foregoing covers the general principle of the apparatus, but certain refinements seem necessary for its practical application.

The quantity of mercury that would be required if an ordinary steam-type boiler was used would make the cost prohibitive. For this reason a special type of boiler had to be designed to give a maximum heating surface and at the same time require a minimum amount of mercury. The first designs for the boiler proper called for the use of flattened tubes for the elements of the boiler. This shape of cross-section gives much more heating surface with less volume of liquid than a circular tube would give. The later designs call for sections of similar shape, but made up of sheet metal. Experiments are now going on to determine the necessary proportions of such elements to provide for proper liquid circulation and release of vapor.

The question of preventing leaks was a serious one, as even a small amount of mercury vapor leaking into the engine or boiler room would poison all the operators. Great care was exercised in the design and in the construction of the fittings and pipes containing the mercury vapor, the mercury parts of the outfit are run at low pressure so that there is a minimum tendency to leakage and means are provided to condense and save all mercury which leaks from joints. The diaphragm valve, which is shown on the mercury-vapor pipe near the mercury turbine, is simply a safety relief valve.

This safety valve, instead of discharging into the open air, is arranged to discharge into the mercury condenser.

The temperature of the mercury in the boiler is so high that the temperature of the flue gases leaving the tubes would be entirely too high for conomical operation if they passed directly to the stack. To avoid such losses the flue gases, after leaving the tubes of the boiler, pass over a mercury preheater (not shown in the illustration), then over the steam superheater, and finally over the feed-water heater or economizer, and then to the stack. In this way the temperature of the gases entering the stack can be made as low or even lower than would be possible with a steam boiler plant of the ordinary type.

It should be remembered that a steam turbine is not an essential part of this device, but the intention is to afford a substitute for the existing boiler. The steam may be used as it now is for any desired purpose. The mercury acts as a conveyor of heat from the furnace to the steam and incidentally delivers a certain amount of power as a byproduct. A large part of the power generated in the mercury turbine is net gain, as it comes in part from heat that would otherwise be rendered unavailable by the great drop in temperature between the furnace gases and the steam.

Another advantage of this process is that the interior of that part of the boiler exposed to the fire is always perfectly clean. Also the boiler in which steam is made is subject to no large temperature differences.

Mr. Emmet has claimed that by the addition of this device to an assumed good modern power station with an increase of 15 per cent in the amount of fuel used, the same amount of steam can be supplied to the steam turbine as under present conditions, and the mercury turbine will generate power equal to about 66 per cent of the power generated by the steam turbine. This results in a gain in station capacity of approximately 66 per cent with an increase of only 15 per cent in the amount of fuel required.

The experimental equipment was in operation for a short time last summer with over 1,000 kw. load on the mercury turbine, and its operation showed that the economies predicted were fully realized.

Trouble Hunting in Refrigerating Plants

How a Faulty Gate Valve in the Brine-Circulating System of a Southern Packing House Plant Causes a Freeze-Up of Nearly the Entire System

By J. C. MORAN

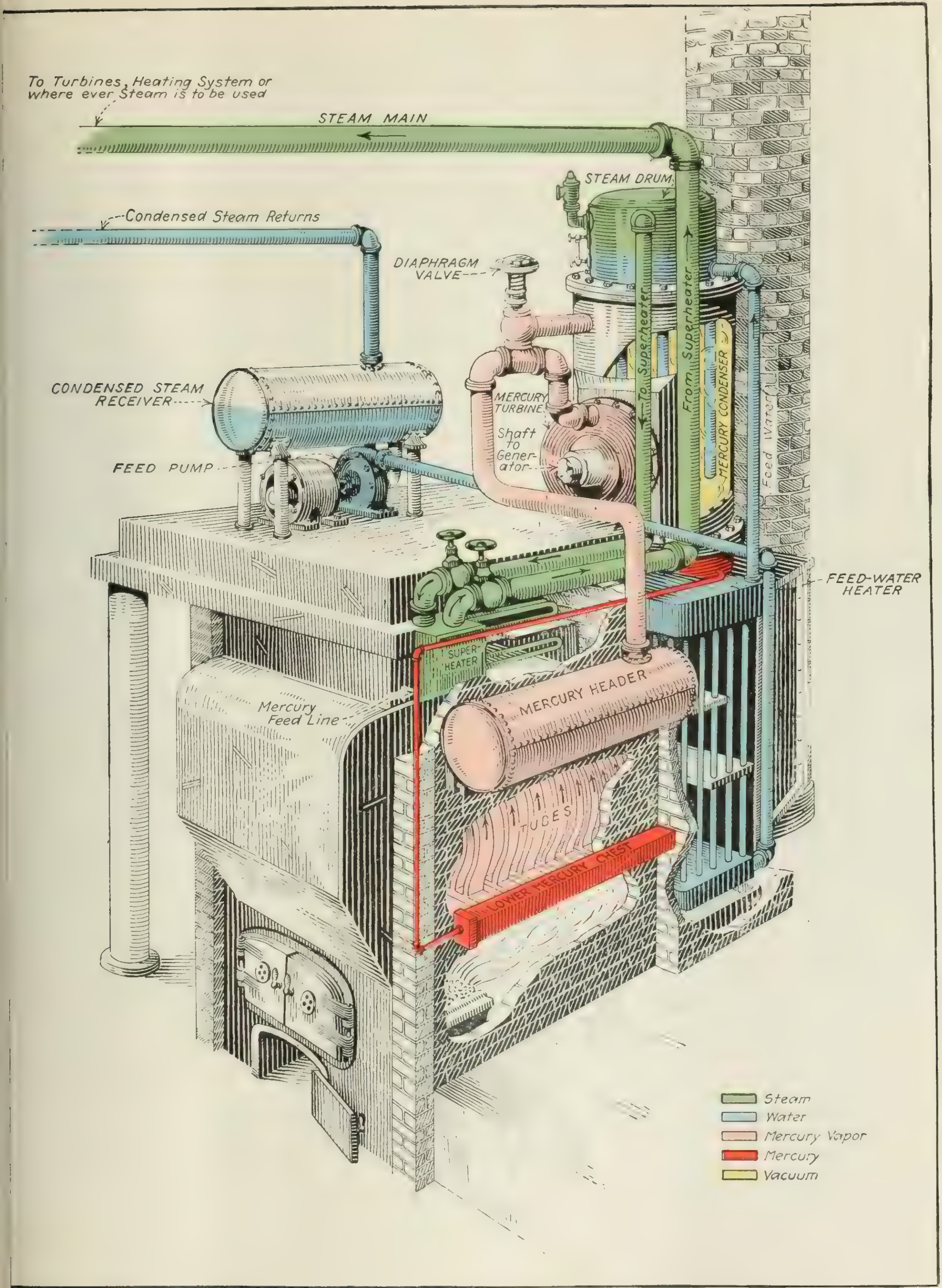
IN A SOUTHERN packing-house plant there were two 75-ton machines, one of them working direct expansion on the sharp freezers and other low-temperature work, while the other was run on a brine cooler of the triple-pipe type, which cooled the brine used for cooling the chill rooms and other high-temperature work. The engineer had originally been a steamfitter around the plant, and when the old engineer died he got his job. The fitter had been in charge about three months when I came to town, and soon he came over and got acquainted. He had trouble in keeping the temperatures down, and he came to me, seeking advice. After looking the job over, I set him straight and gave him a few pointers on how to handle the machines. As a consequence he began to call regularly whenever anything went wrong that he could not at once remedy.

One Monday morning he came in on the run and asked me to come over right away. I went back with him. It seems that the trouble started during the night, yet no one could find anything wrong with the machine, which was the one working on the brine cooler and seldom caused any trouble. First the machine began to freeze. The night man had pinched back on the expansion valves until they were almost entirely shut without helping things in the least. At the same time the suction pressure had dropped until it was somewhere around 5 in. vacuum with the machine running slow. The condenser pressure had dropped to less than a hundred pounds while normally they carried about 140 lb. at this time of the year. In addition the machine had started to pound very hard as it passed over the crank-end center. The thermometer on the inlet registered about 35 deg., while the temperature indicated on the outlet from the brine cooler was around zero. Generally the temperature of the outlet brine was between 18 and 20 deg. and the inlet temperature, which was also the temperature of the brine returning from the chill rooms, was generally 25 deg. or lower.

The brine was circulated by a centrifugal pump, the suction of which was connected to the returns from the chill rooms and the discharge of which was connected to the inlet of the brine cooler. This was working about the same as usual, except that the discharge pressure was considerably higher than it used to be. Apparently, there was something wrong with the brine circulation or there would not have been such a large difference between the inlet and outlet temperatures of the brine as it circulated through the cooler. The engineer suggested that we take a trip up to the coolers with a lantern, and we did so as the first step in the investigation. The chill rooms were cooled by a curtain system located above the coolers. The brine was delivered into distributing troughs hung near the ceiling of the cooler, on which were hung curtains over which the brine trickled down to the floor of the curtain deck, thence running into gutters to the return pipes to the centrifugal pump in the engine room. When we got on the curtain deck, there was not a sign of brine circulation anywhere, and as far as I could see the pump might just as well have been shut down.

So we went back to the engine room in a hurry. It was now plain that there was no brine circulating through the brine cooler and that this was the reason the machine froze, because there was no heat to evaporate the ammonia fed into the cooler. So it came back to the machine in about the same condition it left the expansion valve.

Judging from the engineer's statement that the trouble had started during the night, I suspected that the brine cooler was frozen by this time. Accordingly,



Supplement to Power, Aug. 3, 1920

Schematic Diagram of Emmett Mercury Boiler

I went to try one of the individual valves on each stand of the cooler to see if I could shut it. It refused to budge, and I was now sure that the brine cooler was frozen.

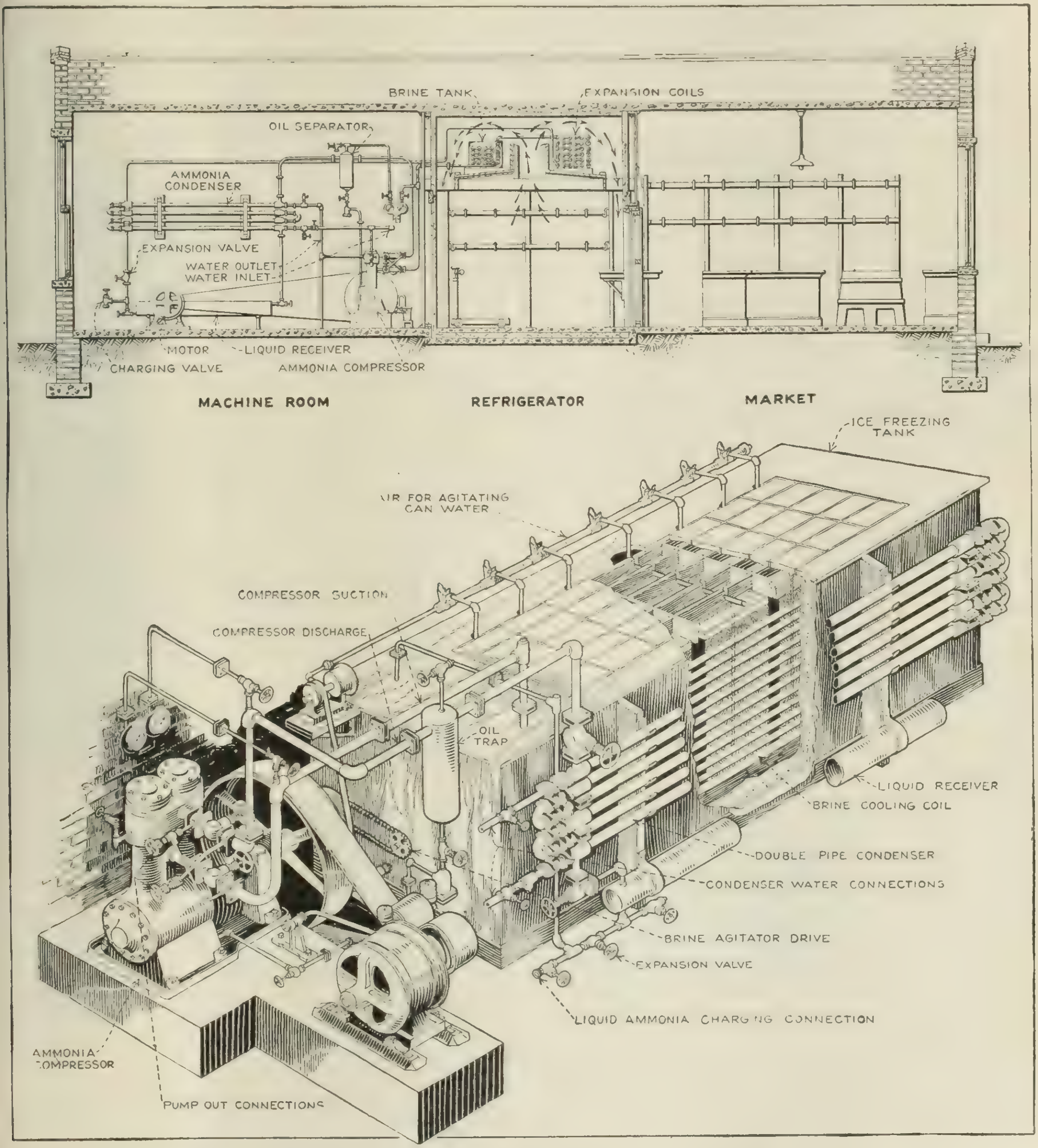


FIG. 1. TYPICAL LAYOUTS OF REFRIGERATING AND ICE-MAKING PLANTS

We pumped out the ammonia and removed the return bends. Sure enough, every one of the stands was frozen solid. We got a hot-water hose with a steam and water connection rigged, and played steaming hot water all over it for several hours. Also we rigged a smaller steam lance which we used for thawing out the inner pipes. Finally, we got the thing thawed out. Luckily, none of the pipes burst. After we had all but the last return bend of each stand on again, I decided to test everything and make sure that every stand was clear so that we would not have the same trouble over again, or that one or more of the stands might not freeze while the others kept on working. To do this I opened the suction and discharge valves on the pump, believing the pressure on the suction line, due to the chill rooms and gutters being located about 40 ft. above the engine room and the cooler, would be sufficient to force the brine through the cooler and clear out small obstructions that might be present. I was surprised to find that this did not work. I looked around the pipe line and cooler thinking some valve might be shut, but all were open. Not having any success with this method, I next started the pump, feeling sure that the pressure produced by the pump would start things. It did not. One of the men finally called attention to the high pressure on the pump, which could be expected if there was an obstruction some place in the line. So we began to look for trouble in the discharge line between the cooler and the pump. We came to the gate valve used as a stop valve in the discharge line, just ahead of the pump. After opening and closing it a number of times we concluded that it worked too easily. So we removed the bonnet, and sure enough, the gate had dropped and shut off the line; this was the true cause of all the trouble.

The shutting off of the circulation of the brine through the cooler caused this to freeze, and as practically no work was then being done in the cooler, the liquid ammonia did not evaporate, and so came back to the compressor in liquid form, freezing the machine With little or none of the liquid evaporated there was practically no gas generated, and of course the suction pressure went down. With the large amount of liquid coming back, the machine froze, got very cold, and this in turn contracted the piston rod so that it was a little shorter than usual. In adjusting the bearings the piston had been shifted so that it came very close to the crank-end head when the machine worked at normal temperature. When it got real cold, the contraction of the rod was sufficient to bring it up against the head, and this caused the knock. After the cooler was thawed out and the gas came back at the proper temperature, there was no knock, but as a precaution against future trouble we backed the rod out of the crosshead a fraction of a turn so as to get the clearance at both ends of the cylinder.

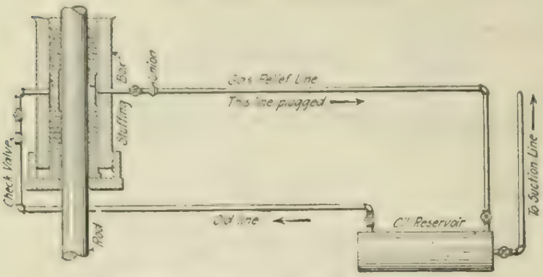


FIG. 2. THE GAS RELIEF LINE WAS PLUGGED

THE STUFFING BOX BOTHERS THE ENGINEER

Some weeks later I dropped in for a visit and found the engineer nursing the stuffing box on the machine working on the brine cooler. This stuffing box had been giving trouble for a long while. We shut the machine down for a few minutes, and first calipered the rod, thinking that this might be smaller in diameter in the center than at the ends; but the difference was so small that it could not have been the cause of the trouble. I had run a number of rods where the difference was much greater. I have in some cases run rods that were $\frac{1}{16}$ in. smaller at the center than at the ends without serious trouble. The difference in this case was but $\frac{1}{64}$ inch.

We checked the adjustment of the crosshead shoes to see if they were adjusted so that the rod traveled in a straight line. A lot of trouble is often met from this cause, the shoes being so adjusted that the rod is thrown up or down at the end of the head-end stroke, and caused to travel up and down in the stuffing box, and of course it is next to impossible to keep the packing tight. There was nothing wrong with the adjustment, however, in this case.

I was puzzled by this time when I happened to think of the gas-relief line from the stuffing box, as shown in Fig. 2. The gas relief line, it will be seen, connects to the top of the oil reservoir which feeds the oil to the stuffing box through the pipe connected to the bottom. The pipe leading from the top connects to the suction line of the compressor, which allows the gas that comes to the oil reservoir from the stuffing box to pass on to the suction line. It also insures suction pressure on the reservoir, and no more, while the gravity head of the oil is about right to keep the oil feeding well through the stuffing box.

There was a union in the line near the stuffing box, and this we disconnected. The pipe was obstructed in both directions with old packing and gummy oil, and to get it out we had to take the whole line down in sections and blow each out with air. For some of them we had to fix up long packing hooks and dig out part of the obstruction until we were able to get the rest free to start.

After we had the pipe cleaned, connected again and the compressor started, there was no more trouble with this stuffing box. The main purpose of this connection is to let whatever gas gets by the first section of packing escape back to the suction line, and as a consequence there is never more than suction pressure on the front section of the packing, of that part in front of the lantern. When the line got blocked, the pressure accumulated in the lantern until it was probably the same as the discharge pressure, and of course there was a lot more trouble to keep the stuffing box from leaking under these conditions.

The first step in the process of obtaining alcohol from wood is digestion at a pressure of 115 lb. for fifteen minutes in dilute sulphuric acid, says *The Engineer*. The cooked wood is transferred to a series of cylindrical cells so connected that water may be passed through them in rotation. From these cells is obtained an extract called "acid juice," which holds in solution practically all the sugar mixed with other water-soluble ingredients. This liquid is neutralized, either with high-grade limestone or slaked lime. Calcium sulphate is produced, which requires about twelve hours for settling. The clear juice is drawn off and cooled to about 88 deg. F., yeast added, and the fermentation carried on in the usual way. The juice must be slightly acid, as ordinary yeasts do not operate well in alkaline solutions. By distillation the alcohol is obtained, and may be readily refined.

Multiple-stage reciprocating compressors are used when high pressures are desired. In this type of compressor the air receives an initial compression in one cylinder. Passing through an intercooler, it is compressed in a second cylinder and so on until the desired compression is accomplished. Because of efficiency in cooling and because clearance losses are reduced, multiple-stage compressors are the most efficient. Theoretically, the more stages the higher the efficiency, but the size and cost of machinery and also frictional losses limit the number of stages to four at the most.

POWER DRIVES FOR ROLLING MILLS

By W. O. Rogers

The latest development in power drives for rolling mills is the direct-current reversible motor. Those described in this article are of 5,000 and 15,000 hp. capacity and are used to run reversing blooming mills.

ONE of the principal electrical developments of recent years in steel-mill power equipment has been the reversing-mill motor, and it is safe to say that of all the applications of electric motors none is subject to more severe conditions than those driving reversing mills. The mills of recent design include reversing roughing stands and tandem arrangement of mills, which gives the plant greater flexibility of size, of production and increases its tonnage output with a decrease in power requirements. Some of those included are plate mills, strip mills and structural mills. In a former article several large reversing engines were illustrated, but unlike the steam drive, which calls for an unusual steam supply for a reversing mill, the reversing motor drive acts as an equalizer for the three-high continuously operated mill because the power taken from the main feed line is uniform in the former and intermittent with high peak loads for the latter type of mill. Reversing motors are frequently subjected to overloads several times their continuous capacity, and they must carry these overloads throughout the full range of speeds, from rest to maximum speed in both directions when driving the mill or operating as a generator in braking; that is, coming to a stop.

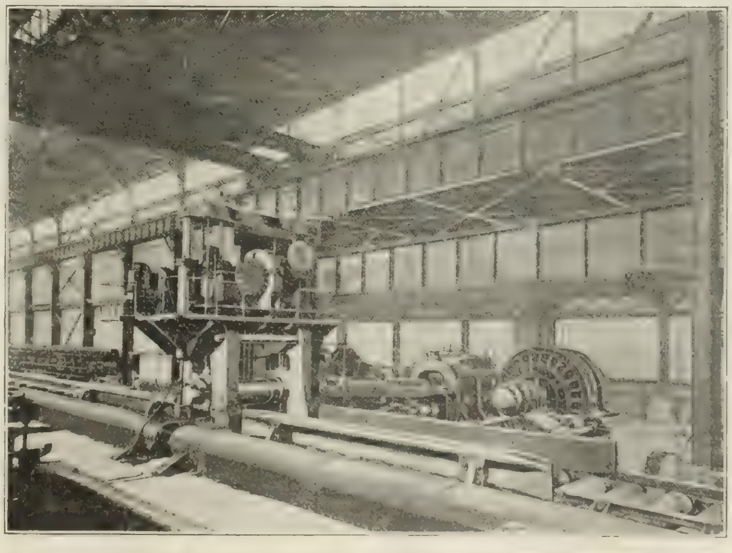


FIG. 1. A 15,000-HP. DIRECT-CURRENT REVERSING MOTOR DRIVING A 35-IN. REVERSING BLOOMING MILL

When an ingot is put through the rolls for the first few passes, the piece, being short, requires less than one revolution of the rolls to carry the metal through them. In order to force the rolls to bite the ingot, as well as to prevent them from throwing the piece out on the table after making the pass, it is necessary to keep the speed down. With so short a piece of metal high roll speed is not necessary and would only interfere with the quick handling of the equipment. However, after the piece has lengthened out, the roll speed is increased and the remainder of the passes can be made at high speed. Owing to the unusually severe conditions under which they operate, rolling-mill motors are designed with liberal factors of safety so as to permit of rapid acceleration and reversing. In reversing-mill motors the speed is adjustable over the full range from rest to maximum speed in either direction of rotation, and, when so adjusted, is practically independent of the load. This type of motor is capable of carrying extreme overloads at all speeds during acceleration, driving the mill at full speed or during regenerative braking in slowing down the mill at the end of the pass. Another characteristic of this type of motor is that the inertia of the revolving parts is low, so as to permit of rapid acceleration and reversal, which is necessary because the greater part of the time consumed in breaking down an ingot is taken between passes.

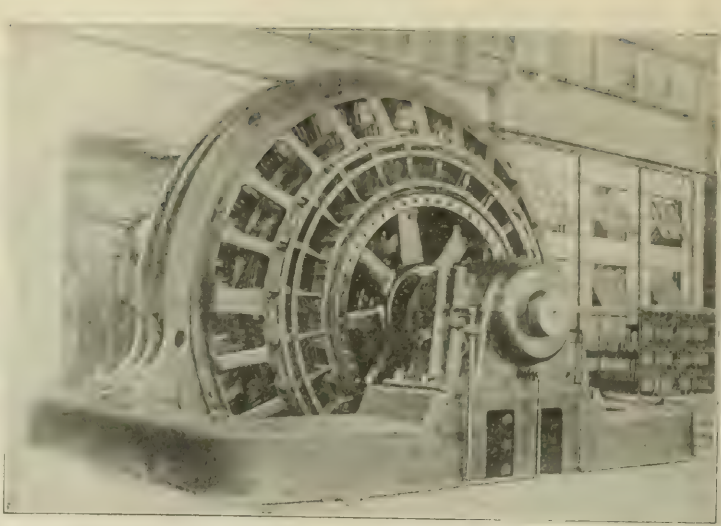


FIG. 2. SINGLE UNIT, 8,000-HP. REVERSING MOTOR DRIVING A 27-IN. UNIVERSAL MILL

The Ward-Leonard control is used. Briefly, this system consists of a constant-speed motor driving a generator that supplies current to the motor whose speed is to be regulated. This motor-generator set is placed between the variable-speed motor and the system supplying the current. The driving motor of the motor-generator set is usually of the wound-rotor induction type coupled to a direct-current generator, the machine carrying a flywheel on the shaft.

The excitation of the direct-current generator is arranged to vary over a wide range by means of a rheostat in its field circuit. The generator armature and the motor armature by themselves constitute a circuit which is not interrupted in service. Manipulation of the field rheostat and switch gear in the exciting circuit of the generator, and also the speed and direction of rotation of the variable-speed motor, are under control at all loads.

The flywheel of the motor-generator set serves to smooth out the peaks from the reversing motor's load, which are extremely high and of short duration, and which, without a flywheel, would follow back to the main power system.

When the motor of the motor-generator set comes up to speed, it stores up energy in the flywheel, and when a heavy current is demanded by the roll motor, the motor of the motor-generator set is automatically

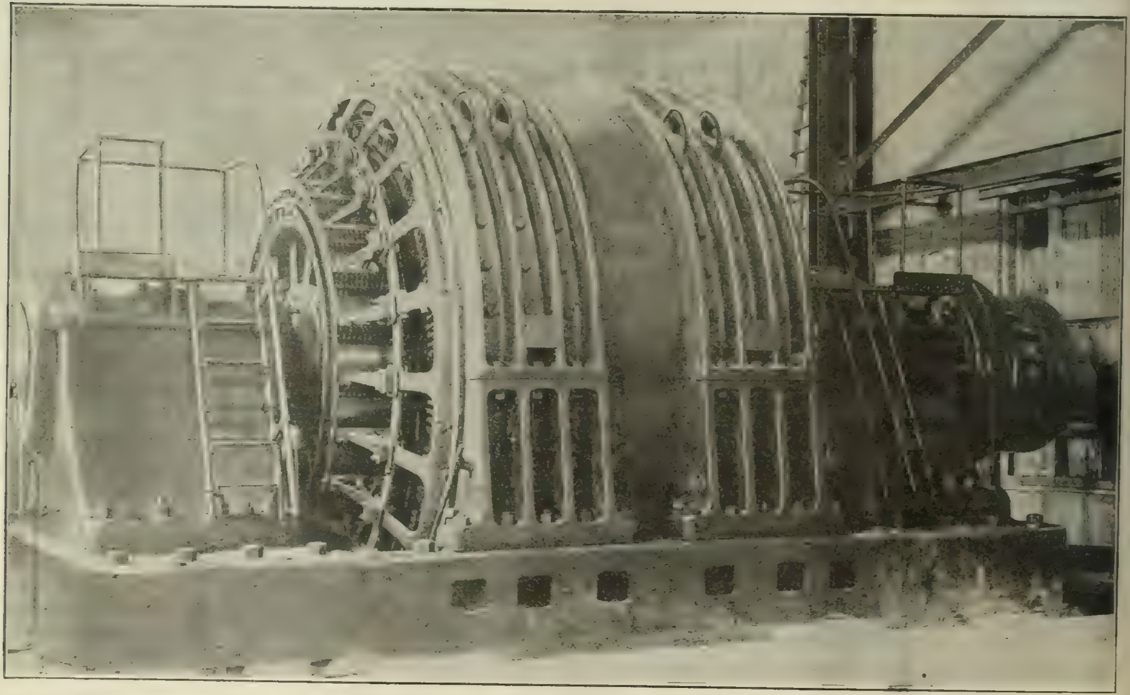


FIG. 3 A 5,000-HP. DOUBLE DIRECT-CURRENT REVERSING MOTOR DRIVING A 36-IN. BLOOMING MILL

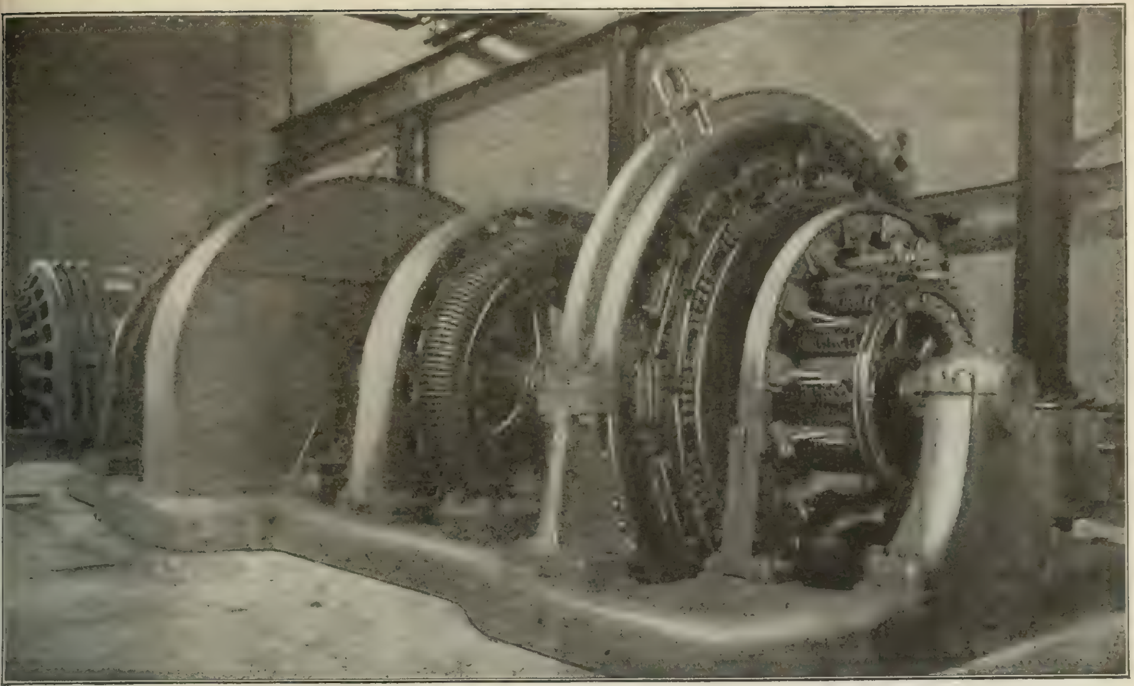


FIG. 4. MOTOR-GENERATOR SET CONSISTING OF A 3,000-HP. INDUCTION MOTOR AND TWO 2,000-HP. DIRECT-CURRENT GENERATORS

slowed down by means of a slip regulator. As the motor of the motor-generator set slows down, the flywheel carries a part of the load. When the peak load is removed or, in other words, when the ingot has passed through the rolls, the motor of the motor-generator set speeds up again and returns energy to the flywheel. In this way the load on the alternating-current motor is greater than that on the roll motor when the latter is driving light load, and is less when it is carrying a peak load, as when the ingot is making a pass. Automatic slip regulators are used to regulate the speed of the induction motor and consequently the rate

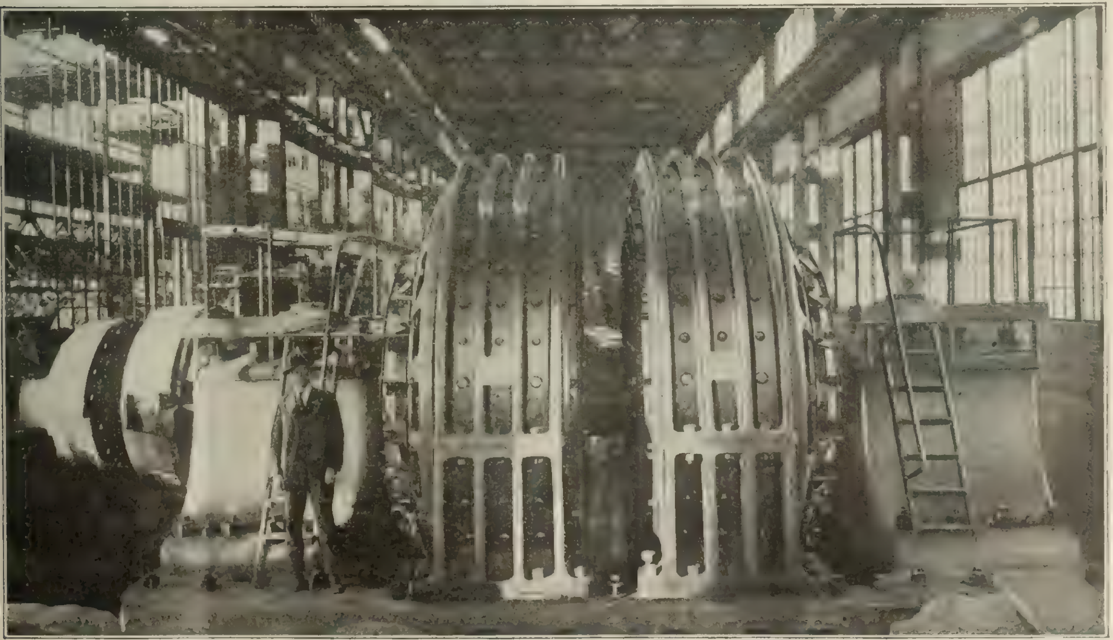


FIG. 5. SIDE VIEW OF A 5,000-HP. DIRECT-CURRENT REVERSING MOTOR

at which energy is delivered to the flywheel, which permits of obtaining better equalization of the motor load. The slip regulator consists of a liquid rheostat with three stationary electrodes connected to the three phases of the rotor on the induction motor driving the motor-generating set. Three movable electrodes are connected to an arm that is mounted on the shaft of a small torque motor, the other end of the arm being provided with a counterweight. This small motor receives current from series transformers in the main line (see Fig. 9). When the current in the line increases, the motor pulls the electrodes apart and in so doing introduces resistance into the rotor circuit of the alternating-current motor. This reduces its speed and throws the peak of the load on the flywheel. When the line current decreases, the motor allows the electrodes to come nearer together again, and the alternating-current motor speeds up.

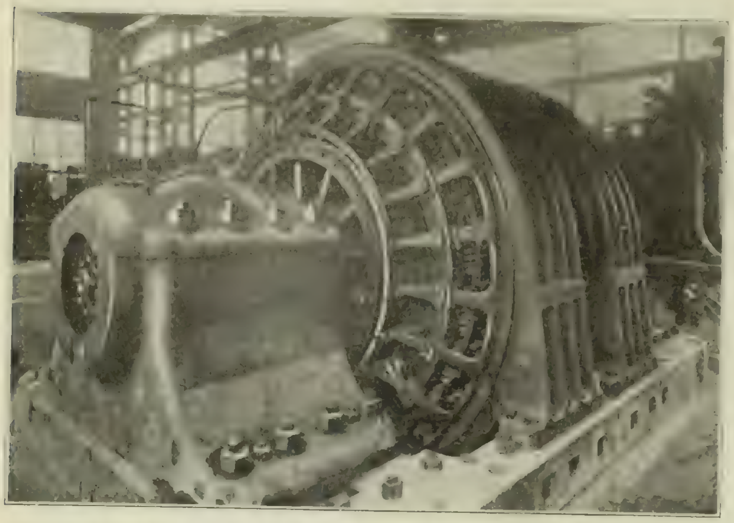


FIG. 6. A CLOSE-UP VIEW OF THE COMMUTATOR END OF THE 5,000-HP. MOTOR

In bringing the motor-generator set up to speed, the generator field is gradually excited to bring up the voltage across the motor armature, which causes it to revolve in the direction indicated by the master switch. The speed curve of the mill motor follows very closely the voltage curve of the generator up to full-field speed. From this point the speed is increased by decreasing the field of the mill motor, which is accomplished by means of the operator's drum controller.

The roll motor is brought to rest by dynamic braking when the operator brings the master controller to the off position. This reduces the voltage of the generator below that corresponding to that of the roll motor, and during that period the generator acts as a motor and tends to speed up the flywheel. By this means a large part of the accelerating energy is reclaimed.

The various operations, including the variation of the field strength, etc., are accomplished by means of magnetic contactors, which are also arranged to insure a proper sequence of operation with proper interlockings for safety and assist materially in accomplishing the desired rapidity.

It will be seen that the control of the roll motor is effected by varying the strength and direction of the field or exciter current in a direct-current generator. Increasing the field current of the generator also increases the voltage of the current that is being delivered to the roll motor, and the motor will speed up. If the field current is decreased, it produces the opposite effect, and if the field current is reversed, the roll motor will revolve in a reverse direction. The wiring of this system is shown in Fig. 9.

In the operation of the dynamic brake to stop the roll motor, if the generator field is so weakened that the voltage generated is less than that generated by the roll motor, the motor acts as a generator and attempts to drive the motor-generator set; and as this acts as a powerful drag on the roll motor, it slows down, as with the application of a mechanical brake.

Several examples of reversing-mill motors are depicted in the illustrations. In Fig. 1 is shown a two-unit 15,000-hp. Westinghouse reversing motor that operates a 35-in. reversing blooming mill at the Mark plant of the Steel and Tube Company of America, Indiana Harbor, Ind. It is of the direct-current type and operates at 600 volts. Fig. 2 shows a single-unit 8,000-hp. 600-volt motor operating the 27-in. universal

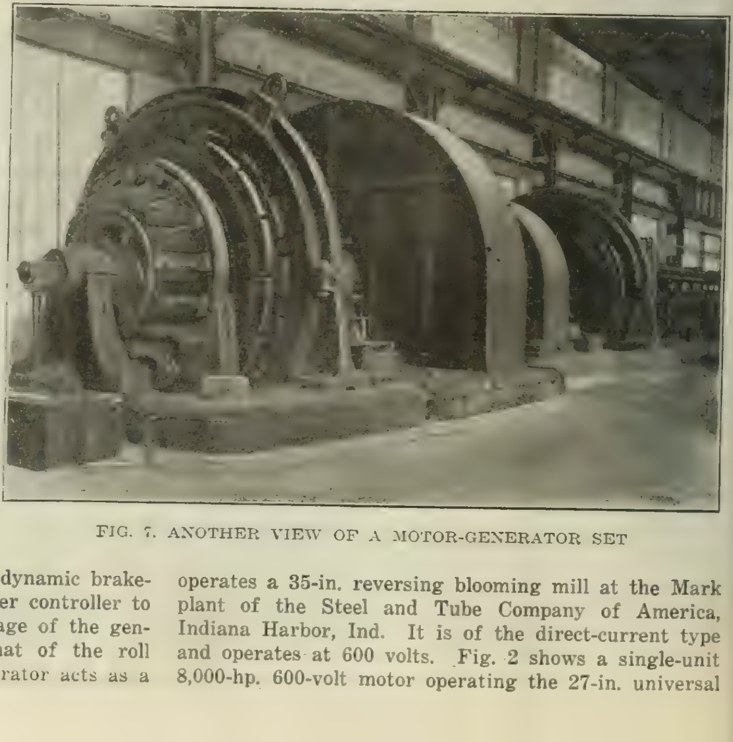


FIG. 7. ANOTHER VIEW OF A MOTOR-GENERATOR SET

plate mill at the same plant. This mill has established an unusual production record, having rolled in one month 17,393 tons of plates averaging less than ⅜ in. in thickness.

I was fortunate in obtaining permission to go through the plant of the Trumbull Steel Co., Warren, Ohio. This plant was right up to date with the leaders in the number and capacity of electrically driven rolls, having several units with a continuous capacity of 17,100 hp. What is said to be the fastest mill in the world is their continuous hot-strip mill, which is driven by adjustable-speed induction motors.

The 36-in. reversing blooming mill at this plant is driven by a General Electric 5,000-hp. from 50 to 120 r.p.m. two-unit reversing motor using 500-volt direct current. This motor (Fig. 3) is directly connected to the mill and has a continuous torque of 656,000 ft.-lb. and 2,000,000 intermittent.

The motor-generator set that supplies energy to the 5,000-hp. reversing motor is shown in Fig. 4. It consists of a 3,000-hp. induction motor using 2,300-volt 60-cycle three-phase current and has a speed of 360 r.p.m. The two generators are of 4,000-kw. total capacity and generate 500-volt direct current. The flywheel weighs 50 tons.

Another interesting installation of the same capacity was found at the Sparrow's Point, Md., plant of the Bethlehem Steel Co. This General Electric double unit, shown in Fig. 5, develops 5,000 hp. when operating at speeds varying from 50 to 120 r.p.m. It is used to drive a 40-in. reversing blooming mill. A close-up view of the commutator end of the motor is shown in Fig. 6. An idea of the massive construction may be had by the comparison of the man standing by the bearing, Fig. 5.

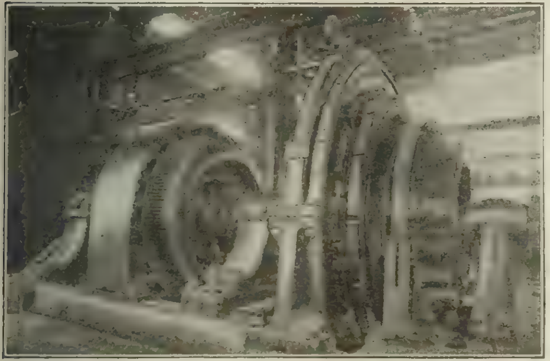


FIG. 8. CLOSE-UP VIEW OF THE MOTOR AND ONE GENERATOR

The motor-generator set used in conjunction with this reversing motor consists of two 2,000-kw. 600-volts per unit direct-current generators driven by a 3,000-hp. 6,600-volt 25-cycle induction motor, Fig. 7. The speed is 375 r.p.m. and the flywheel weighs 50 tons. Fig. 8 is a close-up view of the motor and one of the generators.

A 17,500-hp. Westinghouse reversing motor at this same plant is used to drive a 60-in. universal plate mill. It has a speed up to 100 r.p.m. and uses 700-volt direct current. So far as known, this is the largest reversing motor in this country. Two units of 19,000 hp. have recently been installed at a steel works in England. One drives a 36-in. roughing mill and the other a 34-in. similar mill. The speed is 60 to 140 r.p.m. and the units operate on the Ward-Leonard-Ilgner system. The motor comprises three units coupled together and mounted on a combined bedplate. The complete machine weighs approximately 300 tons.

At the Briar Hill Steel Co., Youngstown, Ohio, the new plate mill, which rolls plate exclusively, consists of two mills, one a three-high single-stand 132-in. mill, the other a two-stand 84-in. mill. The roughing rolls of the 84-in. mill are driven by a reversing direct-current motor having a maximum torque of 1,000,000 ft.-lb. at 40 r.p.m. This motor is supplied with energy from a 1,500-hp. three-phase 60-cycle 2,200-volt induction-motor direct-current generator set. The 2,250-kw. 600-volt direct-current generator is shunt wound and separately excited. It is equipped with commutating poles and compensating windings. On the shaft of this unit is mounted a 60,000-lb. flywheel.

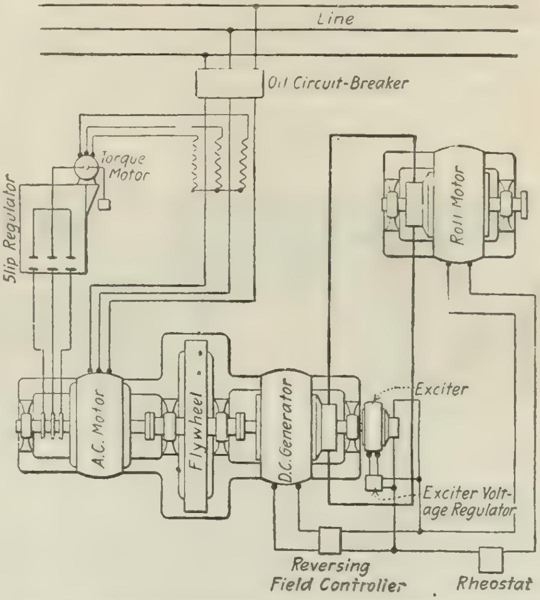


FIG. 9. WIRING DIAGRAM OF THE MOTOR CONTROL

A liquid slip regulator connects with the secondary winding of the alternating-current motor, equalizing the input to the flywheel. Thus, when the motor load reaches a certain fixed volume, the regulator cuts in resistance in the secondary winding, which causes the motor to tend to decrease its speed, and the flywheel gives up some of its energy and so absorbs the short peaks of the roll motor. Just as soon as the peaks go off, the regulator gradually decreases the secondary resistance and the motor speeds up, bringing the flywheel back to full speed again ready for the next peak. Owing to the arrangement of the regulator, the motor cannot be started until the maximum resistance is cut in on the secondary, by means of the slip regulator being wide open. Starting and stopping of the motor is accomplished from a benchboard controller without manual setting of the regulator. The switching of the motor is arranged so that it can be stopped within a few seconds by the application of reverse power.

Motors used for driving mill roll trains are usually of the mill-type, totally inclosed; but in some instances a single motor drives a lay-shaft carrying gears which mesh with corresponding gears that carry the mill-rod train. Direct-current mill-type motors are used for many purposes as steel-mill auxiliary drives. Such motors are built in sizes up to and around 275 hp. and are designed to operate under very heavy duty, especially on front and rear mill rolls and screwdowns where the motor is started, stopped and reversed as frequently as a dozen times a minute.

Most of the larger steel mills generate their own electrical energy at high alternating-current voltage, but it must be transformed to direct current before it can be used with a direct-current type of mill motor. This is done by the use of motor-generator sets or rotary converters. In other instances, the high-voltage current is purchased from outside sources and must also be transformed before it can be used. Fig. 10 shows a substation at the main plant of the Youngstown Sheet and Tube Co.

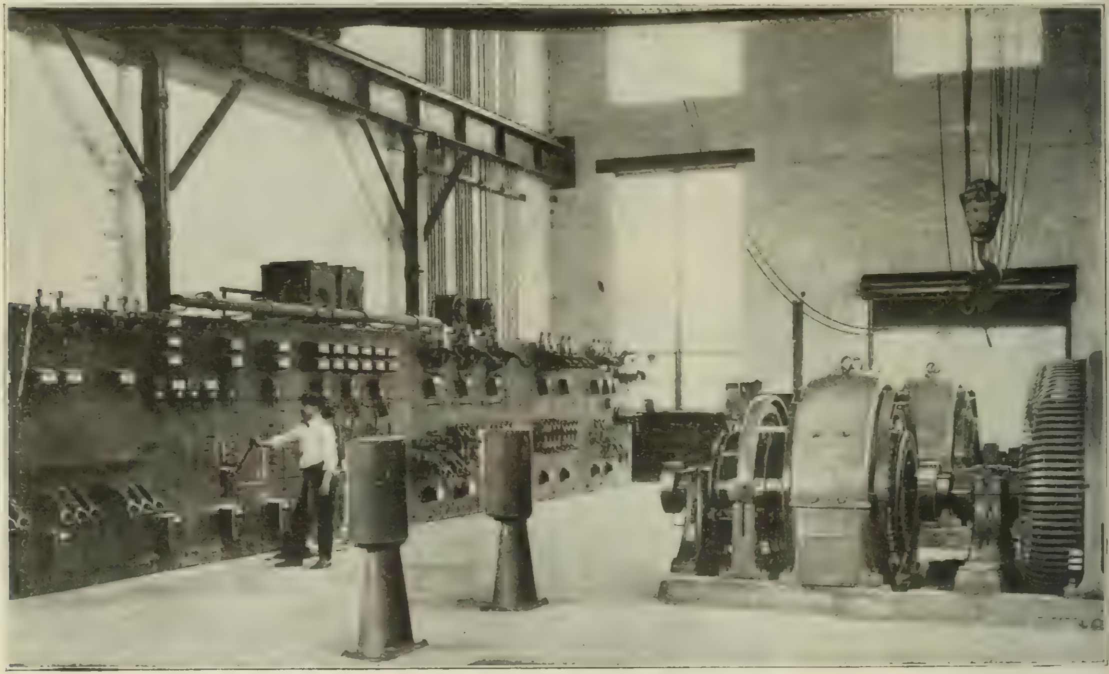


FIG. 10. AN UP-TO-DATE SUBSTATION, SHOWING SWITCH BOARD AT THE LEFT

(The next article will deal with some of the pumping units used for supplying water for various purposes about steel mills.)

Ammonia Coils for Cooling Water

By A. G. Solomon

An estimate of the cooling effect of ammonia coils based on ordinary units of heat transmission through pipes is likely to be very misleading because the rate of heat flow from water, brine or air to the ammonia in a coil will vary greatly, depending on the circulation of whichever substance surrounds the coil. This statement is made plain when one considers the insulating effect of still or slowly moving brine or air in close contact with the ammonia evaporating coils.

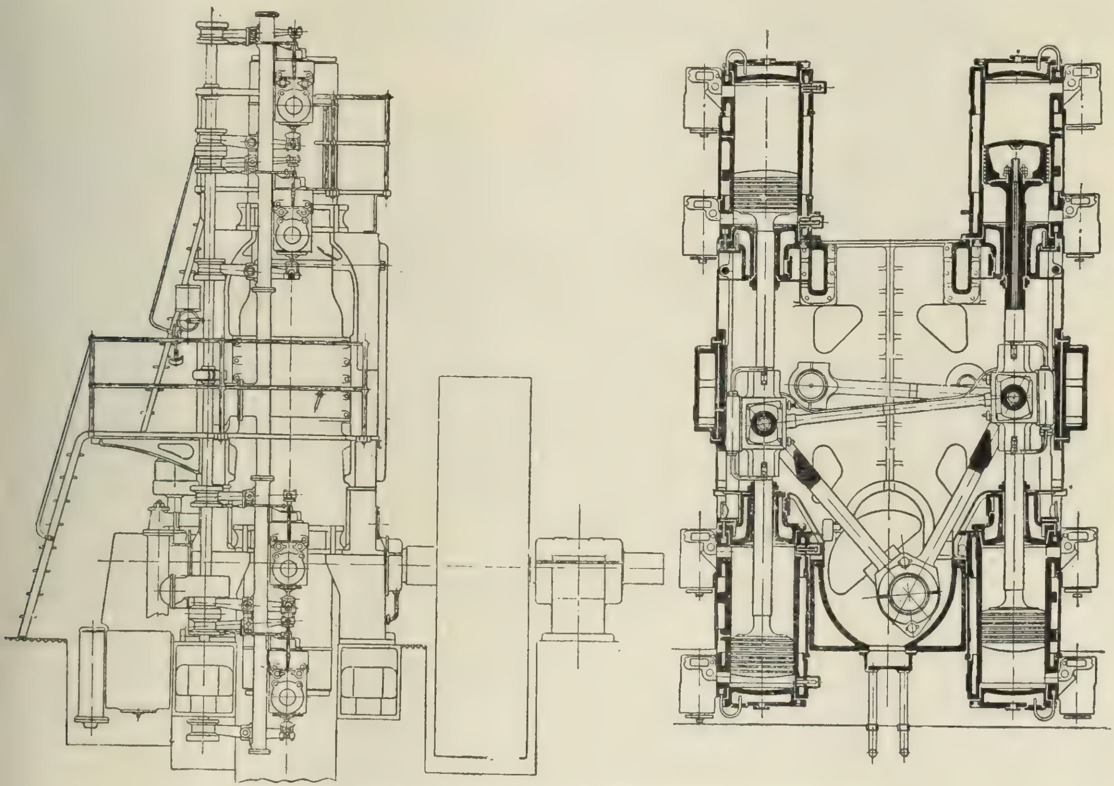
The lowest rate of heat transfer is found to occur in cold-storage rooms having direct expansion coils hung on the walls. The air surrounding such coils is almost still, as the very slight natural circulation is retarded by the pipes of the coil being placed one above the other. The rate of the heat transfer in such cases will never be more than 1.5 B.t.u. per hr. per sq.ft. of pipe surface for each degree difference in temperature between the ammonia in the coil and the surrounding air.

The highest rate of heat transfer is found in brine coolers of the shell and tube type where the brine is forced through the tubes at a high velocity and where the ammonia space is operated as in the flooded system. Here the heat flow can be as high as 25 or 30 B.t.u. In ice tanks having good brine circulation and the flooded system of ammonia evaporation, the heat flow will be about 10 B.t.u. We will assume that the water is cooled in a tank where the flow amounts to 200 gal. per hour and that water is being admitted and taken out continually as in the ice-plant forecooler.

Under the most favorable operating conditions the rate of heat transfer from this water to the ammonia will be no more than 7 B.t.u. This figure is considered rather high, but it can be reached. Suppose the average temperature of the water is $(80 + 35) \div 2 = 57.5$ deg. F., and the temperature of the ammonia in the coil is zero, and the temperature difference is 57.5 deg. F. As 7 B.t.u. is the rate of heat transfer for each degree temperature difference, $7 \times 57.5 = 402.5$ B.t.u. is the amount of heat passing through each square foot of pipe surface per hour. Two hundred gallons of water is equal to 1,666 lb. This amount of water to be lowered from 80 to 35 deg. will call for the removal of 45 × 1,666 = 74,970 B.t.u. in an hour. Dividing the number of heat units to be removed by the heat exchanged through one square foot of pipe surface gives 186.26 sq.ft., or 299.5 ft. of 2-in. pipe; and 20 per cent more pipe, or about 60 ft. of 2-in., should be added to take care of heat leakage through insulation and variations in operating conditions.

A New English Gas Engine

The Premier Gas Engine Works has brought out a large double-tandem double-acting gas engine of a decidedly novel design.



SECTIONAL LINE DRAWING OF THE NEW PREMIER GAS ENGINE

Referring to the sectional line drawing, it will be seen that the cylinders are grouped in pairs, on opposite sides of the crankshaft, with a triangular connecting rod, after the fashion of the old Musgrave steam engine, transmitting the motion of the two sets of piston rods to the single crank. The upper end of the two branches of the connecting rod have gudgeon pins working in short transverse slides in the crossheads, while the right-hand pin also takes the ends of the radius rods that transmit the side thrust of connecting rods to anchor pins on the frame.

The arrangement has the advantage of reducing to a minimum the frictional losses involved in the conversion of the reciprocating motion of the piston to the rotation of the crank. It also gives a very even turning moment. The effect of the triangular rod in this direction is, in fact, equivalent to setting the cylinders at an angle of 60 deg., as in the familiar motor-car engine.

The cylinders of this engine are 24¾ in. in diameter by 30 in. in stroke, which, at a speed of 125 revolutions per minute, gives a piston speed of 625 ft. per min. The mean effective pressure is 66 lb. per sq.in. Working on blast-furnace gas, the engine develops 900 hp., or 1,000 hp. when using producer gas. The over-all dimensions of the engine, including the generator and flywheel, are 18 ft. by 25 ft. by about 20 ft. high above the floor level. A unit of approximately the same capacity, but of the double-acting tandem horizontal type, would require a floor space of 27 x 60 ft. The economy in space is about 70 per cent.

The potential water power of British Columbia experts declare, is equal to that of five Niagaras. Pouring down the mountains comes enough water to develop 3,000,000 hp. At Niagara Falls, there is now developed about 725,000 hp. Only 123,000 electric horsepower is now developed by the plants supplying Vancouver, New Westminster and the towns in that vicinity. This power turns the wheels of mills and factories, propels the street cars of these cities and provides light for the streets and homes. If the entire wealth of British Columbia in water power were harnessed, it would be sufficient to provide power, light and heat for forty cities the size of Vancouver and New Westminster combined. With this cheap power available, economists predict that some day the province will become one of the greatest manufacturing centers of Canada.

What Is the Efficiency of a Steam Engine?

A Discussion of Some of the Misunderstandings Due to Different Meanings Attached to the Names of the Various Steam-Engine Efficiencies

BY DEWITT M. TAYLOR

WHEREVER steam engines are discussed the word efficiency is used, but unfortunately it is frequently used without due care to specify just what it means. To help explain it various qualifying terms are often employed, but authorities differ as to just what certain of these terms mean.

In general the efficiency of a machine or engine may be defined as the ratio of output to input, or of the heat equivalent of the work produced to the heat supplied to the engine. The efficiency of a steam plant, then, might be stated as the ratio of the heat equivalent of the electrical energy delivered at the switchboard to the heat of combustion of the coal burned. This might be and frequently is called the "Over-all Efficiency," although the adjective over-all is frequently used when the heat equivalent of the power at the engine shaft is substituted for the energy at the switchboard. When attempts are made to improve the economy of the engine or plant, it becomes necessary to examine the losses in the various individual parts of the apparatus. This results in the computation of the efficiencies of these individual parts, and it is largely in the names applied to these values that confusion arises.

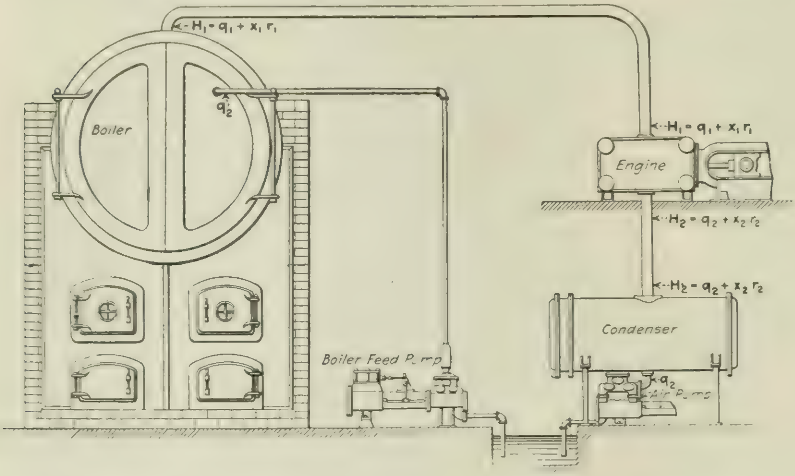


FIG. 1. DIAGRAM SHOWING HEAT CONTENTS OF STEAM AT VARIOUS POINTS AS ASSUMED IN COMPUTING EFFICIENCIES OF ENGINE

When dealing with the engine alone, it is usual to consider that the boiler, condenser, piping and auxiliaries operate at 100 per cent efficiency, or, in other words, not to charge the engine with any losses due to imperfections in other apparatus.

In Fig. 1 the essential parts of a steam-power plant are shown and the heat content of the steam at the various significant points is indicated. The steam leaving the boiler has a certain heat content, which may be designated as H_1 or as $q_1 + x_1 r_1$ where q is the heat of the liquid, r is the heat of vaporization and x is the dryness fraction, the subscript 1 referring to the condition of the steam leaving the boiler. Assuming no loss in the steam pipe the steam entering the engine is in the same condition as on leaving the boiler. In passing through the engine some heat is turned into work and some heat is wasted, and the steam leaves the engine with a heat content of $q_2 + x_2 r_2$ where the subscript 2 refers to the condition at exhaust. In the condenser all the steam is condensed, since it does not pay to pump steam back into the boiler. Any additional cooling of the condensate, however, is the fault of the condenser, not of the engine, so the water entering the boiler is assumed to be at the temperature corresponding to the back pressure on the engine. Its heat content, then, is q_2. The heat added in the boiler to each pound of water, therefore, is $q_1 + x_1 r_1 - q_2$, or as sometimes written, $H_1 - q_2$.

The heat supplied in the boiler per horsepower per hour is $W\ (H_1 - q_2)$ where W is the "water rate," or weight of steam per horsepower per hour. The heat turned into work per horsepower per hour is $\frac{33{,}000 \times 60}{778} = 2{,}545$ B.t.u. An efficiency may be figured from this as $\frac{2{,}545}{W\,(H_1 - q_1)}$ and this ratio is often called the "Actual Thermal Efficiency" or sometimes the "Thermal Efficiency of the Actual Engine." It has also been given the name "Thermodynamic Efficiency."

The theoretical cycle known as the Carnot Cycle is sometimes used as a standard of perfection, since a heat engine working on this cycle would have an efficiency that could not be exceeded. The efficiency of an engine working on this cycle is expressed by $\frac{T_1 - T_2}{T_1}$, where T_1 is the absolute temperature of the source of heat and T_2 is the absolute temperature at which the waste heat is rejected. This is usually referred to as the "Carnot Efficiency," but is seldom computed, as the actual steam-power plant operates on a cycle differing materially from the Carnot Cycle.

The usual standard reference cycle for steam plants is known as the Rankine Cycle, and it differs from the actual cycle only in that the engine proper is made of a perfectly non-conducting material. It can be shown that the heat turned into work by an engine working on the Rankine Cycle is $(q_1 + x_1 r_1) - (q_2 + x_2 r_2)$, where the symbols have the same meanings as in the previous paragraphs with the additional requirement that the entropy during expansion remains constant. Thus the value of x_2 may be computed on the basis of a constant entropy expansion from the condition of steam at the throttle to the pressure of the exhaust. Since the amount of heat added in the boiler is the same whether the steam is expanded in a non-conducting cylinder or in an ordinary engine cylinder, its value per pound of steam is $q_1 + x_1 r_1 - q_2$ or $H_1 - q_2$ as before.

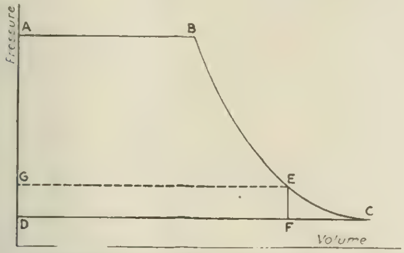


FIG. 2. PRESSURE-VOLUME DIAGRAM FOR RANKINE CYCLES WITH COMPLETE AND WITH INCOMPLETE EXPANSION

The efficiency of an engine working on the Rankine Cycle, then, is $\frac{(q_1 + x_1 r_1) - (q_2 + x_2 r_2)}{q_1 + x_1 r_1 - q_2}$ or $\frac{H_1 - H_2}{H_1 - q_2}$, remembering that the condition designated by the subscript 2 is found from a constant entropy expansion. This efficiency is usually called the "Rankine Efficiency."

One source of misunderstanding is due to the use of the name Rankine Cycle to refer to two different cycles. The distinction may be understood by referring to Fig. 2, which is a pressure-volume diagram. One cycle is represented by the line *ABCDA*, the curve *BC* representing expansion in a non-conducting cylinder. This is the cycle described before in this article and called the Rankine Cycle. By some writers it has been given the name Clausius Cycle and by others "Rankine Cycle with Complete Expansion."

The other cycle is shown by the lines *ABEFDA* and differs only from *ABCDA* in that the adiabatic expansion is stopped at *E* and the constant volume pressure drop to *F* takes place. This corresponds to the action of a steam engine when the exhaust valve opens before the pressure has dropped to the back pressure. The cycle here described has been called the Rankine Cycle by many people, although some authorities avoid confusion by naming it the "Modified Rankine Cycle" or the "Rankine Cycle with Incomplete Expansion." In connection with the diagram in Fig. 2, it should be remembered that this represents the pressure-volume changes of a definite quantity of steam and is not an indicator diagram.

In computing the work done by an engine operating on the "Modified Rankine Cycle," the portion *ABEGA* is treated as a Rankine Cycle with complete expansion and the work of the portion *GEFDG* is found by multiplying the pressure drop from *E* to *F* (in pounds per square foot) by the volume at *E*. This latter value is reduced to the equivalent heat units and then added to the heat equivalent of the portion *ABEGA* to find the total heat converted into work.

Since a perfectly non-conducting engine can never be built, its water rate cannot be determined by actual test. The heat turned into work per pound of steam however, as stated before, is $(q_1 + x_1 r_1) - (q_2 + x_2 r_2)$ or $H_1 - H_2$. The heat that must be turned into work to deliver one horsepower per hour is 2,545 B.t.u., therefore the water rate for an engine working on the Rankine Cycle would be $\frac{2{,}545}{H_1 - H_2}$, and this value is often called the "Rankine Water Rate."

When two engines receive steam at the same pressure and quality and exhaust at the same pressure, either their actual thermal efficiencies or their actual water rates serve as a fair basis on which to compare their performances. When, however, the condition of the steam supplied or the exhaust pressures are different, it is not fair to compare two engines on this basis. For example, assume one engine receiving dry steam at 250 lb. absolute and exhausting at 28 in. vacuum, and a second taking dry steam at 50 lb. absolute and exhausting at atmospheric pressure. In the first case the Rankine Efficiency would be 30.8 per cent, while in the second case it would be 27.2 per cent. If, then, the two engines were found to have the same thermal efficiency, the latter would be the better engine, since it comes nearer its ideal standard. In other words, the Rankine efficiency represents the ideal efficiency for the conditions under which the engine operates and over which the engine has no control, and the best engine is that one which makes the most of its opportunities.

For this reason it is customary to compute the ratio of the actual thermal efficiency to the Rankine Efficiency for the existing conditions. It is in connection with the names given this ratio that the most confusion arises. Some authorities call this the "Cylinder Efficiency," but this has been objected to when applied to steam turbines. The term "Cycle Efficiency" has been used, but as this is sometimes applied to both what we have here called the Rankine Efficiency and the Thermal Efficiency, it causes confusion. The term "Rankine Efficiency" has also been applied to this value, but this is very confusing, since so many use this name as it has been used in this article. Other names have been used, but so far as the writer knows, the term Cylinder Efficiency is the only one that is not also used with another meaning. While this term apparently means nothing when applied to turbines, it at least has only one meaning in general use.

Differences in what is to be considered as the output of the engine also lead to confusion. When reciprocating engines only were considered, the output when figuring thermal efficiencies was taken as the indicated horsepower. This was the logical procedure, since efficiencies based on brake horsepower included the mechanical losses in the engine. With the advent of the turbine, however, and the difficulty of determining a value corresponding to the indicated power of a reciprocating engine, efficiencies were often computed on the basis of the brake horsepower. When the efficiency of an engine based on indicated horsepower is compared with that of a turbine or another engine based on brake horsepower, the results are likely to be misleading.

Since uniformity of nomenclature is obviously desirable, the following definitions are suggested:

Carnot Efficiency is the efficiency of a theoretically perfect engine working on the Carnot Cycle and is given by the expression $\frac{T_1 - T_2}{T_1}$.

Rankine Efficiency is the efficiency of an engine working on the Rankine Cycle and is given by the expression $\frac{H_1 - H_2}{H_1 - q_2}$.

Thermal Efficiency is the ratio of the heat equivalent of one horsepower-hour to the heat supplied to the engine for each horsepower-hour and is given by the expression $\frac{2{,}545}{W(H_1 - q_2)}$. Unless otherwise stated, this value is based on the indicated horsepower.

Cylinder Efficiency is the ratio of the Thermal Efficiency to the Rankine Efficiency.

Mechanical Efficiency is the ratio of the brake horsepower to the indicated horsepower.

The symbols used in the foregoing definitions are those explained earlier in this article. To make these statements cover all cases, the symbol *H* may be taken to mean the heat contents of wet, dry or superheated steam.

It is realized that some of these definitions at least are likely to incur criticism, but they are offered as suggestions in the hope that this or some other list of definitions may become standard. Probably such a standard can become widely recognized only if it is backed by some such body as the American Society of Mechanical Engineers.

Testing a Closed Heater

By R. W. Riordan

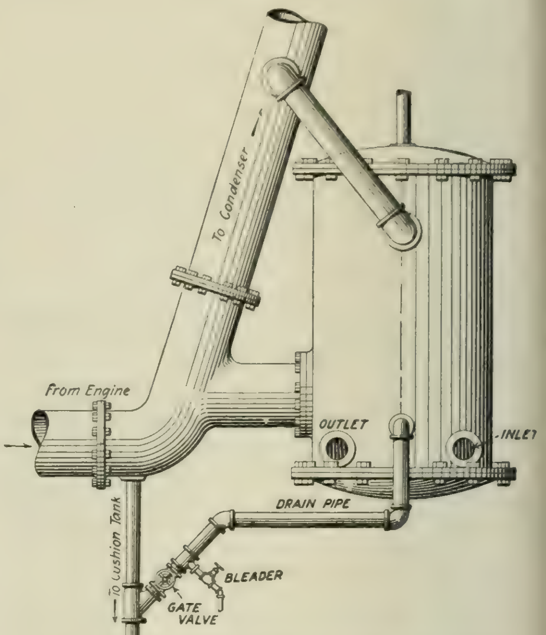
A closed heater, set vertically, was connected to the exhaust pipe of a 2,700-kw. cross-compound unit, about midway between the cylinder and a barometric condenser, as shown in the sketch. The lower connection was of the same diameter as the exhaust pipe; the upper one was much smaller, but of sufficient capacity to allow circulation of the exhaust steam. A drain pipe leading to a "cushion" tank carried off any condensate accumulating on the bottom tube sheet, and on this drain line a bleeder valve was placed to determine whether there was any excessive flow of water passing through this line, indicating a leak in the heater. After a run of any appreciable length the heater was tested as soon as the unit was shut down.

Water from the city mains flowed through the tubes, which were divided into sections, providing for six passes, and the temperature rise obtained varied from 50 to 75 deg. before going to an open feed-water heater. The city water averaged 50 lb. gage, and with a pressure of 2 lb. absolute on the steam side of the heater considerable water was wasted when leaks occurred in the tubes, for the condensate and circulating water were discharged from the "cushion" tank into the canal running alongside the plant.

The point that I wish to bring out is the difficulty experienced in locating the leaking heater tubes and how this difficulty was overcome. Of course, on account of the layout of the piping, it was out of the question, when testing to locate the leaks, to fill the steam side of this heater with water, as is often done with those of horizontal design, so the candle test was applied, while a vacuum was maintained in the steam space. This method proved unsatisfactory, for while it located one serious leak, it failed to disclose the whereabouts of several minor ones, and the result was that the total leakage was reduced only about one-half.

Next, the bottom head was put back in place and the tubes were filled with water to a height of a few inches above the top tube sheet. The vacuum pulled the water level down in two certain sections, indicating leaks in those sections, but that was all. The suggestion of putting steam pressure on the exhaust side of the heater was next carried out, but naturally, the water absorbed all the steam that leaked through, and when the tubes were drained dry the heat evidently expanded the metal and closed up the leaks.

After much discussion among those of the operating force, the use of compressed air was suggested, and this method gave the most gratifying results. A hose was used to connect the compressed-air reservoir with the small bleeder valve on the drain line of the heater, and with the water a few inches above the top tube sheet, the air was turned on. On account of the small capacity of the hose and the bleeder valve, it was impossible to create a pressure of air in the exhaust-steam space as had been planned, for the air leaked through stuffing boxes, valves, etc., as fast as it flowed to the heater. After waiting a sufficient length of time to allow all the passages to become filled with air, the throttle valve of the engine was opened slightly. This produced the desired result, for the steam rushing through the engine and exhaust pipe, drove the air before it and caused such a rapid rise of pressure in the heater that air was forced through the leaks in the tubes. It was then a simple matter to mark the tubes from which the air bubbles were discharging. Several leaks were located and repaired, and when the heater was closed up and tested, not even a trickle of water appeared at the bleeder.



PIPING OF CLOSED HEATER TO EXHAUST PIPE

Operation and Adjustment of Turbine Machinery-III
Examining Turbines and Generators

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

WHEN a large-sized turbine is put into operation, the same course as for small turbines is pursued but with greater refinement. The piping and foundations should be carefully gone over. Strains due to pipe weight should be eliminated. In large machines an expansion joint is always placed at the condenser.

After cleaning and filling with oil comes the question of mechanical adjustment. In large machines alignment becomes the greatest single factor, as it affects the operation of the steam upon the blades, and the shaft packing rings as well as the operation of the bearings, couplings and the whole machine itself. Alignment depends upon the accuracy with which the machine is installed, and this should be among the first things checked. Alignment of bearings does not need to be checked in a two-bearing unit. In a three-bearing set this is checked by separating the coupling flanges a small amount and then measuring between them with a feeler gage to see that they are approximately parallel. The flanges should separate equally on each side, but the top should open up somewhat more than the bottom, which is usually from 0.002 to 0.006 in. to allow for expansion in the turbine end. In a turbine and generator set that is mounted on four bearings, the coupling is usually set so as to be parallel at the flanges and also central in regard to the axis of each shaft. The flanges can be measured as before to check them for parallelism. They can be tested for eccentricity with a straight-edge. Lay the straight-edge on one flange parallel to the shaft and allow it to project so as to touch the other flange. This should just barely touch on both sides, top and bottom. It is customary, if the machine is cold, to set the generator a little higher than the turbine so as to allow for turbine expansion. This allowance is 0.004 to 0.008 in. per foot of height above the bedplate.

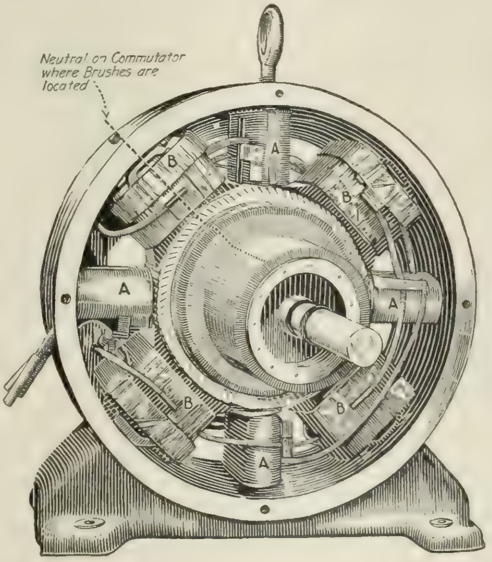


FIG. 1. THE MECHANICAL NEUTRAL POINT IS THE COMMUTATOR BAR THAT CONNECTS TO THE COIL IN THE CENTER OF THE SPACE BETWEEN THE MAIN POLES

The alignment of the shaft and turbine casing should be checked by removing the cover of the packing rings at each end of the machine and measuring from the shaft to the bored surface of the casing. The casing should be central under full-load conditions when it has reached its running temperature. In checking this alignment when cold, expansion should be considered. It often happens that the turbine bearings are supported directly on the turbine casing. Then there is little expansion effect. When the bearing is supported on the bedplate, we have greatest expansion of the turbine casing. The allowance for expansion should range from 0.002 to 0.01 in. per foot of height.

Impulse turbines do not require as close an alignment in this respect as reaction turbines, generally speaking, as in the former case there is only the nozzle alignment to be considered, while in the latter there is often a close clearance between revolving blades and turbine casing.

Setting the clearances is the next principal adjustment. This refers to axial clearance or, in other words, the distance measured parallel with the shaft from a moving blade to a stationary blade taken on each side. Before moving the shaft so as to adjust this clearance, be sure to look the rotating element over from end to end so that there will be no danger of damaging an oil deflector, gear or piece of governor mechanism. All such parts should be either disconnected or held under close observation. Peep-holes are usually provided by which it is possible to measure the actual clearances with a shim gage. The shaft can then be set so that the revolving and stationary blades will properly clear, with an allowance for expansion. It should be borne in mind that the shaft expands away from the thrust bearing. The revolving blade, therefore, should be set fairly close to the stationary blade—that is, on the same side as the thrust bearing—and the excess clearance can then be taken up by expansion away from the thrust bearing.

Some thrust bearings are set by means of shims. These shims can be removed until the shaft is moved into its proper position, and then they can be replaced in accordance with the new setting of the bearing. The shaft can be moved endwise by using a bar or a small jack against some solid part of the rotor. Thrust bearings are often made with a bolt which can be turned to move the shaft. It is safer, in this case, to turn the machine over by hand or by light steam pressure when moving the thrust bearing.

In turning over a large machine it is often most convenient to take a few turns round a coupling flange with a rope and pull one end with a crane.

There is another method of setting the clearances when it is not convenient to measure them through peep-holes. This consists in turning the machine over and setting the shaft toward one end until rubbing is heard and then setting the shaft in the other directon until it rubs at the other end of the travel. The actual travel of the shaft can be measured and the final setting made in the middle of this travel. This is best suited to small, rigid machines, but should be undertaken only with the greatest care and preferably omitted, if possible, in large machines with delicate blading.

The radial clearance, or that which is measured from the revolving blades to the turbine casing in a radial direction, is usually so large as to be negligible in impulse machines, but is of great importance in reaction machines. This adjustment is made in lining up the turbine casing and simply means, in the latter case, that the job should be well done.

Further progress follows the course of that pursued in smaller machines. Often an auxiliary oil pump driven by steam is supplied for use in starting. Sometimes the oil rings are omitted and it is necessary to use a squirt can on each bearing before starting. Bearing temperatures should be watched with greatest care; also leakage of oil along the shaft that might work its way into the generator should bear close scrutiny.

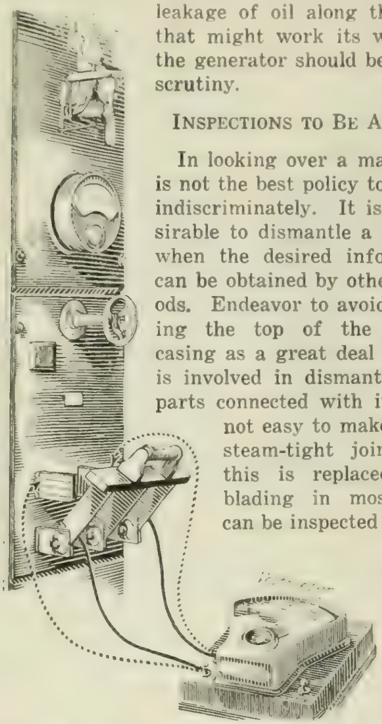


FIG. 2. TO TEST THE POLARITY OF THE MACHINE A POSITIVE VOLTMETER IS CONNECTED ACROSS THE OPEN MAIN SWITCH

INSPECTIONS TO BE AVOIDED

In looking over a machine it is not the best policy to inspect indiscriminately. It is not desirable to dismantle a machine when the desired information can be obtained by other methods. Endeavor to avoid removing the top of the turbine casing as a great deal of work is involved in dismantling the parts connected with it. It is not easy to make a good steam-tight joint when this is replaced. The blading in most cases can be inspected through peep-holes. In special cases, where there is reason to suspect trouble with the buckets, it may be necessary to dismantle the machine. The packing rings should always be tested by actual operation rather than by inspection. Assembling the packing is sometimes the most difficult job on the whole machine, and there is always a chance of breaking the delicate and expensive packing rings. The governor itself is difficult to assemble and should not be taken apart unless there is good reason and plenty of time for the work.

Steam engineers frequently are required to handle electric generators. In small plants especially, the engineer is frequently required to take charge of everything from supplying coal to the boiler up to the point of delivering mechanical energy from the electric motor. Putting a generator in service may become the engineer's responsibility, and this may prove an easy job or an unlooked-for accident may make it appear to be a proposition of no small proportions.

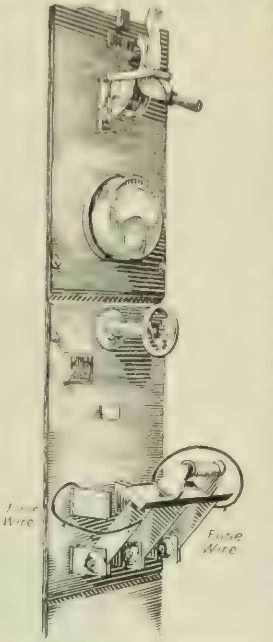


FIG. 3. JAWS AND BLADES OF MAIN SWITCH CONNECTED WITH FUSE WIRE WHEN POLARIZING MACHINE

Placing an alternating-current generator in service is comparatively simple. The brushes on the collector rings should be accurately fitted and the machine blown out and wiped off as before. When using compressed air, always use a fairly light current of air which would be equivalent to a strong electric fan close to the blades. Very high air pressure is injurious to the insulation and causes varnish, mica and wrapping to be blown off eventually.

An alternator is thrown in on the line by means of a synchronoscope. There are many methods of connecting synchronoscopes and of testing them to make sure they are right before throwing in a machine. The simplest method for checking them is, in the writer's opinion, as follows:

First, test for phase rotation. Bring the voltage up to normal; clear all the other generators off the switchboard and close the switch of the new generator so that it will energize the busbars.

Then start one of the induction motors on the line or in the power house. If this machine rotates in its usual direction, the phase rotation is correct. If not, the phase rotation must be corrected by interchanging any two of the three leads of a three-phase generator and either phase leads of a two-phase machine.

After the phase rotation has been corrected, the synchronoscope should be checked for accuracy. Disconnect the cables coming from the machine at the generator itself and mark them so that they can be connected again in the proper manner. Insulate the cables from the oil switch. Now close the oil switch, which will energize these leads with current from the busbars. Plug in the synchronoscope, and if the connections are correct it will read 12 o'clock. If it jumps to any other position, the connections should be corrected. In case the instrument is already in the 12 o'clock position, it should be moved away by hand so that its action can be plainly noted when it is plugged in. After opening the oil switch, the machine can now be connected to the leads and brought up to speed and loaded.

Direct-current generators are directly connected to turbines only in small sizes, and in larger sizes are connected through reduction gears. They should be disconnected until the turbine has been put in good running condition. It is a good plan to open the field circuit by disconnecting at a terminal so that there will be no danger of the voltage building up unexpectedly, until the engineer is ready.

The air gap between the rotating and stationary parts should be checked in all positions. The brushes should be sandpapered so they will fit the commutator. This is a delicate matter on high-speed machines. A good surface that fits the commutator can be secured by sandpapering against rotation with rough sandpaper and then going over with fine sandpaper, this time in the same direction of rotation.

The dust should be blown out with compressed air or, if none is available, a hand bellows may be substituted. Keep the current of air away from the windings so that the dust will be blown away from the machine. Wipe the brushes off with a clean rag and place them in the brush-holders. The remaining parts of the brush rigging and insulators, cable connections, etc., should be carefully wiped.

The brushes should be set in the running position. In many cases the brush rigging is marked with a pointer or other means so that this position can be easily located. In nearly all cases the running position is at the mechanical neutral point or perhaps one or two bars with rotation from this point. The foregoing applies to interpole machines, and in generators without interpoles the running position is sometimes two to four bars off the neutral. Machines of this character are not built to any great extent for turbine work. The mechanical neutral point is the commutator bar that connects to the coil in the center of the space between the main poles. This can most easily be found by marking the armature end windings between the main poles and then following the lead nearest this mark down to its commutator bar. In an interpole machine the neutral is at the center of the interpoles *A*, as indicated in Fig. 1.

If the coils lead off toward the center of the main poles *B*, then the neutral point on the commutator will be opposite the center of the main poles, and it is in this position that the brushes must be located.

Connect up the field. Test the machine for grounds with a magneto, turn the rheostat so that the resistance is all in and bring the machine up to speed. Build up the voltage slowly by turning back the rheostat and short-circuiting the field resistance. Watch the commutator as the voltage rises.

TESTING MACHINES FOR POLARITY

The next step is to test the polarity of the machine and of the equalizer before closing in the main switch. This can be most easily done by closing the circuit breaker and placing the leads of a voltmeter across the blades of the main switch and also across the jaws of the switch, as in Fig. 2. The voltmeter should be of the positive type, which will read backward or deflect back of zero when current is circulating through it in the wrong direction. The meter reading from the left blade to the right blade should be the same as that from the left jaw to the right jaw. If the voltmeter reads right in one of these positions and reads backward in the next, it indicates that the polarity of the machine is reversed.

The easiest way to polarize the generator correctly with absolute safety is to shut down and remove the brushes. The brushes should be placed so that they will not touch the commutator or the frame of the machine. It is general practice to let the brushes on the lower studs hang by their pigtails while the brushes in the upper studs can be thrown backward over the studs so that the pigtail will not allow them to touch the commutator. Also it is a little more trouble but somewhat safer to place these brushes crosswise on the tops of the holders and hold them in place with the spring. If some fiber is handy, this can be slipped between the brushes and the commutator instead of removing brushes from the holders.

Now turn the rheostat to the "all-in," or "low-voltage" position. See that the circuit breaker is open. Connect the left switch jaw to its blade with a piece of fuse wire. Do the same to the right switch blade and jaw, as in Fig. 3. Now close the circuit breaker and slowly cut out the resistance. Then cut the resistance all in again so that the field current will be reduced as much as possible and open the circuit-breaker and remove the fuse wire.

FIELD MAY BE WRONGLY CONNECTED

Bring the voltage up to normal as before. Now test for polarity, and if the directions have been followed it cannot fail to be correct, except in the possible case of the field being wrongly connected. When the field is wrongly connected, the voltage will not build up. The remedy is to reverse the field connections at the machine. In case there should be an open-field connection, there will be no arc when the circuit breaker is opened as before described.

Take the polarity from one switch blade to the equalizer switch blade and then to the two corresponding switch jaws. If the equalizer is on the proper side of the line, the same polarity will be obtained in each case. The machine can now be adjusted to the same voltage as that on the switchboard and closed in on the line and loaded.

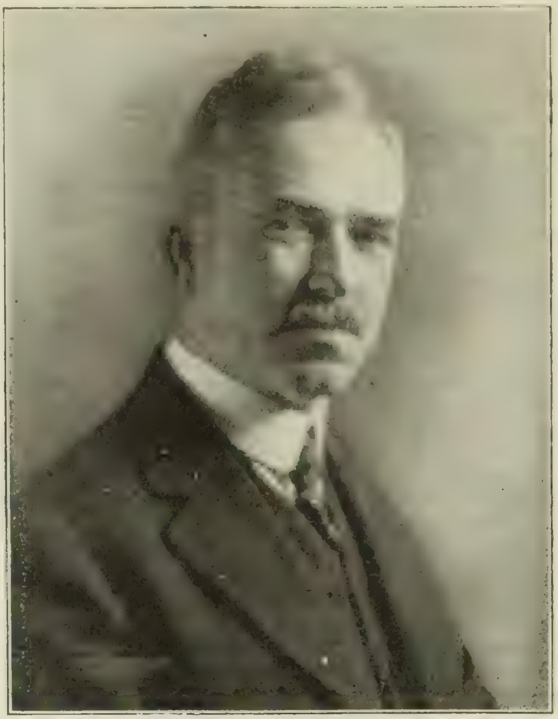
(In the next article Mr. Thompson will explain some points on the proper handling of a turbine.)

Experience has shown that wire ropes of compound construction, subjected to corrosion influences, are likely to deceive engineers as to the strength remaining in them, says a circular issued to managers of mines on the Rand, South Africa. Where reduction of diameter or circumference of the rope has taken place, not accounted for by the evidence of wear, the part of the rope under examination should first be fully loaded and then relieved of the load. Any noticeable difference in circumference in these circumstances and the slackening of the outside wires when the load is off will indicate that internal corrosion has taken place. The extent of corrosion inside the strand can be estimated only by the slackness of the outside wires. The corrosion between the strands can be further examined by untwisting the rope or displaying the strands sufficiently with a marlin spike.—*The Engineer.*

An ideal air compressor would have no clearance space at the end of the compression stroke or cycle, as any air remaining in the clearance space simply expands again, reducing the capacity of the unit. As zero clearance is practically impossible as well as inexpedient, and cooling in the compression chamber limited, when high pressures are desired it is found advantageous to use multiple-stage units, cooling the air between the stages in what are known as intercoolers.

Ozni P. Hood, Chief Mechanical Engineer of the Bureau of Mines

DURING the war the national peril aroused an acute public sense of the importance of fuel economy. By the suggestion of simple measures, and a ready acceptance of them by fuel users through patriotism or apprehension of a compulsory shut-down, it was demonstrated positively that fully a quarter of the nation's coal consumption can be saved, and this by ordinary attention to common principles and simple practices. As a war measure this work of the Fuel Administration was a success. It would be equally beneficial, if not so imperative as a peace measure. The hope has been that it would be carried on by the Bureau of Mines, and the possibility of making a start in this direction by having the Bureau undertake the inspection of coal on its way to the purchaser has been discussed. Should this be done, the man who would probably be intrusted with the institution of the system is Ozni P. Hood, the Chief Mechanical Engineer of the Bureau. Just at the present time Mr. Hood's attention is being directed toward the solving of the mechanical and chemical obstacles which separate the great lignitic resources of the country from commerical success. A plant embodying many ideas worked out in Mr. Hood's office is being created in the North Dakota lignite field, and the most pretentious effort ever made to commercialize lignite is well under way.



OZNI P. HOOD

Practically every year of Mr. Hood's life, since the days he worked as an apprentice for his father, who was a pioneer in the development of cash registers and adding machines, has seen an accomplishment of more than ordinary merit. Much of his work has been with the idea of increasing the efficiency of power plants.

Mr. Hood was born in Lowell, Mass., June 14, 1865. His parents moved to Indianapolis shortly after his birth, and it was there that he learned his trade as a pattern and model maker and secured his early education. His technical education was obtained at Worcester Polytechnic Institute and at Rose Polytechnic Institute. He was among the first to be graduated by the latter institution. His first position after graduation was as instructor and mechanical engineer at the Kansas State Agricultural College. He was a member of the faculty of that institution for twelve years. He then joined the faculty of the Michigan School of Mines, where he served thirteen years. In addition to his school work Mr. Hood was allowed to maintain a consulting practice. During the thirteen years he was with the Michigan School of Mines, he made special reports for nearly every mining company in the Michigan copper district. In 1911 Dr. Joseph A. Holmes came to him with a request that he help him make a success of the Bureau of Mines, which had only recently been established. He accepted the offer and has been Chief Mechanical Engineer of the Bureau ever since. The United States Geological Survey superpower investigation staff is being organized and Mr. Hood has been designated as one of the engineering staff to co-operate in this work. In this work his attention will probably be directed to the various problems of fuel economy.

It is anticipated that gas may possibly form one important medium for the transfer of energy from the western Pennsylvania and West Virginia fields to the region nearer seaboard, where the demands for power and other forms of energy are greatest. If so, it will be very important, indeed, to have these aspects of the work properly represented on the senior board of engineers. Extensive plans have often been discussed for coking of coal at the mine, and it is possible that such engineering projects may require considerable attention in the course of this work.

EDITORIALS

The Emmet Mercury-Vapor Power Apparatus

EVER since Carnot showed that the efficiency of a heat engine depends on the range of temperature over which it operates, engineers and scientists have been trying to increase the temperature range of power-generating apparatus. In the earlier engines steam was used because of its convenience, and the same reasons still exist for its continued use. The difficulties of mechanical construction to handle large pressure ranges, however, placed a practical limit on the temperature range. With this fact in mind, scientists investigated the properties of other substances in the hope of finding a substitute for water vapor, but found the same difficulty in every case. It is true, they found vapors having much higher boiling points at usable pressures, but these same vapors had high boiling points at workable condenser pressures so that no very great gain was made in the available temperature range. The same facts held for substances having boiling points lower than that of water.

The next suggestion was to use two substances in series. A liquid having a high boiling point was to be vaporized in a boiler, used in an engine or turbine and condensed in a condenser which acted as a boiler for a second liquid having a lower boiling point. This second substance was to be used in an engine and condensed as usual. In most cases water was suggested as one of the substances—sometimes as the first and sometimes as the second, depending upon the properties of the other liquid chosen.

On paper this scheme worked beautifully. It promised to revolutionize the power-plant industry. Its actual application, however, encountered obstacles. The complicated apparatus necessary offered apparently unsolvable problems. The chemical properties of the various substances presented new difficulties. Thus, most engineers came to think that the binary-vapor power plant was a good idea that could not be made to work.

One man, however, felt that it could be made to work. He knew that the idea was theoretically sound and was convinced that the practical difficulties could be overcome. In this issue of *Power* is a short account of the binary-vapor apparatus using mercury vapor and steam which has been developed by W. L. R. Emmet. Mr. Emmet made public a description of his plant about six years ago, and at that time he apparently had a workable apparatus. The intervening time has been spent in experimenting and perfecting the various details until commercial application seems possible.

When the Edison Medal was presented to Mr. Emmet recently, he stated, in reply to remarks by H. W. Buck, that commercial application was being made, and expressed the hope that it would be a commercial success in a very short time. In this connection there is a persistent rumor that an Emmet mercury-vapor plant is being built for the Hartford (Conn.) Electric Light Company. The reputation of President Samuel G. Dunham, of the Hartford company, for intelligent progressiveness in power-plant engineering, adds strength to this rumor. It will be remembered that it was in the plant of this company that the first steam turbine of commercial size was installed for electric-power generation. It would be appropriate if the first commercial binary-vapor plant should be installed there.

The success of Mr. Emmet's apparatus will have an almost revolutionary effect on power-plant engineering. It cuts down, by a very appreciable amount, the loss of available heat, which results from the big temperature drop from the furnace to the water in the ordinary boiler. In other words, it increases the amount of heat that may be transformed into power and decreases the amount that must be thrown away in the condenser cooling water. Thus, the power per unit of fuel in the central station will be greater. In the industrial plant using exhaust steam for heating or steam at any pressure for processes, power may be taken out from that part of the temperature range which has been unavailable. The date of the installation of the first commercial Emmet mercury-vapor plant will take a prominent place among the epoch-marking dates in engineering history.

The Interstate Inspection of Boilers

C. O. MYERS, chief deputy in charge of the boiler-inspection division of the Industrial Commission of Ohio, has an article in the July issue of the *International Steam Engineer* which deserves wider circulation and the interested attention of all who are concerned with the inspection of boilers. With the boilers already installed a state department can deal after its own fashion without complications with the boiler manufacturers or the inspection departments of other states. In any effective system of supervision, however, new boilers must conform to some accepted standard, and unless there is to be all sorts of confusion in the interstate use of boilers and all kinds of expense and complication to manufacturers, there must be a common standard, a boiler built to which will be acceptable to the inspection department of any state.

Such a standard is that formulated by the Boiler Code Committee of the American Society of Mechanical Engineers. A boiler built to that code, the adequacy of which has been avouched by the best authorities on boiler construction in the world, ought to be acceptable to any board whose decisions were controlled by nothing but real purpose to guard the public safety. But how is the boiler inspection department of Massachusetts, for example, to know that a boiler built in Ohio has been built in accordance with the code? The boiler must be inspected in the process of manufacture, and no state can maintain an inspector of its own in every boiler shop that is likely to send boilers to it.

The natural suggestion would be that the states accept the certificates of each other's inspectors; that when a duly qualified inspector puts the A. S. M. E. stamp upon a boiler, it should be generally acceptable. But what is a "duly qualified" inspector? Some of the states are more particular than others as to the qualifications of the men upon whose painstaking and conscientious performance of their duty, life and property depend. It is not unheard of that a barber or another having as little training for and knowledge of the boiler inspector's duties has been appointed through political favor to this office, and it is the possibility of such malpractice that makes it impracticable to get the heads of all state departments to agree unreservedly to accept each other's inspections.

A logical solution is through the national organization of the heads of inspection departments, known as the National Board of Boiler and Pressure Vessel Inspectors, of which Mr. Myers is secretary. This organization ought to determine what the qualifications of an inspector should be, and every inspector should be required to pass its examination and receive its certificate of competency. Most of the chief inspectors of whom the board is composed control the appointment of the inspectors under them, and in a case where one does not, the appointing power would hesitate to appoint a man who could and would not qualify under such an arrangement. If this could be done, the department of any state could accept with confidence a boiler marked with the A. S. M. E. stamp, confident that it has been put there by one competent to certify that it has been built in accordance with the requirements of the code.

What Is the Efficiency of a Steam Engine?

A RECENT number of a popular magazine contained an article on the question of what is a luxury? It was pointed out that a luxury is something we can do without, while a necessity is something we must have if we are to live in decency, comfort and health. That was easy to define, but when it came to making legal lists of luxuries and necessities trouble began. There were too many differences of opinion.

In the same way the word efficiency seems easy to define, but when we try to pin it down to actual application in engineering, there are differences of opinion and more or less confusion. It is one of the prime requisites of an engineering vocabulary that no ambiguity or uncertainty of meaning is permissible. Therefore it is to be regretted that a word so frequently used as "efficiency" should be used in so many different senses. Someone has said that it is a word that should never be used without a qualifying adjective. In engineering literature it generally is accompanied by an adjective, but different men attach different meanings to the same adjective and the confusion is only made worse.

Power frequently receives letters calling attention to supposed inaccuracies in articles when the only error consists in a difference in the meaning attached to the same term by the author of an article and the correspondent who criticizes it. Both are correct according to their own interpretations of the terms, and both have authority for their interpretations. The result is confusion and unnecessary controversy over points on which everybody is really in accord.

This confusion of terms is an especial hardship on the student or recent graduate of a technical school. The faculty of his school use a given set of names for the various efficiencies, and the student learns to think in those terms. When he attempts to read general engineering books or papers or comes in contact with engineers from other schools, he finds what seems to him a foreign language. His time must be spent learning over again what he has already been taught instead of acquiring additional information.

In this issue of *Power* is an article which points out a few, but only a few, of the cases where authorities differ in the names of the various ratios which come under the broad head of efficiencies. This article contains a short list of suggested definitions as the beginning of a standard for these terms. Obviously, action by some representative body of engineers is necessary before any general adoption of such definitions, but it would appear that some such action should be taken or at least considered.

Cheap Hydrogen?

TWO more inventors have wandered off into that path that leads to a dead end. Two Grand Rapids boys, now serving sentences in the state prison at Marquette, have written friends at home that they believe they are successful in developing a chemical process from which they may devise means of commercially extracting hydrogen from water, thus affording fuel and power startling in economy.

It takes as much energy to separate hydrogen and oxygen as they will generate by coming together again. The alleged discovery is just the same as though they had discovered a new way of lifting a weight. However it is lifted, it will take as much energy to separate its center of gravity from that of the earth as will be generated by their approach to the original distance. In combustion the atoms of hydrogen and oxygen "fall" toward one another, and the momentum acquired in the fall is heat. It takes as much energy to "lift" them away from one another as is generated by their rush toward one another. There is nothing in it unless the dissociation can be effected by energy now wasted.

According to the fourth monthly bulletin on coal costs of the Federal Trade Commission the average sales realization of the 812 operators reporting to the Commission for April was $3.26 per ton, while their reported f.o.b. cost amounted to $2.76. These figures are interesting to those who, notwithstanding they have contracts at much lower prices, are paying four, five or six times as much. We have yet to learn of any intelligent attempt to put an end to the conditions which permit this continued preying upon the industries of the country and upon those who buy the products of the industries. And we have yet to learn of a single instance where summary and adequate punishment has been inflicted upon those who practice it. If it is legal, there is something radically wrong with the laws. If it is legally, as it is certainly morally, criminal, there is something radically wrong with those who are charged with the administration of justice.

If it is a fact that the present high prices of coal and interruption to industry, to say nothing of the threatened shortage of the coming winter, are due to car shortage every shop in the country that can make cars ought to be running twenty-four hours a day. Are they?

CORRESPONDENCE

Recently Inspected Boilers

I recently operated a tugboat, the boiler of which was inspected and hydrostatically tested a short time ago at Buffalo, by United States inspectors. One week later I took the tug as engineer and found the crown sheet with a patch 8 in. wide by 11 in. long, placed on the inside and electrically welded. Stays were put in the patch less than ½ in from the weld. I also found three small cracks and two bags.

I made one trip with the captain who owns the tug, and he says the boiler is all right. The patch would not stay tight at 60-lb. steam, and 145 lb. is the operating pressure. What kind of inspection was it?

Syracuse, N. Y. R. G. SUMMERS.

Comparison of Pulverized-Coal Tests

Joseph Harrington's comments in the June 22 issue of *Power* regarding the comparison of pulverized-coal tests were read with interest. It is difficult to see the logic of his assertion that the fundamental principles involved in the underfeed-stoker design are incorrect. In view of the well-known part that this type of stoker has played in the progress of economically generating the ambiguous boiler-horsepower from less than the arbitrary ten square feet of heating surface (Why not measure it in boiler-heating power?), surely it should be credited for some of the most far-reaching progress made in central-station operation in the last ten years, and it has been the means of spreading a better knowledge of the fundamental principles of burning bituminous fuels than any other type of stoker in existence.

Judging from a theoretical and scientific standpoint of the fundamental requirements of burning unprepared bituminous fuels high in volatile matter content, the underfeed principle conforms admirably with these requirements and the widespread practical application of this principle, and stokers embodying the same, cannot be overlooked.

Mr. Thompson's remarks have a bearing on the true solution of any engineering problem in connection with the generation of heat, steam, or electricity. The power-plant designer and operator alike fully realize that the maximum commercial efficiency is the ultimate criterion of a piece of power-plant apparatus and that this term as applied to a stoker and its relationship to a boiler room, at large, embraces a well-adjusted relation of many independent factors, such as first cost, installation cost, cost of brickwork, combined furnace and boiler efficiency, combustion capacity, ability to efficiently handle almost any kind of coals (especially the low-grade and clinkering coals) without excessive labor, flexibility of operation, simplicity in handling, low maintenance to stoker parts as well as furnace brickwork, reliability against shutdowns, service of the manufacturer, etc.; that the best obtainable value of only one or two of these factors, if the remaining factors are not considered, will lower the value of the maximum commercial efficiency; and that to compare, say, one system of burning a particular fuel or one stoker with another on an efficiency basis alone, is, to say the least, incorrect.

If a certain method or principle of burning fuel, having all the theoretical and scientific requirements for the proper combustion of the volatile as well as the fixed-carbon portion of such fuel, yields results known in practice to be superior to any other method of burning such fuels under the same conditions, then the principle or basis of burning such fuel is demonstrated to be correct.

This principle, however, may be incorporated in a particular stoker design and give unsatisfactory results from "clinker formation, periodic dumping, uneven thickness of fire, fuel-bed disturbance, etc.," and also, as Mr. Thompson states, from the emission of "large sparks indicating the carrying away of combustible." Such results, however, are due to imperfect stoker design, not to the underfeed principle.

The gross efficiency mentioned by Mr. Harrington, is, of course, a combination of boiler and furnace efficiency at a certain rating, with a certain fuel. Such factors as boiler and furnace performance are involved in this figure and make it difficult to see the comparative value between the gross efficiency figure mentioned at the Oneida Street plant test with an underfeed stoker and a predicted future method of stoking which will produce "a gross efficiency of 80 per cent."

If I recall correctly, Dr. Jacobus' figures from tests on underfeed stokers at the Delray plant of 79 to 80 per cent gross combined boiler and furnace efficiency were obtained at 107 to 125 per cent of boiler rating during 24- and 48-hour periods with a special Stirling boiler rated at 2,365 hp., coal of the Red Jacket kind, 14,000 B.t.u., and a stoker having an underfeed-grate area of 250 square feet.

It seems that too often in our technical magazines comparative figures of performance are given which, if analyzed, are found to have no common standard of comparison, and offhand statements are made which a fair-minded engineer, or surely a competitor in a friendly way, would label as commercialism.

Frederick, Md. EDWIN LUNDGREN.

Maximum Length of Longitudinal Joints in Boiler Shells

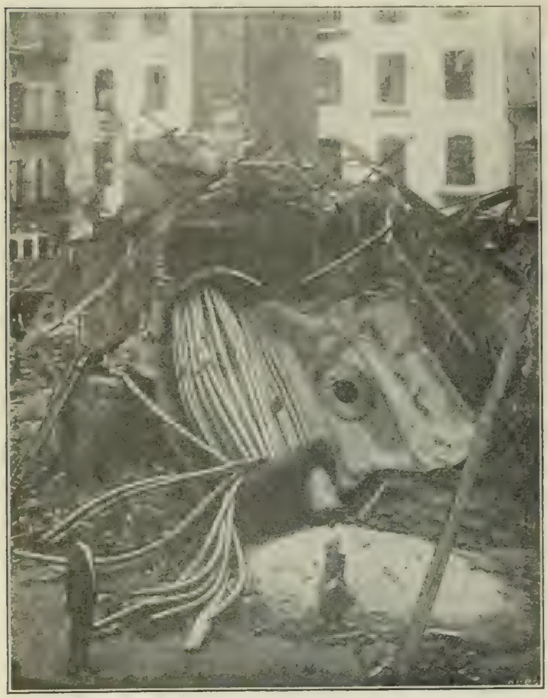


FIG. 1. NOTE THE PLATE DESIGN OF THE EXPLODED BOILER

Owing to distance, this contribution relating to the maximum length of longitudinal joints of boiler shells will be a little late, but as the subject is of interest a further discussion may not be out of place. The difficulty of the problem to determine with accuracy the stresses to which the material of a cylindrical shell is subjected by internal pressure is clearly shown by the differing opinions of various correspondents. If the common rule in designing machinery, to make it of equal strength in all its parts, were adhered to in the case of a vessel of uniform thickness of walls, the shape of the vessel would have to be that of a sphere. The form of a sphere alone remains stable under any pressure, and the strain of the material of which it consists is identically the same in every direction. Inasmuch as the shape of a cylinder differs from that of a sphere, there are different stresses working in the various directions.

The common methods of calculating these stresses are based upon so many assumptions that their results are highly misleading. But within the limit of elasticity a measure of the actual stresses working may be found in the deformations of the shell under pressure. By these means Mr. Stromeyer tried to solve the problem. The startling results he obtained are far from being improbable. He found that in one case the stress in the solid plate, next to the end of the longitudinal joint of the neighboring course, was eight times as great as that in parts of the solid plate farther away from the joint. But this certainly holds good only for a definite height of pressure. The proportion may be still greater at a lower pressure, while the absolute stresses may be smaller, for the stresses wander and shift with the rising pressure.

The manner in which a boilermaker handles the plates cannot be compared to that of an instrument maker. The plates of a boiler receive hard treatment when they are hammered, bent and riveted one to the other. This treatment strains the material in some parts even without any internal pressure working. These pre-existing stresses augment or reduce, as the case may be, the strain produced by the internal pressure.

Now, a cylindrical boiler shell is neither rigid enough nor so elastic that the rising strain produced by an augmenting internal pressure would be immediately transmitted to every part of the structure. The well-known noises heard when a boiler is tested by hydraulic pressure testify that one part after the other takes its charge, and there can be no doubt that in some parts the limit of elasticity will be reached and transgressed at relatively low pressures if the ultimate strength of the whole depends on the strength of all its part. A comparison may help to make matters clearer.

A weight hanging on several ropes strains them in a different measure, as it is practically impossible to get ropes of exactly equal length and of the same quality. The unavoidable differences account for the fact that as long as the weight is light, it is borne only by the shortest ropes or by those of least elongation. It is only after the stretching of these ropes that, with a heavier weight, the other ropes partake of the weight and the stresses equalize. No doubt the limit of elasticity might have been transgressed in some ropes. Furthermore, the conception of a limit of elasticity corresponds to no reality. In fact, there is no other limit but a limit to our senses and faculties of seeing and measuring. By controlling the interference stripes of monochromatic light, as Mr. Stromeyer did, the so-called limit of elasticity must have been reached at much lower values than generally assumed.

To answer the question whether long or short courses were preferable in boiler construction, let us first consider shells without any longitudinal joint. The well-known formula $S = \frac{Dp}{2t}$ applies to a cylinder of infinite length. A hose of a fire engine may serve for an example. The pressure p causes the diameter D to increase, but there is no possibility of its assuming the shape of a sphere. Should there be iron bands placed around the cylinder certain distances apart, they would prevent the cylinder from expanding at the places where they are put, by themselves taking part of the stress, while the remaining stress on the plate would not be sufficient to stretch it as much as the entire stress does in those parts where there are no rings. The stress in the plate under the ring is therefore smaller than elsewhere. The strengthening effect of each ring may even be noticeable to some extent on both sides of the ring and the stress in the solid plate midway between two rings cannot even reach $S = \frac{Dp}{2t}$, though its value would be the nearer to this limit the farther the rings are set apart. The elongation of the material being proportionate to its strain, the cylinder becomes barrel-shaped between any pair of neighboring rings. The rings cannot be considered otherwise than that they are strengthening the structure.

The overlapping ends of the plates at the circumferential lapped joints or the butt-straps of butt-strapped girth joints may well be compared to such rings, the more so as the section of the doubled plate in the joint after deduction of the rivet hole is still greater than the section of the solid plate. The result of this reasoning is, therefore, that a cylindrical shell consisting of several courses riveted together by lapped or butt-strapped circumferential joints will better resist internal pressure than a drum without girth joints. The lower resistance lengthways may be left out of consideration, as circumferential joints are necessary in any case for joining the heads to the drum.

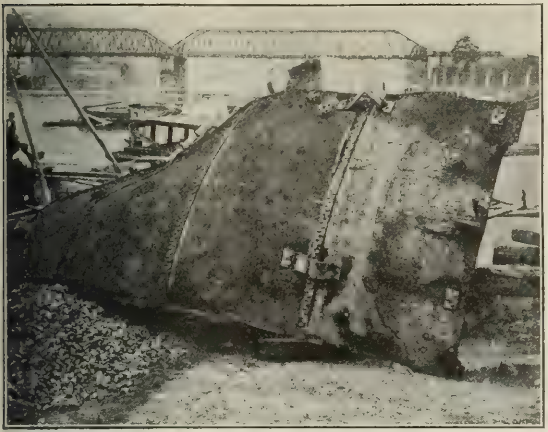


FIG. 2. EXPLODED SCOTCH MARINE BOILER

The next question is in how far this reasoning stands when there are longitudinal joints. In a drum of infinite length with no circumferential joint and one longitudinal joint, the internal pressure p would set up a strain of the material in the joint of $S = x \frac{Dp}{2t}$, with $x > 1$. The calculated stress in every other part of the plates and in a direction transversely to the axis of the drum would be, as formerly, $S = \frac{Dp}{2t}$. These stresses deform the cylinder, the length of which cannot any more be assumed infinite, as the one-sided weakness due to the joint would cause the curving of the cylinder, the joint being on the concave side of the curvature. There would be no curving if the cylinder had two or any even number of joints diametrically opposed to each other.

The shearing stresses set up in the plates near the seams have been explained very clearly by Mr. Stromeyer in his book, "Marine Boiler Management and Construction," and there remains hardly anything to be added in this respect. These queer shearing stresses are produced by the tendency of the strained joints to contract lengthways and to bend the cylinder. Although a symmetrically opposite joint may prevent bending, nevertheless the tendency exists and is at work. The strain caused by it is independent of the length of the seam, and in this respect a short joint is no better off than a long one. Now, as these strains are due to the stresses working transversely to the axis of the cylinder, all means that help to reduce these stresses may serve as well to reduce the strains herein referred to.

As has been shown, circumferential joints, whether lapped or butt-strapped, are a means of reducing the transversal stresses. It follows that circumferential joints must be regarded as strengthening the structure. Moreover, girth joints allow the staggering of the longitudinal seams in the courses and thereby another advantage is obtained, as part of the stress of the longitudinal joint is borne by the solid plate of the adjoining course, as Mr. Stromeyer has clearly demonstrated. The weakest points of a drum consisting of several cylindrical courses, riveted together in the usual manner, are to be looked for in the midst of the several longitudinal joints, and I think Mr. Jeter is right in assuming that a boiler tested to destruction would first give way at one of these points.

In our country every boilermaker is free to make the longitudinal joints as long as he chooses; our laws do not interfere, and if a boiler shows no signs of weakness at the official hydraulic test, there is no restriction whatever for it to be put in use.

The return-tubular boiler, so much used in the United States, is not a favorite in our country. In fact, it is regarded as rather a poor boiler. The majority of our boilers up to 1,000 sq.ft. of heating surface are of the Cornish or Lancashire type with one or two internal furnaces. Larger units of cylindrical boilers are of a combined type. Our boiler manufacturers, fully aware that the weakest points of the shell are in the longitudinal joints, try to make each course of the shell with as few longitudinal joints as possible. The weakness of a boiler shell betrays itself by the leaking at its longitudinal seams, while girth seams seldom become leaky. There is also a small difference in the tensile strength of a plate lengthwise and crosswise to the direction of its having been rolled, and for this reason there is some advantage derived by disposing the length of the plate circumferentially. Therefore, the courses of the shells of our cylindrical boilers do not generally exceed the length of six feet.

Some of the very few exceptions to this practice had very discouraging results, and the accompanying illustrations show the result of two fatal explosions that occurred some years ago with boilers whose shell consisted of only one course with four longitudinal joints of considerable length. The illustrations speak for themselves. The exploded boiler of Fig. 1 was a two-story boiler consisting of a shell with two internal furnaces beneath and a tubular boiler on top. The shell of the latter, which measured 6 ft. in diameter and 13 ft. in length, consisted of one course of plates 0.65 in. in thickness with four longitudinal double-riveted lap joints. The allowed pressure was 156 lb. per square inch.

The other boiler, the shell of which is shown in Fig. 2 after the explosion, was a Scotch-marine boiler with two furnaces; the shell measured 6 ft. 5 in. in diameter and 9 ft. in length and consisted also of only four plates, ½ in. in thickness with four longitudinal double-riveted lap joints. The boiler was considered safe for a steam pressure of 114 lb. per square inch. It carried about 110 lb. per square inch at the time of the explosion.

It is only recently that the drums of some novel types of water-tube boilers are made with continuous longitudinal butt-strapped joints, 8 and 10 ft. long. No failure of such has as yet been reported.

Vienna, Austria. **Fritz Krauss.**

Burning Sawdust To Reduce the Fuel Bill

I thought it might be of interest and possibly of some benefit to tell the readers of *Power* what I am doing during the present serious and critical fuel situation to keep our power plant in operation and reduce running expenses.

The last car of coal we bought on contract, received in April, cost us $3.09 per ton f.o.b. mines. The next car we bought cost us $9 per ton f.o.b. mines. Our average consumption of coal is three 50-ton cars per month. The increase, therefore, in the price of coal would add approximately $900 per month to our fuel bill. This was more than we felt we could stand. Furthermore, it was almost impossible to get coal at any cost. I decided to try something that I hoped might help us out.

There were several large piles of sawdust from three to five miles distant that could be reached by an ordinary truck and I determined to rent a truck and haul this sawdust to the power plant to be used, to a large extent, as a substitute for the expensive coal. With two men on the truck we are hauling 12 tons of sawdust per day, six days per week. Now, instead of burning four to five tons of coal per day we are burning not to exceed 1½ tons. We are hauling sawdust fully 50 per cent faster than we are burning it. After we get rigged up as planned we do not believe it will be necessary to burn even one ton of coal a day. The expense of hauling the sawdust does not exceed $18 a day. We are, therefore, saving over the present prices of coal approximately $100 a week. I have been conservative in regard to the amount of sawdust mentioned as hauled.

At present we are hand-firing the sawdust, but will soon have a rig that will make it easy on the firemen. We have a blower system for conveying sawdust to our furnace from a small sawmill near by, but the sawdust we are hauling is too wet to handle with this system.

We have a dutch oven that was built under our boiler when installed to burn sawdust, shavings and peanut hulls.

There must be many light and power plants facing similar fuel conditions that should take some steps to utilize as fuel some of the immense piles of sawdust around them.

L. R. MILLS, JR.
Supt. Light and Water Commission.
Scotland Neck, N. C.

Determining Depth of Crack in Crankshaft

The letter of D. L. Fagnan on circumferential cracks in a 14-in. crankshaft reminds me of an experience. The circumstances were different from those related by Mr. Fagnan, in that there was no doubt as to there being a crack, which was gradually growing longer, and the telltale red or brown oil had continued to ooze out for some time. The crack is represented by Fig. 1.

The owners desired to know how deep the crack was and something of the remaining strength of the shaft. F. W. Salmon, with whom I was then associated, assumed that if the neutral axis of the shaft could be located, the depth of the crack could be found, assuming it to have the shape of a saw cut, as shown.

There was a heavy rope wheel on the shaft close to the crack, which had a tendency to cause the shaft to bend. The method employed by Mr. Salmon to locate the neutral axis and find the depth of the crack was as follows: He drilled and tapped a ¼-in. hole at each side of the crack, and similar holes were made diametrically opposite the first ones. Then ¼-in. rods were screwed in and a gage, such as is used in machine shops for setting up work, attached to each pair of rods and placed 8 in. from the shaft, as shown in Fig. 2.

The crack was placed on the top center and the gages read. The crack was next placed on the outer and inner centers, but the gages showed no change in reading. When the crack was placed on the lower center, the opening effect was apparent by the reading of the gages.

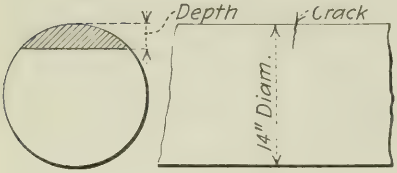


FIG. 1. SHOWING DEPTH OF CRACK

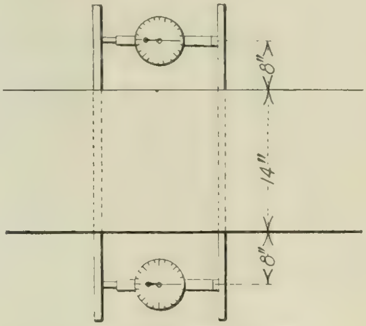


FIG. 2. POSITION OF TEST GAGES

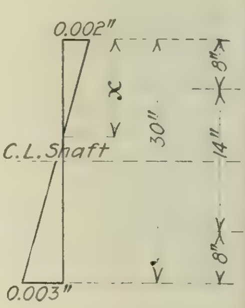


FIG. 3. POSITION OF NEUTRAL AXIS

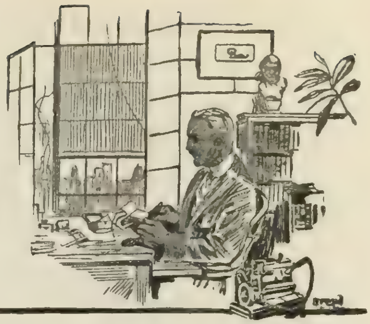
Had there been no crack, the readings should have remained the same and the neutral axis would be at the center of the shaft. Suppose the difference between the original readings of the gages and the readings with the crack on the lower center were 0.002 in. for the top gage and 0.003 in. for the bottom one, Fig. 3. Then the neutral axis is found from the equation,

$$\frac{0.003}{30 - x} = \frac{0.002}{x} \qquad x = 12\,in.$$

The neutral axis would be 15 — 12 = 3 in. from the center of the shaft.

I do not remember the readings of the gages or the depth of the crack, but I know that Mr. Salmon recommended a new shaft, and I checked analytically the depth of the cut and computed the strength of the shaft in bending and in torsion.

INQUIRIES OF GENERAL INTEREST



Semi-Steel—What is the material that is known as semisteel? R. N. B.

So-called semi-steel is a special kind of cast iron produced by adding to the molten cast-iron scraps of wrought iron or steel by which the strength and toughness of the cast iron is increased, making it suitable for many purposes where more expensive material would be required.

Falling and Rising Exhaust Line—What is indicated by falling and rising of the exhaust line of an indicator diagram? M. S.

A falling and rising exhaust line may be due to contracted exhaust ports or pipes that do not allow the steam to pass out as rapidly as it is displaced by the piston at its greatest velocity, thus creating greater back pressure toward the middle of the stroke; or a rise of pressure may be due to leakage of the piston or steam valve.

Air Contained in Steam—Does steam contain the same amount of air as the water from which it is generated, or is there a different amount present? J. H. B.

When water is heated to the boiling point, practically all of the air becomes liberated and that weight of air is present as a mechanical mixture with the steam at the same pressure. When the steam is condensed to water, nearly all of the air that was mixed with the steam becomes disengaged as air saturated with moisture, the amount of moisture depending on the temperature at which condensation takes place.

Negative Lead—What is meant by negative lead, and how would a valve be set to give negative lead? F. J. G.

Lead is the width of port opening when the crank is on dead center, and negative lead would be the amount the valve overlaps the admission edge of the port when the crank of the engine is on dead center. To set a valve with the same amount of negative lead at each end, turn the engine over and lengthen or shorten the valve rod, as may be necessary, to obtain the same travel of each end of the valve beyond the admission edges of the ports. Then place the engine on a center and set the eccentric in such a position that the valve overlaps the admission edge of the port for forward rotation by the amount of negative lead that is desired.

Formula for Computing Pump Capacity—What is a simple formula for estimating the capacity of a pump? W. L. A.

The capacity of a single, double-acting pump can be calculated theoretically by the formula

$$Q = \frac{a \times F \times 12}{231}$$

where Q = displacement of one double-acting plunger in U. S. gallons, a = area of plunger in square inches, and F = piston speed in feet per minute.

Where d = diameter of plunger in inches, the formula becomes

$$Q = \frac{d^2 \times 0.7854 \times F \times 12}{231} \text{ or } Q = 0.0408\,d^2F$$

For actual capacity the displacement by the piston rod and percentage of slip of the pump must be deducted.

Removing Grease from New Boilers—How can oil and grease be removed from a new boiler before it is put in service? J. S. A.

Place in the boiler about half a pound of soda ash per horsepower capacity and, with the boiler filled with clean water to the highest gage cock, start a slow fire. After holding the water to the boiling point for about twelve hours, allow the fire to die out and the boiler to cool slowly, after which drain the boiler and then open it and wash out thoroughly.

Sling Stays of Internally Fired Boilers—What are sling stays, used in construction of internally fired boilers? R. G.

In locomotive and marine types of boilers, where girder stays are used for supporting the crown sheet or top of the combustion chamber, the girder stays, in addition to having end supports, are commonly supported at intervals of their span by short articulated stays, called sling stays, fastened to the girder and top of the boiler. The required depth of the girder stays is thereby reduced, and with the crown sheet suspended from the girders the staying is equivalent to having a flexible arrangement of through stays from the crown sheet to the top sheet of the boilers.

Sizes of Tubes for Return-Tubular Boilers—What determines the sizes of tubes suitable for a horizontal return-tubular boiler? W. A.

The most suitable size of tubes depends on their length, the kind of coal to be burned, the facilities for cleaning and the force of the draft. The smaller the tubes the greater the total heating surface for the space occupied, but the more easily they clog with soot and choke the draft. The larger the flues the less the heating surface for a given amount of tube space and less efficiency of heating surface. For operation with natural draft a common rule is to allow one inch of nominal diameter for each four feet of length for use of bituminous coal or for each five feet of length for anthracite. With forced draft and frequent cleaning smaller tubes can be used.

Testing for Engine Oil in Feed Water—What simple test can be made to determine whether boiler-feed water contains oil from the engine? W. E. D.

The presence of grease or oil in water will be shown by addition of caustic soda. Prepare about one-half pint of concentrated solution of caustic soda, and in separate clear glass vessels take the same quantities of the raw water and of the feed water supposed to contain engine oil. With a measuring beaker determine how much of the soda solution must be added to the feed water to produce a milky precipitate. Add the same quantity of the soda solution to the sample of raw feed water and then by adding engine oil drop by drop until the sample of raw water has acquired the same turbidity as the sample of feed water, it may be approximately found what equal quantity of oil has been picked up by the sample quantity of feed water.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Limitations to High Vacua*

By A. B. BAILEY†

The question of high vacuum has interested plant operators recently especially on account of the more efficient air-removal devices used. The tendency toward the use of high vacuum condensing equipment has been continually to demand higher vacuum with the idea that this means greater economy. Under ordinary conditions this is admittedly true, but the conditions under which greater vacua could be obtained introduce a number of factors that may more than offset any possible gain in economy.

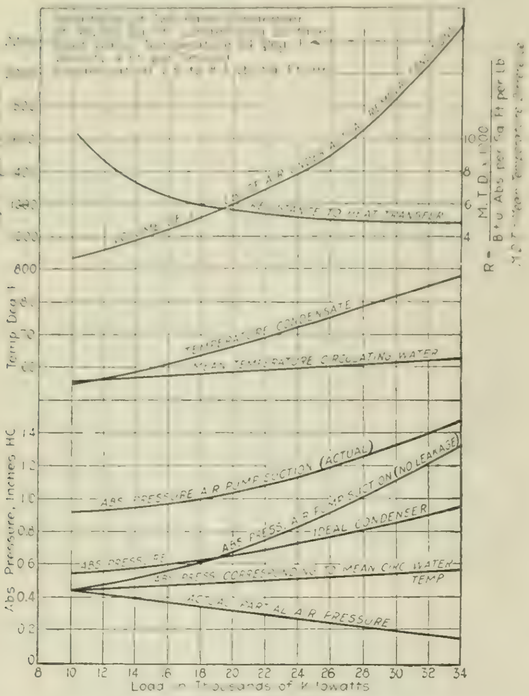


FIG. 1. THE CURVES SHOW THAT THE AMOUNT OF AIR TO BE REMOVED IS MORE AT LOW THAN AT HIGH LOADS

It appears that a large number of plant operators have gone on demanding higher vacuum under their present equipment without regard to the difficulties to be overcome. Others have maintained that there is a definite limit to the vacuum obtainable beyond which it would not pay to go. The former advanced the usual theoretical reason for higher vacuum, but produced no actual data to substantiate the claims, which for this reason are nothing more than professional opinions.

On the other hand, the claim that there is a definite limit to economical vacuum has at least partial substantiation by experiment on equipment as it is, but this does not necessarily indicate the possibilities of a turbine-condenser equipment designed originally for high vacuum. By high vacuum is meant an approach to the conditions of an ideal condenser working under average conditions as to temperature and velocity of circulating water.

As no real data are available to show just what are the limitations of maximum economical vacuum, the discussion here is confined mostly to the problems that future developments must overcome in approaching the conditions of an ideal condenser. It is ordinarily considered that higher vacuum is a function of the condenser only, but as a matter of fact it involves not only this but the design of the turbine, particularly the final expansion stages, tightness of turbine casing and condenser and the ability to remove highly rarefied air.

For the purpose of illustration in this discussion the conditions of a surface condenser operating in connection with a 30,000-kw. Curtis-Rateau turbine are used and shown in Figs. 1 and 2. These conditions can be considered as present good practice, and the opportunities for and chances of further development are as good as with other types of generating units, or possibly better.

One of the most important factors governing the maximum vacuum possible is, of course, the amount of air to be removed. So condenser manufacturers claim that the amount of air to be removed from a condenser is directly proportional to the steam condensed. This may be true of a tight condenser wherein all the air enters by entrainment with the feed water. Actual operation shows that a tight condenser and exhaust casing is a rare condition. Referring to Fig. 1, it is shown by the curves of partial air pressure and resistance to heat transfer that the amount of air to be removed was not proportional to the steam condensed, but actually more at low loads than at high loads. This fact is an indirect indication that the air in the condenser was largely a matter of leakage, instead of entrainment with the feed water. Thus it can be seen that a condenser that is tight under all loads and temperature conditions offers opportunity of increased vacuum. The vacuum conditions of no air leakage or entrainment are shown in Fig. 1 for all load conditions. This is probably impossible of attainment, but there is still a chance of improvement in this respect.

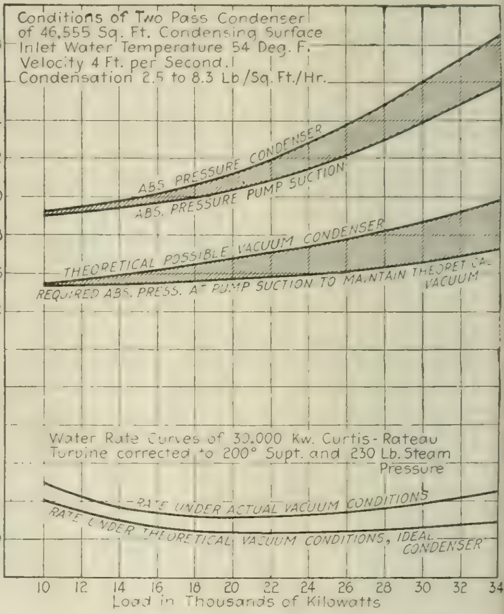


FIG. 2. SHOWING THE PUMP SUCTION AND CONDENSER PRESSURES FOR ACTUAL AND THEORETICAL CONDENSERS

A limiting factor of actual vacuum is the temperature of the condensate, inasmuch as a vacuum greater than that corresponding is impossible. It has been claimed that there were high vacuum possibilities in reducing the condensate temperature, the limiting possibilities of which would be a mean of the circulating-water temperature. Referring to Fig. 1, this hypothetical vacuum is greater than that possible with an ideal condenser operating under the conditions stated and is, therefore, impossible. Any gain in economy resulting from increasing the vacuum by reducing the condensate temperature would have to do more than balance that lost through the feed-water temperature. A heat balance shows only slight possibilities at high load.

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*Presented at the recent convention of the National Electric Light Association, Pasadena, Cal.

†Chief engineer, Fiske and Quarry Street Stations, Commonwealth Edison Co., Chicago, Ill.

The most important limitations to high vacuum have to do with the design of the turbine itself, which is designed for a definite vacuum at its most economical load. The volume of a pound of steam at 1 in. abs. is 652 cu.ft., and at 0.5 in abs. is about 1,260 cu.ft.—almost twice the volume. On the present equipment this would mean a corresponding increase in the exit velocity for the last row of buckets, which means a large increase in the lost kinetic energy, this being in proportion to the square of the velocity. Such incomplete data as are available show that at loads from 10,000 to 12,000 kw. (see Fig. 2) there is an increase in economy of about 3 to 3½ per cent, while at higher loads no increase is indicated over a range of 1 in. to 0.5 in. abs. These percentages at 0.5 in. abs. were, however, assumed, as actual conditions of 0.5 in. abs. condenser pressure could not be obtained.

Turbine-bucket design requires that the speed of the bucket bear a proper relation to the steam velocity. If this relation is to be carried out under high vacuum conditions, difficulties of design in the last stage of buckets nullify any possible gain in economy. If buckets are made too long, the velocity conditions on account of the flare would be such that steam would blow through without doing any work.

If high steam velocities are used in the last stage, it must necessarily follow that a greater proportion of the work done must be accomplished there; and this would mean less efficiency than if designed for a lesser proportion of work.

It would then appear from the foregoing that there are limitations to economical vacuum, but owing to the lack of complete data pertinent to this question, no exact limit or any set of conditions can be stated at this time. It does not appear that the conditions of an ideal condenser or vacuum of from 0.5 in. to 0.9 in. under the conditions as shown by Fig. 1 are impossible of attainment if increased economy is the governing factor.

An Experimental Investigation of Steel Belting*

Attention has been called from time to time to the successful use of thin ribbons of steel for belting, and the experiments here described were undertaken to determine the characteristics of operation of this type of power transmission.

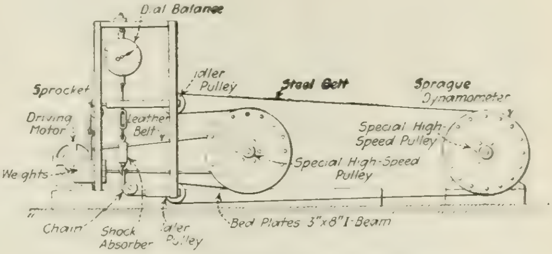
The apparatus designed for testing is shown diagrammatically. Two specially built high-speed pulleys with sheet-cork facing were arranged as shown, the driven pulley being directly connected to a Sprague dynamometer. Two idler pulleys running on ball-bearing axles were arranged to measure the tensions in the belt. The idler on the tight side was held by a yoke to which was attached a short chain passing over a sprocket and carrying a scale pan on which weights might be placed. The loose-side idler was carried by a similar yoke with a chain and sprocket, the chain passing vertically upward and being connected to a dial spring balance. Between the chain and dial balance was placed a spring balance to act as a shock absorber and a turnbuckle to adjust belt tensions.

The two pulleys being of the same size, the introduction of the idlers prevented the two sides of the belt from being parallel, and therefore the tensions were not equal to the values indicated by the weights or dial balance. This was corrected for by preliminary tests in which a spring balance was inserted in the belt and readings taken while rotating the whole apparatus slowly. From these readings plots of actual tensions against readings of the dial balance and the amount of weight on the scale pan were made.

The material tested was what is known commercially as clockspring stock. It is a very high-carbon steel, drawn and rolled, apparently ground to size, hardened and drawn to a dark blue color. A rough test showed a tensile strength of 300,000 lb. per sq.in. and an elastic limit nearly as high. Pieces 0.01 in. thick receive no permanent set when bent around a radius of ½ in., but break clean when bent around a radius of $\frac{1}{16}$ in.

The chief difficulty in using such material for belting is to get a joint having a reasonable proportion of the strength of the material. This was further complicated in the tests by the necessity for the reverse bending of the belt around the idler pulleys. A plain butted joint held with silver solder was found satisfactory, although the short time it was in use gives no indication of its durability.

Tests were run keeping the speed and tight-side tension constant and varying the load. Loads were increased until the loose-side tension became so low as to allow the belt to become unstable. After covering the possible power range, the tight-side tension was changed and another series of tests was run. Finally, speeds were changed for further runs.



EXPERIMENTAL APPARATUS FOR TESTING STEEL BELTING

In the first part of the paper, describing tests by Messrs. Hampton and Leh, it is pointed out that the slip was determined from differences of readings on revolution counters attached to the driving and driven shafts. The error introduced by this method in some cases was as much as 100 per cent of the slip, although the absolute values of revolutions per minute were determined with reasonable accuracy. In later experiments by Mr. Helmick, a differential revolution counter was connected to the two shafts by chains and sprockets and arranged so that differences of $\frac{1}{100}$ revolution would be indicated by the ring gear, with a probable error of 5 per cent.

The difficulty of measuring the velocity of slip led to considerable study to discover the laws governing the relation of slip to the various other quantities involved. It was found that at a given speed and tight-side tension the slip increased slowly, but in direct proportion to the horsepower to a certain point, beyond which it suddenly increased very rapidly. Further investigation showed that this point corresponded to that at which the tension due to centrifugal force equaled the slack-side tension, loads beyond this of course resulting in excessive slip and unstable conditions.

As a result of the entire investigation the authors suggest that the equation $Hp. = 0.17 T_1^{0.65} V_s$ (where T_1 is the tight-side tension in pounds and V_s the velocity of slip in feet per minute) may be useful in determining the tight-side tension for a given horsepower transmission with a reasonable slip (not greater than 3 ft. per min.). Knowing this tension, the belt may be cut to length by computing the total elongation due to tension and the distance the cork will be depressed.

Considerable study was made of the relations of the coefficient of friction to the various other factors and equations deduced which are mainly of technical interest. It is noted that the efficiency of transmission fell below 98 per cent only in extreme cases.

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*Abstract of a paper by F. G. Hampton, C. F. Leh and W. E. Helmick, for which the authors were awarded the Student and Junior prizes at the annual meeting of the American Society of Engineers in December, 1919. The complete paper was published in the July, 1920, issue of *Mechanical Engineering*.

Fuel Oil in Steam Plants*

By Edward H. Colegrove

In buying oil certain specifications are made. The following are fairly indicative of the demands made for a good grade of fuel oil: Specific gravity not over 0.96 nor under 0.85 at 59 deg. F.; B.t.u. not less than 18,500 per lb.; water not over ½ of one per cent; sulphur not over 2 per cent; dirt and sand, none.

The flash point of an oil is the temperature at which vapor is given off which in a closed container will ignite. The flash point of an oil should not be under 140 deg. F. Oil varies considerably in viscosity; that is, some oil flows through a pipe like cold molasses, and other oil flows like hot molasses. Very viscous oils will need to be heated to higher temperatures than thin oils for easy flow.

If oil burning is to be introduced into a plant, it is of course necessary to make provision for storing and handling it, safely and economically.

It is usually necessary to have storage space for three weeks' supply. The storage tanks are either of cement or of steel. In New York State the insurance regulations require that they be not less than 2 ft. under ground and 50 ft. from any building. Some authorities recommend that two tanks be used, so that one may be available for use while the other is being cleaned or repaired.

The highest level of oil in storage should be below the lowest point in the piping of the oil system to prevent flooding of the burners in case of accident. The tank should be vented to allow the vapor to pass off. Steam lines are often piped to the top of the tank that possible fires may be extinguished. All oil piping should be installed so as to drain back into the storage tank by gravity. Arrangements should be made to deliver oil at the burners at constant pressure. This can be effected by a standpipe. The connections for the delivering car or wagon should be at sufficient elevation to overcome the head of water to the desired height of oil in the tank.

Joints in Piping Must Be Tight

Because of the penetrative nature of fuel oil all joints in the piping must be made tight. If possible, elbows should be avoided in oil piping, as foreign matter will collect at these points and eventually clog the pipe. It is best to use bends of long radius and arrange a steam connection so the pipes when drained may have steam sent through them to blow out the asphalt or tarry matter.

As most burners atomize oil by forcing it through small orifices, an efficient strainer is needed in the feed line. The duplex thimble type is excellent, as one strainer can be removed and cleaned without affecting the pressure while the oil is passing through the other.

As hot oil flows more easily, atomizes more readily and burns better than cold oil, it will be appreciated that an oil heater is necessary to furnish the oil to the burner at a temperature of from 125 to 140 deg. F.; that is, just under the flash point. Care should be taken not to heat the oil above the flash point, as excessive heat precipitates the carbon in the pipe lines and at the burner tip, and should even small leaks develop in the oil lines, explosions would be likely.

Broken into small drops, oil presents a large surface. The smaller the drops the more perfect the spheres and the easier to burn. If oil is broken into drops 0.1 in. in diameter the ratio of the area to the volume is 60 to 1, but if broken into drops 0.01 in. in diameter the ratio of area to the volume of the original drop is 600 to 1. That is, a drop 0.01 in. in diameter exposes ten times as much surface in proportion to its volume as a drop does which is 0.1 in. in diameter. The spray entering the furnace should be almost too fine to be seen. The economy of a burner is measured by the amount of steam used to atomize a pound of oil. This will vary considerably with type of burner, kind of oil, temperature, etc. At one of the Standard Oil Co.'s plants recent tests showed a variation from 1.36 to 3.39 per cent of total steam used for atomization. It will often go higher, from 5 to 10 per cent.

Burners are often located in the front of the furnace; sometimes the burner tip is housed in a recess in the bridge wall and the oil projected forward. The first pass should be directly over the furnace, that the heating surfaces may absorb the radiant energy of the incandescent firebrick. Oil burners may be grouped into three classes: (1) Mechanical spray, in which the oil, previously heated to about 130 deg. F. is forced through nozzles in such a way as to break up the oil into a fine spray, usually by giving it a spiral motion. 2. Vapor burners or carburetors in which the oil is volatilized in a heated chamber and then admitted to the furnace. This burner is seldom used except for refined oils. 3. Spray burners are by far the most common. In these the oil is forced into the furnace by steam or compressed air. There are two types, "outside" and "inside" mixers, the name explaining where the atomization takes place. The weight of authorities seems to be in favor of the outside mixer.

Design of Furnace Depends Upon Type of Boiler

The design of the furnace must in a measure depend on the type of boiler, and in oil burning the forms of furnaces are numerous. The basic idea should be to give the oil room to thoroughly atomize and mix with the oxygen without striking the heating surfaces, and to have the oil projected into the furnace in such a manner that the air supply will be available along the path of the flame as needed. If the air can be preheated, it will, of course, aid combustion.

One consideration of the size of the combustion space is that incandescent walls of the furnace assist materially in the combustion of the oil. In burning oil furnace volume has the same relation to boiler steaming capacity as the grate area has in a coal-burning installation. The consideration should properly be of "effective furnace volume," or that part of the furnace actually occupied by burning gases.

With water-tube boilers the burners ordinarily discharge into one combustion chamber. Here eddies of gas and the interference one flame gives to another are not always indicated by the draft gage, but no doubt affect air admission and control. For example, with a furnace with four burners properly installed as to space and air control, each having a furnace volume of 60 cu.ft., operating at ½-in. draft at the damper, a certain maximum boiler capacity can be reached when all four burners are used. This capacity cannot be increased 25 per cent by placing in service a fifth burner of the same size with a like air opening. On the other hand, if only three burners are installed instead of four, size of burner and air opening for each the same per burner, the capacity will be more than 75 per cent of the capacity attained with four burners. This is because each burner now has 80 cu.ft. of furnace volume instead of 60.

The furnace volume should be sufficient to permit complete combustion and not give the gases too rapid a flow through the furnace, as this will result in the formation of CO instead of CO_2 with the resultant heat loss.

How the Amount of Air Affects Efficiency

A slight difference in the amount of air used may mean a great loss in heat units. It is comparatively easy to have a smokeless fire, but the efficiency will greatly increase if the proper amount of air is used. "In ordinary operation the complete absence of smoke is viewed with suspicion. Smoke may result from other causes than lack of air, for instance, imperfect atomization. Analysis of the escaping gases is the only sure way of obtaining information by which to adjust the furnace conditions to maximum efficiency," said E. H. Peabody at the International Engineering Congress. "Taken by itself the gas analysis indicates better than any other one thing about a boiler plant what sort of economic results are being attained."

If insufficient air is given the flame CO is formed instead of CO_2 and about two-thirds of the heat units are wasted. Some firemen attempt to fire oil and gage the air supply by the eye. Some time ago in a Texas plant in which oil had been burned for several months where the operation depending on the judgment of the firemen, a CO_2 recorder was connected to a furnace. The firemen were instructed to ontinue to fire to the best of their ability, adjusting the il feed and damper as they thought best. The recorder as covered over so the record could not be seen. After a eriod of time the recorder was uncovered and indicated per cent CO_2 for the time. Then with the recorder un-overed, by watching the record the same firemen were nmediately able to make 14 per cent CO_2. The recorder as evidently saving about 12 per cent of their oil.

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*From a paper before the Buffalo Association (N. V. No. 16) of the National Association of Stationary Engineers.

Beginners often think that a white flame indicates eco-omical combustion. It does not but indicates excess air. he color of the flame in best combustion is usually yellow-h white. The combustion of oil is accompanied by a roar-g noise. It is noticeable that an increase of cold air adds this noise, and that preheating the air renders combus-on quieter. It is therefore believed that this decreased oaring is accompanied by increased efficiency.

If wet steam is used, the moisture should be removed and. etter still, superheated before it reaches the burners. very drop of water that goes into the furnace will pass ut as superheated steam and carry with it that much heat. n some installations the steam line to the burners passes hrough the combustion chamber and superheated steam is elivered in that way. If not convenient to superheat, it ill be well to place a steam separator in the line to the urners so the steam used will be free from moisture. The lea that steam admitted to the furnace with the fuel in-eases the amount of heat generated is an error. The mount of heat resulting from the burning of the hydrogen the steam is precisely equal to the amount of heat re-uired to set the hydrogen free in decomposing the steam.

Automatic control is employed in some large plants and accomplished in a manner somewhat similar to the miliar damper regulators. The steam pressure controls e rate of oil feed as it does the damper for draft.

Damper Should Be Used To Regulate Air

It is good practice to use the damper to regulate the ipply of air. If ashpit doors are left wide open all the me a sufficient air supply is assured to take the place of e hot gases which escape up the chimney. By impeding e flow of hot gases with the damper, they are kept in ontact with the heating surfaces for a longer time and e retarded gases are given plenty of time for complete ombustion.

When shutting down the oil should be cut off first; this ops combustion. The steam should be allowed to flow after e oil is cut off, then gradually cut off. This tends toward aving a clean burner.

The work of firing oil requires no physical exertion. ommon sense, a certain knowledge and a watchful eye the instruments are all that is required. A better class men are attracted to the plant. The oil-burning more an coal-burning plant gives a fireman time to look to nprovement in himself and his plant. This attracts in-elligent firemen and no doubt accounts for a great part the efficiency in oil-burning installations.

The back damper should always be left open enough to low the gas to escape should a burner snuff out, other-ise a serious explosion might occur. Where oil is used, is well to have one coal-fired boiler in which steam can raised to at least 20 lb. to start the burners. It is well so that an auxiliary coal fired boiler be retained in case e oil supply fails for a time.

When the change is made to oil with horizontal tubular oilers, firebrick may be laid on the grates and a floor of rebrick continued to the rear of the boiler with only a ight rise at the point where the bridge wall was located. his makes the bottom part of what was formerly the com-ustion chamber combined with the space formerly the shpit, into a space through which air for combustion may drawn and preheated by the hot brick above. An open-g is then made at the rear of the setting to admit the air, hich flows through the grates to the flame.

There is but little data on the cost of changing from coal oil burning, not even on the cost of construction of the orage tanks. In nearly all cases, however, the cost has een far in excess of the estimated cost. The question of nange can only be determined in each plant by itself. The load factor evidently has a bearing on this decision. A Philadelphia engineer of prominence believes that plants that have a load factor of 60 down may change to oil advantageously, but for those with a load factor above 60 coal is more economical.

The present cost of oil in central New York State is too high to make it look attractive. To be a satisfactory fuel, oil must be available not only in large quantities but must be continually available to prevent operation ending suddenly.

Power-Station Design in Relation to Thermal Efficiency*

The paper recites a few of the lines along which modern power-plant designers have worked in an effort to increase thermal efficiencies. The manufacturers of apparatus are responsible for progress in increasing the range of temperature in saving or reclaiming low-grade heat and an increased size of units.

The upper temperature limit has been gradually raised to 650 or 700 deg. F with a comparatively wide range of pressure obtained by varying the amount of superheat. Increase of pressure with a constant maximum temperature, obtained by reducing the superheat, is advocated as giving a greater heat drop. This also results in greater steam density and therefore allows smaller piping and fittings. Pressures of 500 lb. with temperatures as high as 700 deg. F. are predicted for the near future. The lower temperature is limited by considerations of the expense of maintaining high vacuums.

Saving low-grade heat has been attempted in two ways: (1) By heating the condensate to higher temperatures, using steam tapped from the main turbine, and (2) by reheating the steam after partial expansion until the initial superheat is restored. Assuming 10 per cent of the turbine steam withdrawn at suitable points, the condensate temperature might be raised by 100 deg. F. with a saving of about 1,000 B.t.u. per pound of tapped steam. With 23 per cent of the steam tapped out, the condensate temperature rise might be as much as 225 deg. F. The effect is a slight improvement in spite of the loss of efficiency in the low-pressure blades.

The second method—reheating the steam—has been tried experimentally, but does not seem to promise much commercial success.

The size of turbine discs is limited by transportation as well as mechanical difficulties. An examination of thermal and financial considerations indicates about 30,000 kw. as the maximum desirable capacity for a single unit with plants of 180,000 kw. load and 240,000 kw. installed capacity.

As to methods of driving auxiliaries the use of an electric drive with a separate turbo-driven generator exhausting to a surface feed-water heater is thermally the most efficient, for in this case all the latent heat of the auxiliary turbine is saved. Other methods give reasonable results and are sometimes dictated by circumstances.

The material of which turbine blades are made is an item in maintaining the efficiency of the machine against loss due to erosion and corrosion. For moderate steam velocities and stresses standard 70/30 bronze is satisfactory, while 3 per cent nickel steel is successful at higher velocities and stresses.

In condenser air-pump calculations it is customary to credit steam-ejector pumps with all the heat in the discharged steam which may be returned to the boiler in the feed water. The author claims that the usual boiler losses are involved in the raising of any steam, and therefore all the heat is not reclaimed by condensing the steam from the jets.

The paper concludes with a discussion of turbine efficiencies at various loads under guarantee tests and suggests that a Willans line be drawn for the over-all fuel consumption of the plant so that steam requirements may be predicted for various conditions.

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*Abstract of a paper by I. V. Robinson, read at the Incorporated Municipal Electrical Association Convention at Bradford, England.

General Precautions in Gas-Piping Work

The National Fire Protection Association Committee on Gases has reported a gas piping code which was adopted at the recent meeting of the association and presumably will form the basis of the National Board of Fire Underwriters' requirements for gas piping of buildings hereafter Those who desire full information at an early date can best secure copies of the code from the 1919 and 1920 reports of the National Fire Protection Association, 87 Milk St., Boston.

The general precautions that should be observed in such work are well summarized in rule 3 of this code, which is as follows:

3. GENERAL PRECAUTIONS.

a. Work with Gas Off—Gas-fitting, appliance installation and repair work shall be done with the gas turned off so that the danger from leakage during the work will be a minimum, except as provided in paragraph b.

b. Working on Pipes Filled with Gas—Work which involves removal of an appliance or unscrewing of a cap, plug or pipe which will open an outlet and permit the escape of gas should never be done without shutting the gas off, except in emergency cases where interruption of the service is impracticable, and unless the work can be done without danger to life and property with the gas on.

It is suggested that when working on pipes filled with gas, outlets larger than ⅜-in. size and pressures in excess of 10 in. of water be not handled except by a specialist. In any event the following precautions shall be observed:

1. Determine the location of the meter cock or line cock by which the gas supply to the proposed opening is controlled and see that it is in working order.
2. Make sure that no fire or flame or spark-emitting device of any kind is near enough to set fire to the gas which may escape.
3. Determine that even the slight escape of gas expected will not be injurious to persons, especially invalids or small children.
4. Examine the threads to be used, to make sure the opening can be quickly and tightly closed.
5. Have at hand a plug of rubber or other suitable material to fit snugly into the opening.
6. Make sure that no lighted burners or pilot lights supplied from the line to be opened are turned so low that they may go out or flash back because of the sudden drop in pressure in the pipe when it is opened.

After the work has been completed, all appliances shall be examined and any pilot lights and burners which may have been extinguished relighted or turned off.

c. One Man Shall Not Work Alone—In any one of the following conditions there shall be more than one man present, one of whom should be in such location that he is not exposed to any possible asphyxiating influence from the escaping gas:

1. When necessary to make installations, repairs, or do other work on piping filled with live gas.
2. When work is done in a gassy atmosphere.
3. When work is done in any confined space where gas may accumulate or in any space not readily accessible; for example, where the gasfitter must lie down or assume a cramped position.

d. Use of Matches, Candles and Flames—No matches, candles or flames or other sources of ignition shall be used by a gasfitter or his helper when working on meters, piping or appliances filled with gas, except for such work as necessarily involves the use of such flames. A flame shall never be used in searching for leaks. In no case should a flame be allowed to touch a meter, meter connection or other piping. When an open-flame light, as a match or candle, is used in a basement, it should, when practicable, be carried or set not more than three feet above the floor level.

e. Smoking—A gasfitter shall not smoke while working on piping which is filled with gas or has been filled with gas, nor permit others to smoke while near such work.

f. Safety Lights to Be Provided—Every gasfitter shall be provided with an approved electric flash lamp or safety lamp which is adequately protected to prevent explosion or fire if used in a gassy atmosphere. No other type of lamp shall be used in such atmosphere when searching for a leak or when working on piping filled with live gas.

g. Handling Combustible Liquids—Alcohol, gasoline and other combustible liquids, including the liquid which is removed from meters or from drips in gas piping, shall be handled with proper precautions and shall not be left by the gasfitter on the premises of the customer. The ordinary fitter's torch or furnace shall not be left within the premises from the end of one working day to the beginning of the next unless the torch or furnace is of an approved type or is placed in a fire-resistive receptacle.

Shunt- or Compound-Wound Exciters*

By J. T. Barron and A. E. Bauhan

Wherever it is necessary that exciters be operated in parallel, it is recommended that shunt-wound exciters be used, especially if they are to be controlled by voltage regulators. The instances of compound-wound exciters causing trouble are so many that in spite of all the explanations of causes that are given, it is difficult to convince an operating man that has been through any of these experiences that compound-wound machines should ever be used where the exciters are operated in parallel.

If the saturation curves and voltage characteristics of the exciters being operated in parallel are identical and if the equalizer conditions are perfect, there is no difficulty. However, regardless of the care which may be taken in obtaining these conditions when the exciters are installed, there are disturbing influences which may occur later to interfere with the perfect conditions. For instance, equalizer switches may develop high contact resistance. Equalizer connections may be taken down and carelessly reconnected. Saturation curves of exciters may be changed by putting shims under field poles or by taking them out on account of some commutation trouble, the effect on parallel operation being forgotten. The speed of an exciter may be changed from that at which it was intended to be operated. This may be due to carelessness of attendants in not having machines operating at correct speed, or it may be due to some trouble in the turbine such as ice, or may occur from power-system troubles in the case of motor-driven or direct-connected exciters. All these conditions tend to change the shape of the saturation curves, and if operating under the influence of a voltage regulator, reversal is likely to be caused. The compound-wound exciter is also subject to reversal due to internal short-circuits. Loss of exciter shunt field may also cause reversal of compound-wound exciters. If the driving power of a compound exciter is lost, the tendency will be for the exciter to speed up and draw a heavy current, and it may even run away if not prevented from doing so by a reverse-current relay or overspeed trip.

It is therefore recommended that only shunt-wound machines be used where exciters are to be operated in parallel and that wherever compound-wound exciters are at present so used, especially in connection with voltage regulators, steps be taken to remove the series windings if the characteristics of the machines permit. The series windings should be cut out of the circuit but not short-circuited. A short-circuited series winding causes sluggish regulator action. Where exciters are to be used individually with voltage regulators, there is no objection to the series winding. It is then an advantage from the standpoint of voltage regulation.

Shunt-wound exciters also are subject to reversal from induced voltages in generator fields, regardless of whether they are operated in parallel or not. The induced voltage may be caused by a short-circuit on the generator or by sudden reduction of its field current. These two causes may work simultaneously in direct-connected exciters. Sudden reduction of field current may be caused by sudden reduction of exciter speed, by rapidly cutting in a generator field rheostat with too large steps, or by rapid reduction of exciter field current when operating on the steep part of the exciter saturation curve. If the resultant induced voltage in the generator field exceeds the exciter voltage, reversal will occur. The greater the resistance in the field circuit the less is the likelihood of reversal.

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*Abstract from a paper, "Considerations Which Determine the Selection and General Design of Excitor Systems," presented at the 36th Annual Convention of the American Institute of Electrical Engineers, held at White Sulphur Springs, W. Va., June 29-July 2, 1920

Connecting-Rod Bolts

The Diesel Engine User's Association of England has devoted much time to the discussion of connecting-rod bolts. The subject is of vital importance, since a number of engine failures have been recorded as due to the fracture of the big end bolts. The subject resolves itself into three heads—material, working stresses and design.

In regard to the material, without question a tough substance is highly desirable. Some builders have a preference for wrought iron, claiming that it has less dangerous crystalline tendencies. The majority of manufacturers and users favor some form of steel bolts, either of ordinary carbon steel or of a high-tensile alloy steel. Considerable variation in opinion as to the advisability of heat treating the bolts was expressed. Apparently, the majority felt that, if heat treatment was adopted, the steel should be treated while in the bar rather than after being machined. It was suggested at one of the meetings that bolts in service should be heat-treated at stated intervals. Several members claimed that heat treatment lowered the elastic limit of the steel and did not increase the life of the bolt. Examples were cited on bolts that had been in service for 25,000 hours without heat treatment.

It was brought out that the big end bolts are subjected to tensile stresses every second revolution, due to the inertia of the piston during the exhaust and suction stroke. These stresses are augmented if the piston is a very close fit or if piston seizure occurrs. This must be taken into account when designing the bolt.

The May meeting of the association was devoted to a further discussion of the subject. The statement was offered that the bearing clearance played an important part in the determination of the actual stresses in the bolts, since an impact occurred between the crankpin and the bearing at each reversal of the stress. Furthermore, the torsional vibration of the crankshaft when the engine passed through the critical speed point, in those cases where the critical speed was below the normal speed, had some effect on the bolt stress. One member suggested that something should be allowed in consideration of the initial stress due to tightening the nut, over and above the stresses arriving from the inertia forces. He thought it necessary to provide a comfortable margin in the design to insure safe operating condition. It was also stated that the working temperature might affect the tightness of the nut, greatly increasing the impact stress by loosening the bearing. Attention was called to some notes on "Gas and Oil Engine Accidents," issued by one of the insurance companies, from which it appeared that 25 per cent of the total engine failures resulted from fracture of the connecting-rod bolts. (*Power*, May 25, 1920.)

Mr. Charles Day, in a communication to the association, wrote that the rod bolts usually adopted are quite suitable for the normal stresses arising from the inertia of the piston, etc. In his opinion breakage was due, almost invariably, to abnormal conditions such as excessive piston friction, improper tightening of the nuts, and slack bearings. As to improper tightening, bolts were often injured by being sledged up excessively hard, thus unduly stretching the bolts and at times twisting them. Many bolts are injured by the workmen sledging the nuts in order to bring the cotter hole in the bolt in line with the castellation on the nut. To remedy this, he suggested increasing the number of castellations and placing two holes in the bolt instead of one.

Considering the effect of excessive friction, he continued, this may vary from a slight excess to a severe seizure. In the latter event the bolts will probably be badly stretched or broken. When, however, the stress has not been sufficient to show a decided stretch in the bolt, the question arises as to whether the bolts have been injured. To detect a slight elongation he recommended that a definite length be marked on the bolt when installed; the length should be measured from the bottom of the bolt head to a point on the thread. To facilitate locating the point a flattened surface could be filed on a thread and a small center punch used. A stretch of 2 per cent should be considered as justifying renewal of the bolt.

For some years, Mr. Day stated, his firm had been experimenting with various steels. It has now adopted the following specifications for the material for the rod bolts: Carbon, 0.30 to 0.40; silicon, 0.30 maximum; manganese, 0.50 to 0.80; nickel, 2.75 to 3.25; sulphur and phosphorus, as low as possible. The material to be oil hardened and tempered to give the following values: Tensile strength, not less than 100,000 lb.; field point, 56 per cent; elongation, 20 per cent; reduction of area, 45 per cent; impact value, 40 ft.-lb.

Duquesne Light Company to Install 60,000-Kw. Unit

So great has been the demand for electric energy by various industries of the Pittsburgh district that the Duquesne Light Co. has been compelled to arrange for the doubling of the proposed initial installation of 60,000 kw. at its new Colfax power plant. The second 60,000-kw. turbine-generator with 100,000 sq.ft. surface condensers divided in four shells, which has just been ordered from the Westinghouse Electric and Manufacturing Co., will be a duplicate of the first machine. It will be designed to operate at maximum efficiency when subjected to a load of 50,000 kw. and to take care of a maximum load of 70,000 kw. for short periods.

Steam will be supplied to the turbine at 275-lb. pressure, 175 deg F. superheat and 29-in. vacuum.

In addition to the equipment mentioned, a 2,000-kw. a.-c. house turbine has been ordered to furnish energy for the plant auxiliaries.

The official inquiry into the explosion of a boiler blowdown pipe at Birtley, Durham, indicates an unusual cause of failure. The blowdown pipe parted from the valve, and the resultant discharge of boiling water killed the attendant. On examination of the pipe it was found that the part screwed into the flange was eroded almost entirely away at the upper quarter of its circumference. This was evidently caused by the scouring action of the sediment from the mud drum, which had continued to erode the inside of the pipe until it reached the bottom of the threads. On the same boiler a similar pipe, which is used for blowing from the other end of the same mud drum, was found to be in an almost exactly similar condition. Both pipes had two deep scores about 90 deg. apart on the inner circumference. These scores or grooves were about ¼ in. wide, and extended about 1½ in. into the pipes, tapering away to nothing. The metal between the scores was wasted to a smaller extent. In another valve, by the same makers, it was found that in the outlet passage there were four projections at angles of 90 deg. to one another. The lower ones evidently had the effect of causing the sediment to flow in two streams in an upward direction of about 30 deg. to the horizontal, thus impinging on the edge of the pipe where screwed into the flange.—*The Engineer.*

The latest figures on the world's oil supply given out by the United States Geological Survey show that foreign countries are using only half as much petroleum as the United States, but have seven times as much oil in the ground. These foreign countries have an oil supply sufficient to last for 250 years at the present rate of consumption while in the United States at the present rate of consumption there is only an eighteen-year supply.

Hydro-electric power developments in India are advancing with great strides, according to the July 13 issue of *Commerce Reports*. Construction of power plants has centered particularly in Mysore state. The whole valley of the Cauvery has been surveyed with a view to increasing the existing power output. The gold fields in this state require much more power to carry on operations and produce a maximum amount of gold.

Notes on the Coal Situation

That New York City's yearly coal bill is running at least $10,000,000 in excess of what it ought to be was one of the facts brought out at the hearing of the Senate Committee on Reconstruction and Production, at its offices, 29 West 39th St., New York City. The witnesses were representatives of the public utilities and the Public Service Commission of New York City, and a representative of the public utilities and coal consumers of northern New York State.

The figures relating to the city's coal bill were brought out in the testimony given by John W. Lieb, vice-president of the New York Edison Co. The public utilities of New York, Mr. Lieb said, consume roughly 5,000,000 tons of coal annually. This includes both bituminous and anthracite, but the latter is only an insignificant portion of the total. At a conservative estimate, owing to the necessity of purchasing spot coal where and how it can be obtained, the coal bill of the public utilities is running at a rate of from seven to eight million dollars in excess of its normal amount. Adding two to three million dollars increase in the price of coal to citizens for heating purposes makes the total of more than $10,000,000 increase.

Answering a question by Senator William M. Calder, chairman of the committee, Mr. Lieb said that normally the Edison company had in storage between 150,000 and 200,000 tons of coal. At the beginning of last winter the quantity was less, 120,000 to 125,000 tons, and that reserve was finally exhausted a month or two ago.

Senator Calder was interested particularly in the question of spot coal. Mr. Lieb testified that under contracts already made his company was receiving only 52 per cent of the coal contracted for. For any additional supply it was dependent on spot coal. The ordinary contract price for coal at the mine, Mr. Lieb said, was $4.25 to $4.75, whereas for spot coal his company had been paying up to June 26 from $7.50 to $10.25. Since that date, he said, some coal had been bought as high as $12 at the mine.

Questioned as to the effect of the recent Order No. 10, of the Interstate Commerce Commission, giving preferential assignment of cars to the Northwest, on the situation of public utilities, Mr. Lieb said that he viewed the new order with a good deal of concern. "If this order," he said, "gives priority over the public-utilities order, we shall soon be in difficulties again, and the public utilities of New York City will have to shut down."

Commissioner Alfred M. Barrett, Deputy and Acting Public Service Commissioner for the First District, declared that if an improvement did not soon take place in the situation "something will happen, and New York City will close down. We are not getting coal in summer," he said, "and winter will come and the householders will demand coal. If the railroads cannot carry enough soft coal now, what will they do when part of their cars are carrying hard coal?" Twenty-five thousand tons of coal a day he estimated to be the requirement of New York City for its public utilities, and in the first week of July, he said, these utilities had on hand a total supply of not more than 137,000 tons, or enough to last one week. The situation has improved slightly since then, he said, and last Thursday there was a ten-day supply on hand.

Robert W. Bush, of the Brooklyn Union Gas Co., gave evidence revealing a similar critical situation in his company as that revealed for the Edison company.

Order No. 10 of the Interstate Commerce Commission, granting prior rights in the use of coal cars to the Northwest, was bitterly assailed by John M. Carlisle, of Watertown, N. Y., representing the paper mills, public utilities and coal consumers of northern New York State. Mr. Carlisle's evidence revealed an exceedingly critical situation up state. "If 4,000 carloads a day are to be shipped to the Northwest territories," he said, "it means that a practical embargo is declared against other sections of the country. Twenty-five thousand to thirty thousand tons of bituminous coal must be stored up at Watertown during the summer months for winter use. Climatic conditions in the winter make the shipment of coal impossible. For that reason we have got special tariff provisions permitting the bringing and storage of coal during the summer. To-day there is not a ton of coal in storage in Watertown whereas last year at this time we had 30,000 tons."

THE COAL TRANSPORTATION PROBLEM

That the Interstate Commerce Commission was not impressed by the arguments advanced by those asking the modification of its order giving coal mines prior use of open-top cars was proved conclusively when the commission extended its order for an additional thirty days and issued Service Order No. 10, which will force coal from Pennsylvania, Ohio, West Virginia and Kentucky up the Lakes. The main effort on the part of those opposing the order was intended to impress the commission with the importance of their respective activities. In this they failed in large measure because the commission took the stand that an adequate supply of fuel took precedence over any such activity as building or road construction.

The really telling point made by the opposition was that thousands of open-top cars are in the service of nonessential industries in the transportation of their coal. The contention is that cars should be available to prevent millions of dollars' worth of highways from being destroyed when the cars needed for this purpose are busy carrying coal reserves to the candy factories. Another example is the plea of the constructional industries, who point to the unrest being engendered by inadequate housing. It looks unfair to them to see trainload after trainload of cars engaged in coal transport to automobile factories while they are able to secure only 2 per cent of the cars needed in connection with the building of homes.

It is believed that the coal operators and the railroads will be able to work out plans which will insure New England, the Northwest and Canada an adequate coal supply for the winter. The award by the Railroad Labor Board is having the effect of facilitating greatly the movement of cars, and it is believed that the worst of the situation is past. Owing to the prospects of improvement it is believed that the immediate appointment of a fuel administrator has been averted.

A second effort has been made to relieve the coal shortage in New England. Service order No. 11, issued July 27, repeals service order No. 6, issued June 19. The order was drafted by the operators and the representatives of the carriers. It is entirely satisfactory to representatives of New England, and the operators believe that it will relieve the situation entirely. Those most likely to be hurt by the order are consumers other than New England who depend upon the smokeless field for their fuel supply. These consumers, however, have been assured by the railroads that there will be no curtailment of their coal supply as arrangements have been made to give mines shipping to New England all the cars that they can load. This will mean that there will be enough to meet the New England allotment and allow a remainder sufficient to supply other consumers.

One of the important features of the order is the placing of the three tidewater agencies at Hampton Roads under the direction of a single agent of the Interstate Commerce Commission. Under order No. 6, there were separate agents at Newport News, Lambert's Point and Sewell's Point.

To meet the requirements of the New England States 1,250,000 tons of bituminous coal must be transported by rail and water each month. At the present rate of transportation New England is short about 350,000 a month.

It was ordered that bituminous coal in carloads consigned under this order should not be subject to reconsignment except upon a permit issued by the agents of the commission. A permit will be issued only on a showing that the coal to be reconsigned will go to a pool or pools at one of the ports for New England.

Shippers having credit at any of the tidewater ports that have been obtained by the shipment of coal into the pool of coal consigned under this order, will not be permitted to draw against this credit and ship from the pool to any destination excepting those in New England.

COMMITTEE TO FIX PROFIT

A committee to fix a fair margin of profit on coal has been appointed by Attorney General A. Mitchell Palmer. The committee is composed of Vance McCormick and William Potter, representing the public; J. W. Lieb, vice president of the New York Edison Co., representing the utility companies; G. N. Snyder, of the New York Central, representing the railroads, and Willis G. Townes, Charles A. Owen, Harlow Voorhees and Charles L. Couch, representing the wholesale coal dealers.

The New York *World* in an editorial says:

"When, as alleged, concerns that had contracted ahead for coal at normal prices of $4 to $4.50 can get no coal, while offered plenty at $11, and coal for export sells up to $23, consumers have the best reason in the world to call on the Government for protection. This is brigandage plain and simple, and the quickest way to suppress it is to restict exports until the home market is restored to a stable basis. If some of the worthy persons engaged in rigging prices should find their way to jail, it would cause no mourning."

COAL PRICES OF THE COUNTRY

Embargoes in New England have resulted in a mild recession in prices. For two or three days sales were made at $10.50 per net ton f.o.b. mines on mediocre grades, but on July 24 sales were again made on the basis of $13.75 at mines. On cars at Boston quotations of $17.50 to $20 are made on low volatiles.

Philadelphia—A moderate volume of soft coal was begining to enter Philadelphia when the Pennsylvania R.R. declared an embargo. Public utilities are unaffected by the embargo. The price for stock remains high with $15 as the top. The bulk of sales are made nearer $13.50 for the better Pennsylvania coal. The utility plants are working under the new plan of filling out forms by which they obtain assignment of a certain number of empty cars to the mines of the companies with whom they have contracts.

Baltimore—The price situation is out of control with sales made right along at from $11 to $13 per net ton f.o.b. mines, almost irrespective of grade. Prices at piers have been as high as $17 and $18 per gross ton. The extraordinary demand, both export and domestic, continues unabated. Of the 70 ships in the harbor for coal a week ago and for several weeks past, 30 of them have already been to other ports.

BITUMINOUS

Buffalo—The price of $10.50 at the mine is considered rather low, but is accepted for the Buffalo bituminous trade. It seems to be the general belief that a decline is due before very long because of the fact that production is now a little in excess of consumption and cars are more plentiful.

Detroit—With the summer more than half gone practically no reserves have been created for industrial plants, public utilities, or retail yards; in fact, consumers in all lines are becoming apprehensive of a bituminous coal shortage in Michigan next winter. Under the direction of the Michigan Public Utilities Commission a conference was held in Lansing on July 21 to discuss the situation and plan relief. It was decided that a state coal commission of five or more members to be named by the governor should be appointed. The miners' strike in Illinois threatens to diminish still further the meager supply of coal.

Cincinnati—There is no shortage of soft coal in Cincinnati, but there is a distinct scarcity of smokeless and anthracite. The scarcity of coal cars does not affect this city because of river transportation. It is possible to obtain coal at $8.50 per ton as against $4 for the same coal in Toledo.

Chicago—The coal strike in southern Illinois has, of course, occasioned considerable worry in Chicago. Manufacturers who thought they were covered now find themselves face to face with shut-down conditions. Mines in Indiana have not been affected as yet and are, of course, swamped with inquiries. Naturally the market is advancing.

Louisville—Production in Kentucky has increased as a result of a better car supply. However, demand is keeping pace with production and prices remain about the same as during the last few weeks as follows: Eastern Kentucky gas mine run $9 to $9.50, non-gas $8.50 to $9, western Kentucky lump $5 to $5.50 average, mine run $4.50 to $4.75, screening $4.50 to $4.75. Some west Kentucky lump is selling as high as $6.75.

New Construction

PROPOSED WORK

Conn., New Haven—Yale University will soon award the contract for a 4 story dormitory including a hot water heating system on the campus. About $400,000. W. A. Delano, 126 East 38th St., New York City, Archt.

Conn., Norwalk—The city plans to construct a 2 story electrical plant. Two 300 kw. rotary convertors with transformers, etc., will be installed in same. About $50,000. Westcott & Mapes, Inc., 207 Orange St., New Haven, Engrs.

Conn., West Hartford — The Bd. Educ. will receive bids until September 1 for a 2 story, 200 x 204 ft. high school including a steam heating system on South Main St. About $500,000. W. T. Marchant, 36 Pearl St., Hartford, Archt.

N. J., Secaucus—The Blvd. Comrs of Hudson Co. will soon receive bids for the installation of a motor power electric plant in their power house here. About $30,000.

Pa., Bethlehem—The Chamber of Commerce is having plans prepared for a 10 story, 116 x 120 ft. hotel including a steam heating system. About $500,000. Verus T. Ritter, North Amer. Bldg., Archt.

Pa., Derry—The Pittsburgh High Voltage Insulator Co. has purchased a site adjoining its present property and plans to construct a power house, machine shop, etc., on same.

Pa., Elmhurst—The Greek Catholic Society of America is having plans prepared for a 3 story, 110 x 200 ft. orphanage including a vapor heating system. About $350,000. Morris & MacHale, Burr Bldg., Scranton, Archts.

Pa., McKeesport—The Bd. Educ. will receive bids until August 9 for the installation of a 2 story school. Separate bids for installing a heating system will be received. About $325,000.

Pa., Port Blanchard (Pittston P. O.)—The Pennsylvania Coal Co., River Rd., is having plans prepared for a 100 x 400 ft. coal breaker including a steam heating system and electric power on the Main Rd. About $1,000,000.

Pa., Scranton—Fred Nelson, Archt., Cornell Bldg., is preparing plans for a 3 story, 50 x 100 ft. factory including a steam heating system, electric motors, etc. About $100,000. Owner's name withheld.

Pa., Sunbury—The Sunbury Trust & Safe Deposit, c/o Verus T. Ritter, Archt., Amer. Bldg., Philadelphia, is having plans prepared for a 6 story, 60 x 120 ft. bank and office building including a steam heating system. About $500,000.

Pa., Wilkes-Barre—The School Bd. is in the market for two steam boilers about 20 hp. each.

Ky., Blackey — The Kentucky & West Virginia Power Co. of Whitesburg plans to extend its transmission lines from here into the Elkhorn coal fields to Pikeville, where a large substation will be built.

O., Cleveland—Jacob Babin, 827 Superior Ave., has purchased a site at 3602 Euclid Ave. and plans to build a 4 story, 50 x 200 ft. mercantile building including a steam heating system. About $250,000.

O., Cleveland—The Water Ice Co., c/o A. C. Bishop & Co., Archts. and Engrs., 427 Guardian Bldg., will soon award the contract for a 1 story, 45 x 142 ft. ice plant on West 25th St. About $100,000. Noted July 27.

O., Eaton—The city plans to build a new filtration plant for the local waterworks including pumps, sand filters, etc., at $27,500.

O., Lakewood (Cleveland P. O.)—The city has retained E. A. Fischer, Engr., City Hall, to make a survey and submit estimates for the construction of a pumping station and water system.

O., Warren—The Warren Hotel Co., c/o F. E. Robbinson, Guardian Bldg., Cleveland, is having plans prepared for the construction of an 8 story, 80 x 180 ft. hotel including a steam heating system. About $1,000,000. Moulthrop & Nichols, 5716 Euclid Ave., Cleveland, Archts.

Ind., Crown Point—The Bd. of County Comrs. had plans prepared for a 2 story, 100 x 200 ft. hospital including two boilers, etc., here. About $400,000. J. N. Coleman, 6257 St. Lawrence St., Chicago, Archt.

Ind., Indianapolis—The Indianapolis Athletic Club plans to build an 11 story club building including a steam heating system on Meridian and St. Clair Sts. About $2,000,000. Henry F. Campbell, Pres.

Ind., Richmond—The Bd. of Pub. Wks. will receive bids for a 500 kw. turbine and other equipment for the lighting plant here.

Mich., Detroit—The Bd. of Fire Comrs., West Larned St., will soon award the contract for a 2 story, 50 x 80 ft. fire engine house including a seam heating boiler, etc., on Davison Ave. and Goddard St. About $100,000. Charles Knotting, 2306 Dime Bank Bldg., Archt.

Mich., Detroit—The Bd. Educ., 50 B'way, will receive bids until August 11 for a 2 story, 46 x 117 ft. school on Coplin Ave., $200,000; 2 story, 164 x 206 ft. addition to the Lew Cooper School on the South Side of Grotain Ave. between Heron and Concord Aves., $[illegible]; 2 story, 40 x 1[illegible] ft addition to the Nellie Leland School on the corner of Russell and [illegible] Sts., $[illegible]; 2 story, 88 x 11[illegible] ft addition to the Cooper School Building on Lynwood Blvd. and Midland Ave., $[illegible], and a 2 story, [illegible] x 1[illegible] ft addition to the Crossman School on Hamilton Blvd. and Taylor Ave., $[illegible]. A plenum steam heating system will be installed in each.

Mich., Detroit—The Bd. Educ. received bids for the installation of a heating, ventilating and plumbing system in the proposed 2 story, 1[illegible] x 2[illegible] ft. Pattengill School on Northfield and Smeaton Aves., from Irvine & Meier, 589 Woodward Ave., $91,[illegible]; in the proposed 2 story, [illegible] x 1[illegible] ft. George School on Russell and Superior Sts., the proposed 2 story Webb School on Charles Ave., and the proposed 2 story Davison School on Roman and Joseph Campau Aves., from James W. Partlan, 51 Park Pl., $76,99[illegible]; $97,8[illegible]; O'Conor Bros., Vinton Bldg., $60,416; $99,998; $85,741. Noted July 2[illegible].

Mich., Detroit—The Michigan Creamery Co., c/o Samuel Rabonwitch, Ford Bldg., is having preliminary plans prepared for a 7 story creamery plant along the Grand River here. Plans include a steam power plant, refrigeration system and power operated equipment. T. A. Hyland, 307 Moffat Bldg., Archt.

Mich., Kalamazoo—The Bd. Educ. is having plans prepared for a 2 story, 159 x 362 ft. school including a steam heating system on North Burdick St. R. A. LeRoy, 122 Pratt Block, Archt.

Mich., Traverse City—The City Lighting Dept. plans to build a steam electric power plant. About $75,000.

Ill., Chicago—The Rogers Park Hotel & Bldg. Corp., c/o B. Leo Steif & Co., Archt., 19 North La Salle St., is having plans prepared for a 9 story, 140 x 150 ft. apartment hotel on Sheridan Rd. and Pratt Blvd. Plans include a refrigeration plant, steam heating system, etc. About $1,300,000.

Ill., Chicago—The Standard Electric Mfg. Co., 216 North Clinton St., has purchased a site on Wrightwood Ave. and plans to build a 2 story, 125 x 150 ft. factory including a steam heating system on same. About $250,000.

Ill., Monticello—J. C. Llewellyn, Archt., 38 South Dearborn St., will soon award the contract for a 2 story, 112 x 172 ft. school including a steam heating system and ventilation plant for the city. About $225,000.

Wis., Milwaukee—The Park Bd., City Hall, will soon award the contract for furnishing new boilers in the Mitchell Park Conservatory. About $4,500.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, received bids for installing a heating system in the proposed 3 story addition to the Chemistry Building on the State University campus here from the Hamline Plumbing & Heating Co., 683 Snelling Ave., North, St. Paul, $87,849; Archambo Heating & Plumbing Co., 315 5th Ave., South, $88,919; Belden Porter Gray & Co., 914 Mary Place, $88,996.

Minn., Red Wing—The Lutheran Ladies' Seminary plans to build a 3 story, 120 x 250 ft. seminary including a steam heating system. About $400,000. A. C. Gauger, 302 Central Bank Bldg., St. Paul, Minn., Archt.

N. D., Grand Forks—The Industrial Comn. of North Dakota will soon award the contract for the installation of 17 motors of varius sizes in the new terminal mill and elevator here. C. L. Pillsbury Co., 805 Metropolitan Life Bldg., Minneapolis, Minn., Engr.

Okla., Erick—The city plans to build a sewer system and enlarge the light and power plant. About $120,000. J. A. Richardson, Mgr.

N. M., Fort Stanton—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until August 16 for remodeling boiler here.

Idaho, Worley—The Bd. of Trustees of the village will receive bids until August 7 for an electric power line from here to Plummer, a distance of 7 miles. J. P. Mathews, Village Clk.

Wash., Prosser—The Nyberg & Gellwin Fruit Co. will soon award the contract for a cold storage plant. About $75,000.

Ore., Portland—Joseph R. Keep, 1[illegible] Couch Bldg., has filed an application with Percy A. Cupper, State Engr., for permission to divert 1000 second feet of water from the Sandy River and its tributaries. The project will probably include a power plant in Clackamas County.

Que., Montreal—The United Hotel Co. had preliminary plans prepared for a 10 story hotel including heating, power, ventilating and refrigeration systems. About $8,000,000. Ross & Macdonald, Belmont St., Archts.

Ont., Kingston—Queens University plans to construct a 3 story students' union building including a steam heating system on the university grounds here. About $150,000.

Ont., Kitchener—The Hospital Bd. will receive bids until August 7 for a new power house and steam heating plant for the General Hospital. About $15,000. A. R. Kaufman, Chn.

Ont., London—The city plans to construct a city hall including a steam heating system, etc. About $1,250,000.

Ont., London—W. G. Murray, Dominion Savings Bldg., is in the market for an electric motor and waterworks pumping equipment to supply new school.

CONTRACTS AWARDED

Mass., Boston—The Commonwealth of Massachusetts has awarded the contract for the installation of a ventilating system in various rooms at the State House Building here to the Cleghorn Co., 54 Batterymarch St., at $55,310.

Mass., Boston—The Schoolhouse Comn. has awarded contract for the installation of a steam heating system in the Louisa M. Alcott School to J. J. Hurley, 104 B'way, at $13,394. Noted July 13.

Mass., Boston—The Washington Essex Bldg. Trustees, c/o 723 Scollar Bldg., has awarded the contract for a 4 story theatre, etc., including a steam heating system on Washington and Essex Sts., to the George B. H. Macomber Co., 44 Bromfield St., at $1,500,000. Noted July 30.

Mass., Framingham—The Record Realty Co. has awarded the contract for a 1 story, 50 x 50 ft. power house to the E. A. Abbott Co., 3 Park St., Boston, at $35,000.

N. Y., Wards Island—L. F. Pilcher, State Archt., Albany, has awarded the contract for the installation of electric generators at the Manhattan State Hospital here to T. Frederick Jackson, Inc., 99 John St., New York City, at $14,350.

N. J., Butler—The town has awarded the contract for the construction of a power house addition to Harold Bang, 188 19th Ave., Paterson, at $15,675; for the installation of a steam heating system to John R. Proctor, 19 West 19th St., Bayonne, and for power equipment to John R. Hooly, 95 Liberty St., New York City, at $40,457.

N. J., Newark—The Osborn Branch of the Amer. Color Type, 759 Summer Ave., has awarded the contract for a 1 story, 43 x 75 ft. power house to Samuel Marshall, Arlington, at $50,000.

Pa., Erie—The Second Natl. Bank, 8th and State Sts., has awarded the contract for a 1 story, 60 x 130 ft. bank building including a steam heating system on 9th St. to Henry Shenk, Erie, at $400,000. Noted July 7.

Pa., Philadelphia—The Academy of the Sacred Heart, Convent Lane and Bristol Pike, has awarded the contract for a 1 story boiler house addition to Thomas Reilly, 1616 Thompson St., at $15,000.

Md., Baltimore—The Bd. of Awards, City Hall, has awarded the contract for installing heating furnaces in Schools 23, 34, 42, 68 and 80 to Charles Schulz, 1435 Central Ave.; steam heating plant in School 12 to James McCrea & Son, 19 North Carrollton Ave., and in Schools 3, 20, 54 and 99 to Riggs, Distler & Stringer, 216 North Calvert St.

Va., Petersburg—The Ambursen Constr. Co., 186 5th Ave., New York City, will build a dam on Swift Creek. Plans include a power house. Work will be done by day labor.

O., Cleveland—The Bd. Educ. has awarded the contract for a 1 story, 30 x 60 ft. heating plant at East 92nd St. and Parkgate Ave. to the Drummond Miller Co., 1900 Euclid Ave., at $100,000.

O., Cleveland—The city has awarded the contract for furnishing and installing two 8,000,000 gal. and one 4,000,000 gal. motor driven vertical centrifugal pumps with motors, electrical equipment, etc., to the Dravo Doyle Co., Diamond Bank Bldg., Pittsburgh, Pa., at $20,736. Noted March 16.

Mich., Detroit—The Chinese Merchants' Association, 187 3rd St., has awarded the contract for a 5 story, 78 x 185 ft. hotel including a steam heating system on Woodward Ave. to Shank & Co., 38 South Dearborn St., Chicago. About $800,000.

Mich., Ironwood—Alvord & Burdick, 1417-18 Hartford Bldg., Chicago, has awarded the contract for a pumping station, substations and engineer's residences to W. S. Peters, Wakefield, at $62,613, and for centrifugal pump equipment to the Lee Courtenay Co., at $27,600.

Ill., Chicago—The Canton Bldg. Corp., c/o Fugard, Knapp & Walter E. Perry, Archts., 64 East Van Buren St., has awarded the general contract for a 3 story, 80 x 111 ft. restaurant including a steam heating system and refrigeration plant on Wabash and Van Buren Sts. to Henry Ericson Co., 139 North Clark St. About $200,000.

Ia., Cushing—A. H. Bullock, Secy. of the Bd. Educ., has awarded the contract for the installation of a heating and plumbing system in the proposed 3 story, 59 x 111 ft. school to O. J. Saquety, Holstein, at $19,100. Noted Dec. 23.

Ia., Larabee—H. Montgomery, Secy. of the Bd. Educ., has awarded the contract for the installation of a heating and plumbing system in the proposed 3 story, 82 x 139 ft. school to the Mathew Plumbing Co., LeMars, at $23,000.

Ia., Morning Sun—O. F. Boller, Secy. of the Bd. Educ., has awarded the contract for the installation of a heating and plumbing system in the proposed 2 story, 56 x 120 ft. school to Carstens Bros., Ackley, at $27,174. Noted March 23.

Ia., Packwood—N. E. Olliver, Secy of the Bd. Educ., has awarded the contract for the installation of a plumbing and heating system in the proposed 2 story, 58 x 99 ft. school to the W. D. Reed Plumbing and Heating Co., 3405 Independent Ave., Kansas City, Mo., at $18,675. Noted March 23.

Ia., Pocahontas—W. J. Gilchrist, Pres. of the School Bd., has awarded the contract for the installation of a heating and plumbing system in the proposed 2 story, 56 x 110 ft. school, to Thomas Reinhart, LeMars, at $25,000.

Minn., Deer River—The Bd. Educ. has awarded the contract for the installation of a heating and ventilating system in the proposed 2 story school here to D. R. Black & Co., 314 West 1st St., Duluth, at $26,186. Noted March 30.

Kan., Bushong—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Mo., St. Louis—The city has awarded contract for one 220 brake hp. horizontal, single, direct-connected side crank engine for the sanitarium pumping station to the Chuse Engine & Mfg. Co., 721 Olive St., at $8,917.

Mo., St. Louis—The General Natl. Bank, B'way and Olive St., has awarded the contract for altering building on 7th and Olive Sts., to R. S. Price, Arcade Bldg., at $100,000. A 15-ton refrigerating plant will be installed in same.

Ont., Hamilton—The Firestone Tire & Rubber Co., Sherman Ave., has awarded the general contract for a 4 story tire and rubber factory on Sherman Ave. to the Piggott Healey Constr. Co., 36 James St., South, at $500,000. Contract for installing heating, etc., in same will be sublet.

SEE SEARCHLIGHT SECTION
Pages 116-128

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire		50-Ft. Lengths
Underwriters' 2½-in		85c per ft.
Common, 2½-in		30%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft	$0.60	$0.40	$0.30

Steam—Discounts from List

First grade 20% . Second grade......30% Third grade 45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	30-10%		

LEATHER BELTING—Present discounts from list in fair quantities (½ doz rolls):

Light Grade	Medium Grade	Heavy Grade
30%	25%	20%

RAWHIDE LACING
For cut, best grade, 25%, 2nd grade, 30%
For laces in sides, best, 79c per sq. ft.; 2nd, 75c
Semi-tanned: cut, 20%; sides, 83c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	1.70
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1.70
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1.50
Rubber sheet	.50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		List
For low-pressure heating and return lines	4-ply	50% off
	3-ply	52% off
	2-ply	54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	8½	6.6	8¼@9½	8½	13¼
Fiber or sponge	8½	8.6	8¾@9½	8½	20
Transmission	10	8.1	12@14	8½	20
Axle	...	4.8	5¾@6½	5¼	7¼
Gear	6½	6.1	6¼@6¾	5¾	8½
Car journal	12(gal.)	4.7	8¾@9½	8½	8½

COTTON WASTE—The following prices are in cents per pound:

	New York Current	New York One Year Ago	Cleveland	Chicago
White	15.00@17.00	13.00	16.00	11.00 to 14.00
Colored mixed	9.00@14.00	9.00 to 12.00	12.00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$55.00	$65.00
Chicago	41.00	43.50

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Chicago Current	Chicago One Year Ago
Raw in barrels (5 bbl. lots)	$1.53	$1.90	$2.02	$2.10
5-gal. cans	1.56	2.03	2.27	2.30

*To this *oil* price must be added the cost of the cans (returnable), which is $2.25 for a case of six.

WHITE AND RED LEAD—Base price per pound:

	Red Current Dry	Red Current In Oil	Red 1 Year Ago Dry	Red 1 Year Ago In Oil	White Current Dry and In Oil	White 1 Yr. Ago Dry and In Oil
100-lb. keg	15.50	17.00	13.00	14.50	15.50	13.00
25- and 50-lb. kegs	15.75	17.25	13.25	14.75	15.75	13.25
12½-lb. keg	16.00	17.50	13.50	15.00	16.00	13.50
1-lb. cans	18.50	20.00	15.00	16.50	15.00	15.00
5-lb. cans	20.50	22.00	16.00	17.50	16.00	16.00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel $\frac{7}{16}$ and smaller	List net	30%	30%
Tinned	List net	30%	30%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb

New York $6.00 Chicago...... $5.62 Pittsburgh $4.50

Structural rivets, same sizes:

New York $7.10 Chicago....... $5.72 Pittsburgh $4.60

REFRACTORIES—Following prices are f. o. b. works,

Bauxite brick, 56% alumina, f.o.b. Pittsburgh	M.	$145
Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90- 100
Chrome brick, 9 in. strs. and sizes, f.o.b. Baltimore	net ton	90- 95
Fire clay brick, 1st quality, 9 in. shapes. f.o.b. Pennsylvania, Ohio and Kentucky works	M.	45- 53
Fire clay brick, 1st quality, f.o.b. St. Louis	M.	45-
Fire clay brick, 1st quality, f.o.b. New Jersey	M.	75-
Fire clay brick, 2d quality, 9 in. shapes. f.o.b. Pennsylvania, Ohio and Kentucky works	M.	40-
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	100
Magnesite brick, 9 in. sizes and shapes larger than 9 in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90 100
Silica brick, 9 in. and 9 in. sizes, f.o.b. works, Chicago district	M.	55-
Silica brick, f.o.b. Birmingham	M.	51- 55
Silica brick, f.o.b. Mt. Union, Pa	M.	50- 55

BABBITT METAL—Warehouse prices in cents per pound:

	New York Current	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Best grade	90.00	87.00	74.50	79.00	60.00	75.00
Commercial	50.00	42.00	21.50	17.50	15.00	15.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$20.00	25.50-30.00
Cleveland	20.00	20.00
Chicago	21.00	16.50

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 12c. per lb.

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

	Large Mill Lots Pittsburgh	New York Current	New York One Year Ago	Cleveland	Chicago
Blue Annealed					
No. 10	3.55-7.00	7.12@8.00	4.57	8.10	7.02
No. 12	3.60-7.05	7.17@8.05	4.57	8.15	7.07
No. 14	3.65-7.10	7.22@8.10	4.67	8.20	7.12
No. 16	3.75-6.20	7.32@8.20	4.77	8.30	7.22
Black					
Nos. 18 and 20	4.20-6.20	7.80@9.50	5.30	8.70	7.80
Nos. 22 and 24	4.25-6.25	7.85@9.55	5.35	8.75	7.85
No. 26	4.30-6.30	7.90@9.60	5.40	8.80	7.90
No. 28	4.35-6.35	8.00@9.70	5.50	8.90	8.00
Galvanized					
No. 10	4.70-8.00	8.55@11.00	6.20	9.00	8.15
No. 12	4.80-8.10	8.65@11.00	6.25	9.10	8.20
No. 14	4.80-8.10	8.65@11.10	6.30	9.10	8.35
Nos. 18 and 20	5.10-8.40	8.90@11.40	6.60	9.40	8.65
Nos. 22 and 24	5.25-8.55	9.05@11.55	6.75	9.55	9.05
No. 26	5.40-8.70	9.20@11.70	6.90	9.70	9.20
No. 28	5.70-9.00	9.50@12.00	7.20	10.00	9.50

STEEL AND IRON—The following discounts are to jobbers for carload lots on the Pittsburgh basing card, discounts on steel pipe, applying as from January 14, 1920, and on iron pipe from January 7, 1920:

BUTT WELD

Inches	Black	Galv.	Inches	Black	Galv.
¾ to 3	57@54	44@41½	¾ to 1½	34½@24½	18½@8
			2 and 2½	33½	17½

LAP WELD

Inches	Black	Galv.	Inches	Black	Galv.
2	50½@47	38@34½	2	28½@20½	14½@6½
2½ to 6	53½@50	41@37½	2½ to 6	30½@22½	17½@9½
7 to 12	50½@47	37@33½	7 to 12	27½@19½	14½@6½
13 and 14	41@37½	......			
15	38@35	......			

BUTT-WELD, EXTRA STRONG, PLAIN ENDS

Inches	Black	Galv.	Inches	Black	Galv.
¾ to 1½	55½@52	39½	¾ to 1½	34½@24½	19½@9½
2 to 3	56½@53	44@40½	2 and 2½	34½@24½	19½@9½

LAP WELD, EXTRA STRONG, PLAIN ENDS

Inches	Black	Galv.	Inches	Black	Galv.
2	48½@45	37@33½	2	29½@21½	16½@8½
2½ to 4	51½@48	40@36½	2½ to 4	31½@23½	19½@11
4½ to 6	50½@47	39@35½	4½ to 6	30½@22½	18½@10½
7 to 8	46½@43	33@29½	7 to 8	22½@14½	10½@2½
9 to 12	41½@38	28@24½	9 to 12	17½@9½	5½@5

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	40½	3½ to 4½ in.	15½
2½ to 3¼ in.	30½	3 to 3¼ in.	1
2¼ in.	24	2½ to 2¾ in.	+1
1¾ to 2 in.	19	2 to 2¼ in.	+16
		1½ to 1¾ in.	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in.	$327	1½ in.	$207
1¼ in.	267	2 to 2¼ in.	177
1½ in.	257	2½ to 3¼ in.	167
1¾ in.	207	4 in.	187
		4½ to 5 in.	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department which will be subject to special negotiations.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond M Ft	Three Cond M Ft.	Two Cond Lead M Ft	Three Cond Lead M Ft
No. 14 solid	$104 00 (net)	$138 00	$164 00	$210 00
No. 12 solid	135 00	170 00	225 00	265 00
No. 10 solid	185 00	235 00	275 00	325 00
No. 8 stranded	285 00	375 00	520 00	500 00
No. 6 stranded	400 00	500 00	560 00	

From the above lists discounts are:

Less than coil lots	+5%	+15%
Coils to 1,000 ft	5%	List Net
1,000 ft and over	10%	7%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever-Ready

	Each, Net
Less than 12	$0 45
12 to 50	38
50 to 125 (bbl.)	35
125 (bbl.) or over	32

CONDUIT, ELBOWS AND COUPLINGS—These prices are in 100-lb. lots, f. o. b. New York, with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
Size, In.	Black 2,500 to 5,000 Lbs	Galvanized 2,500 to 5,000 Lbs	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs
	85 00	93 50	22 00	524 60	6 65	7 30
¾	11 50	126 50	29 00	32 00	11 25	12 37
1	170 00	187 00	41 00	45 00	15 50	17 00
1¼	230 00	253 00	52 00	57 00	20 70	23 60
1½	275 00	302 50	70 05	78 00	25 00	27 50
2	375 00	403 00	130 00	145 09	33 70	37 00
2½	585 00	613 80	210 00	235 00	47 50	53 00
3	765 00	841 50	560 00	620 00	70 00	78 00
3½	920 00	1,012 00	1,350 00	1,485 00	92 00	114 00
4	1,170 00	1,287 00	1,469 00	1,617 00	115 00	140 00

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
7/32	250	$0.05½	
¼	250	.06	
⅜	250	.09	
½	200	.12	
⅝	200	.15	Coils.....40% off
¾	150	.18	Less coils, 25% off
1	100	.25	
1¼	100	33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0 12	D. P. D. B.	$0 43
D. P. M. L.	21	T. P. to D. P. S. B.	26
T. P. M. L.	.33	T. P. S. B.	38
D. P. S. B.	.23	T. P. D. B.	.64

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0 50	$1 30	$1.68
T. P. M. L.	70	1 70	2.40
D. P. S. B.	63	1 60	...
T. P. S. B.	1 15	2 40	
D. P. D. B.	1.10	3.00	
T. P. D. B.	1 90	5 40	
T. P. to D. P. D. B.	1.30	3.80	

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.

No. 18 cotton twisted	$23 00
No. 16 cotton twisted	27 50
No. 18 cotton parallel	26 50
No. 16 cotton parallel	34 50
No. 18 cotton reinforced heavy	38 00
No. 16 cotton reinforced heavy	45 00
No. 18 cotton reinforced light	33 50
No. 16 cotton reinforced light	39 50
No. 18 cotton Canvasite cord	30.00
No. 16 cotton Canvasite cord	33 50

FUSES, ENCLOSED—

250 Volt	Std. Pkg	List
3-amp to 30-amp	100	$0 25
35-amp to 60-amp	100	35
65-amp to 100-amp	50	.90
110-amp to 200-amp	25	2 00
225-amp. to 400-amp	25	3 60
425-amp to 600-amp	10	5 50

600 Volt	Std. Pkg	List
3-amp to 30-amp	100	$0 40
35-amp to 60-amp	100	60
65-amp to 100-amp	50	1 50
110-amp to 200-amp	25	2 50
225-amp to 400-amp	25	5 50
450-amp to 600-amp	10	8 00

Discount: Less 1-5th standard package	15%
1-5th to standard package	28%
Standard package	45%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$5 25C
0-30 ampere, less than standard package	6 00C

LAMPS—Below are present quotations on less than standard package quantities

Straight Side Bulbs Mazda B				Pear Shaped Bulbs Mazda C			
Watts	Plain	Frosted	No. in Package	Watts	Clear	Frosted	No. in Package
10	$0 40	$0 45	100	75	$0 75	$0 80	50
15	40	45	100	100	1 10	1 25	24
25	40	45	100	150	1 55	1 70	24
40	40	45	100	200	2 10	2 30	24
50	40	45	100	300	3 15	3 40	24
60	45	50	100				12
				500	4 60	4 90	12
				750	6 50	6 90	8
				1,000	7 50	7 95	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0 24
Composition 2-piece attachment plug	.32
Swivel attachment plug	20
Current taps	40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12 50	$15 50	$17 00	$28 50
12	14 96	18 50	21 45	35 00
10	20 62	24 75	28 05	46 00
8	28 90	33 30	38 50	66 00
6			58 75	...
4			80 75	..
2		....	111 00	...
1		....	154 00	....
0		....	181 50	..
00		....	220 00	.
000	......	......	265 00	.....
0000		.....	330.00	......

Prices per 1000 ft. for Rubber-Covered Wire in Following Cities:

	Denver			Birmingham			St. Louis		
	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$15 64	......	$38.45	$12 23	....	$38 64	$14 00	$19.75	$38 00
10	24 50			27 60		65 57	23 25	26 25	59 50
8	33 48	$56 81		38 64		87 33	32 60	36 00	80 20
6		77 17		69 12			55 85	57.75	
4	......	108 10	......	......	$107 42		80 45	82 75	
2		142 00			138 46		120 90	123 65	
1	......	167 70			178 52	......	156 95	160 45	
0		198 20			217 09		195.50	195 50	
00	......	234 60	......	......	263 57	....			
000	......	279.60	......	......	320 44				
0000	......	......	......	......	389 17				

Pittsburg—23c base; discount 50% St Louis—30c base

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap			In. Cap		
Key Each	Keyless Each	Pull Each	Key Each	Keyless Each	Pull Each
$0.33	$0 30	$0 60	$0 39	$0 36	$0 66

Less 1-5th standard package	+50%
1-5th to standard package	+20%
Standard package	—10%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	55c. lb
No. 18 B. & S. regular 1-lb. coils	56c. lb

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 60c. lb., 100 lb. lots	55c. lb
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c. lb
Wire solder, less 100 lb. 47c. lb., 100 lb. lots	42c. lb
Soldering paste, 2 oz. cans	$1.20 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	74	1 22	1 84	2 44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	.70	1.06	1 60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10 00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+5%
$50 to $200 list value	—10%
$200 list value or over	—15%

POWER

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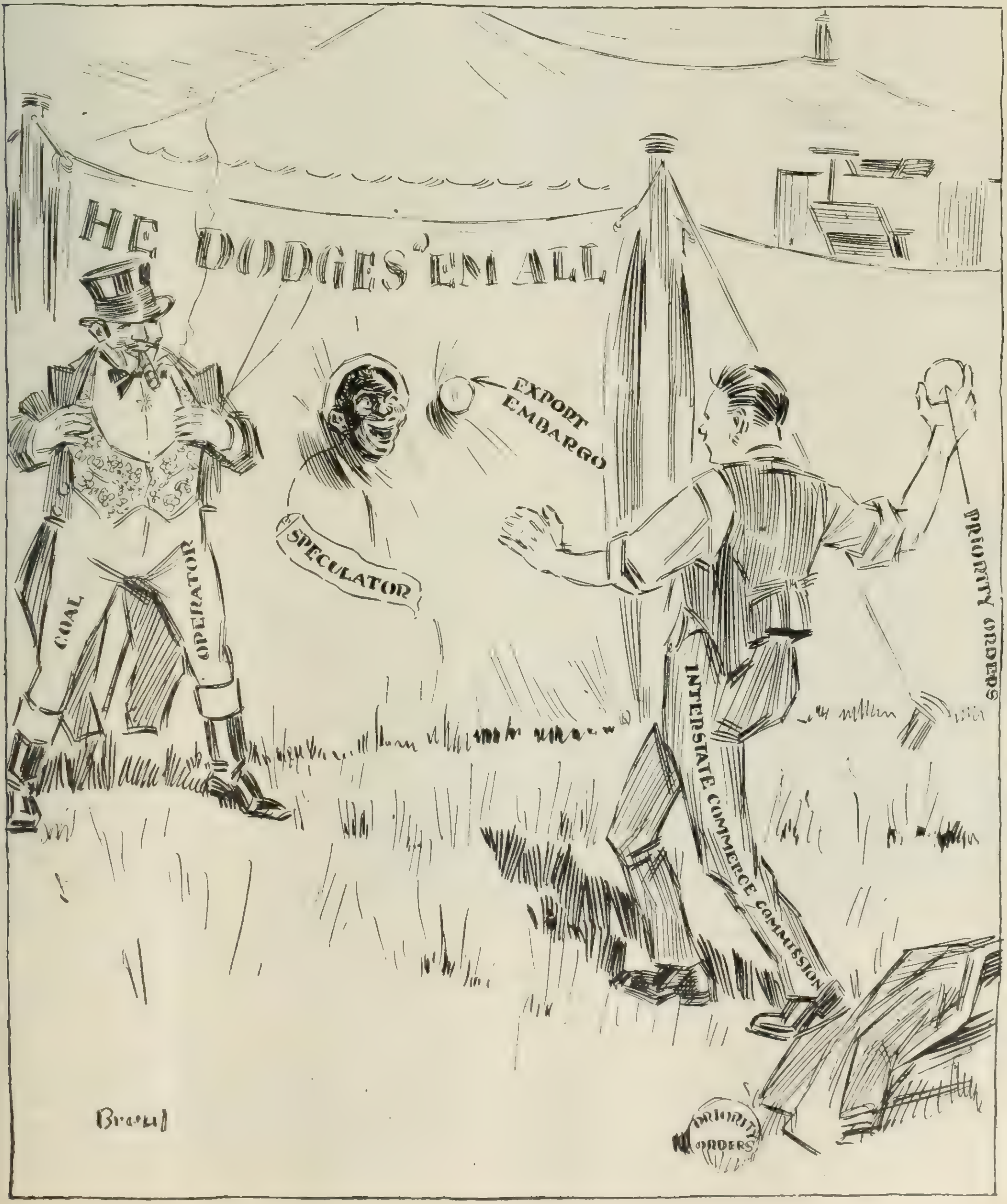


Fuel Utilization and Smoke Abatement in Salt Lake City

By OSBORN MONNETT

In the smoke-abatement work done in Salt Lake City a careful analysis of fuel-utilization equipment and methods was made. This article gives this portion of the Bureau of Mines report, done in co-operation with the City of Salt Lake and the University of Utah. Some of the power- and heating-plant conditions found in this investigation are described. Subsequent articles will take up fuels available to Salt Lake City, and the formation of a smoke cloud. Published with permission of the Director, Bureau of Mines.

IN CONNECTION with a smoke-abatement investigation a fuel survey of Salt Lake City was made to determine the amount of coal burned in the city, the amount burned by different classes of fuel users, the source of the coal and its characteristics. The amount of coal used by the different classes of fuel consumers except for residence and domestic use was obtained by means of questionnaires sent to all coal consumers. The information obtained was tabulated under the following heads: Apartment houses, business houses, churches, cleaning and dyeing establishments, dairies, creameries, hotels, hospitals, industrial boiler plants, laundries, office buildings, central heating plants, public buildings, schools, residences and locomotives. The coal consumed by residences was determined by a house-to-house canvass made by the Boy Scouts. This canvass also included a tabulation of domestic heating and cooking equipment. The quantities used are shown in Table I.

TABLE I. DISTRIBUTION OF COAL AND MEAN SMOKE DENSITY FOR VARIOUS CLASSES OF PLANTS

Name	Total for Summer and Winter	Tons Coal Winter 1918-19	Tons Coal Summer 1918-19	Mean Density
Apartment houses	14,470 25	10,988.4	3,481.9	15.71
Business houses	8,183 10	6,760.0	1,423.1	16.55
Churches	1,089 95	958.6	131.4	22.02
Cleaning and dyeing establishments	830 70	427.9	402 8	18.51
Dairies and creameries	849 00	454.8	394.2	23.17
Hotels	7,790 20	7,790.2	1,655.5	14.51
Hospitals	6,176 90	3,550.6	2,626.3	22.02
Industrial furnaces	45,514 40	18,042.3	27,472.1	13.65
Industrial boiler plants	78,040.60	40,621.8	37,418.8	19.16
Laundries	12,413.70	5,787.8	6,625.9	15.52
Office buildings and central heating plants	32,666.70	26,034.8	6,631.9	28.36
Public buildings, clubs, etc.	3,660.50	3,029 2	631.3	16.90
Schools	6,786 90	5,973 2	813.7	20 38
Railroad locomotives	53,140 00	24,517.0	28,623.0	26 36
Residences	210,000 00	168,105 0	41,895.0	7 98
Miscellaneous	31,589 10	25,287.1	6,302.0	15 00
Total	513,202 00			

The Ringlemann chart method of observation, as used throughout the survey, consisted of making readings of the density of smoke issuing from the stack under observation every fifteen seconds, the results being set down on the form as shown in Fig. 3. The readings, which were taken over one-hour periods, were all calculated to a standard based on No. 1 smoke performance of one plant with another. These readings were taken for the different classes of smoke producers over all hours of the day, the result being that a mathematical record was made available regarding the performance of the various plants from a smoke standpoint. This, when taken with the coal consumed by the different classes of smokers, makes it possible to figure the percentage of the city smoke made by each class for the year or for any period of the year over which it is desired to have this information. Industrial and large heating plants in the average city constitute the heaviest smokers, making a total of 39 per cent of the smoke in the heating season. A survey of the equipment in these plants was made in order to develop the type of plant which was making the smoke and methods of reconstruction necessary to reduce it. While it was not primarily the object of the investigation to do any considerable amount of actual smoke-abatement work, it was thought advisable to do enough engineering work in a list of typical plants to indicate the line along which the problem must be attacked in the future. A list of twenty-five of the worst smokers was selected, and engineers were sent to make surveys and recommendations in these plants. As an indication of the conditions found, a list of the plants with their equipments is presented herewith, with the percentage of the smoke density found during the investigation.

TABLE II. EQUIPMENT AND SMOKE DENSITY OF TWENTY-FIVE OF THE WORST SMOKERS

		Per Cent Smoke Density
1.	One ideal sectional No. S-28-7	66.8
2.	4—375 Gary boilers	....
	4—Westinghouse underfeed	48.6
3.	1—H. R. T. boiler, hand-fired	45.3
4.	1—No. S-25-7 Ideal steam heater	42.5
5.	1—80 hp. Erie tubular boiler	42.3
6.	1—Economic H. R. T. boiler, hand fired	39.6
7.	2—40 hp. H. R. T. boilers	....
	1—60 hp. H. R. T. boiler	38.7
8.	3—100 hp. B. & W. boilers	....
	2—American stokers	34 5
9.	2—Kewanee H. R. T. boilers, 100 hp	....
	2—Hawley downdraft, 100 hp	....
	1—Kewanee, 50 hp	....
	1—American stoker	31 0
10	1—150 hp marine boiler, brick furnace	.
	1—40 hp. locomotive type boiler	30.6
11.	6 ft. 6 in., x 16 ft. H. R. T	....
	D-12 Herbert downdraft	30.1
12	4—100 hp. B. & W. boilers	....
	4—American stokers	29.0
13.	3—200 hp. boilers	....
	3—American stokers	27.7
14.	1—No. 29 Cornell sectional	26.7
15	2—80 hp. Kewanee boilers, hand fired	25.9
16	2—60 hp. H. R. T. boilers	25.5
17.	1—50 hp. H. R. T. boiler	25.0
18	Kewanee boiler, hand fired	24.8
19.	2—80 hp. H. R. T. boilers	23.9
20.	1—U. S. radiator sectional, hand fired	22 7
21.	2—45 hp. Kewanee boilers, hand fired	22.0
22.	4—150 hp. Kewanee boilers	..
	4—American stokers	21 8
23.	1—150 hp H. R. T. boiler	..
	Hawley down-draft furnace	21 3
24.		21 2
25.	2—125 hp. Kewanee boilers	...
	2 2—American stokers	20 9

In going over this list, it will be noticed that a considerable proportion of these plants are already equipped for smokeless operation. At the same time some of those so equipped are making the highest smoke densities. This indicates that one of the important factors in future smokelessness is that of supervision.

This is also shown clearly in Table III in which smoke densities of many installations properly equipped are higher, through careless handling, than in other plants not supplied with proper equipment.

As the work progressed, many more plants were visited, conditions found and recommendations made being listed in detail herewith. From the information given one cannot but be impressed with the necessity for closer supervision of boiler installations not only from the standpoint of smoke abatement, but also of safety. Most states have stringent regulations regarding the use of second-hand boilers, designed to prevent boiler explosion. The unusually large number of boilers that have been installed second-hand in Salt Lake City indicates that this territory has been a market for boilers that would have been difficult to dispose of in other places. A partial list of plants visited as given herewith, together with the conditions found, will be valuable in pointing the way to methods of procedure for those in charge of the work in the future. Among the plants visited was one consisting of six 150-hp. horizontal return tubular boilers fired with six Molock stokers. It was found there was no need of any smoke from this plant if operated properly. Stokers were feeding too fast, which caused steam to rise and the fan to slow down, thus reducing the air blast and giving insufficient air to completely burn the fuel. Stokers should be set at a slower speed with respect to the blower.

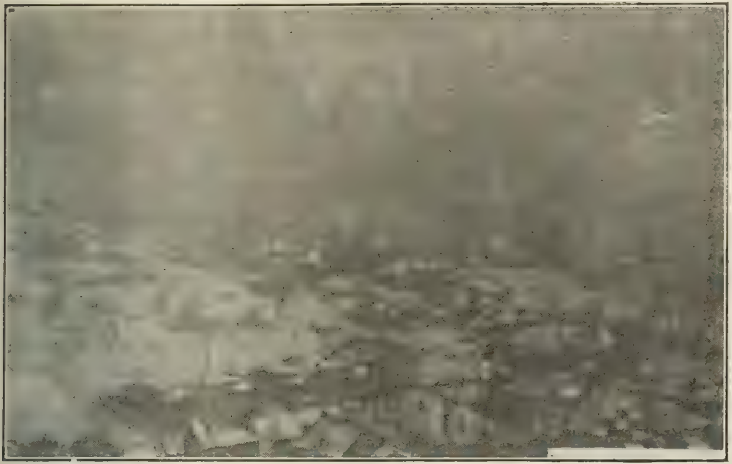


FIG. 1. SALT LAKE CITY COVERED BY SMOKE CLOUD

Another plant consisting of one 80- and one 75-hp. horizontal return-tubular boiler was visited. One boiler here was found to have insufficient combustion space and emitted very much smoke. The other one in the brick setting was full of air leaks, causing insufficient operation. This boiler is also set far too low and should be raised to the required height for a boiler of this type and equipped with a reverse No. 8 furnace. At present only one boiler is in use at a time. If the contemplated future load is sufficient for the two boilers, probably the best way out of the difficulty would be to cover the brick setting with a good grade of boiler covering to stop air leaks and then install the underfeed stoker under both boilers. If only one boiler is needed, it would probably be cheaper and more satisfactory to raise the boiler, which is now set in brick, to the required height and install a wing-wall furnace. A plant consisting of three 110-hp. B. & W. boilers, set with front header six feet from the floor was visited and it was found that boilers are fired with three American stokers. The plant smoked only at periods when fires were being cleaned. The boilers are set too low for really proper smokeless operation, but with the usual load they can operate without objectionable smoke. Another plant consisting of one 80-hp. horizontal return-tubular boiler in regular use and one 50 hp. boiler which is used when the other one is being cleaned or overhauled, was found to be one of the simplest to clean up. Smoke can be prevented by the cracking of the doors for a few minutes after each firing. An automatic air-admission device on the firedoor would assist the fireman in abating smoke, as it would be easier to admit sufficient oxygen over the fire with this device than by cracking of the doors. The damper in the stack is warped so badly that it cannot be closed; this should be remedied. There is no need for this plant to make any objectionable smoke.

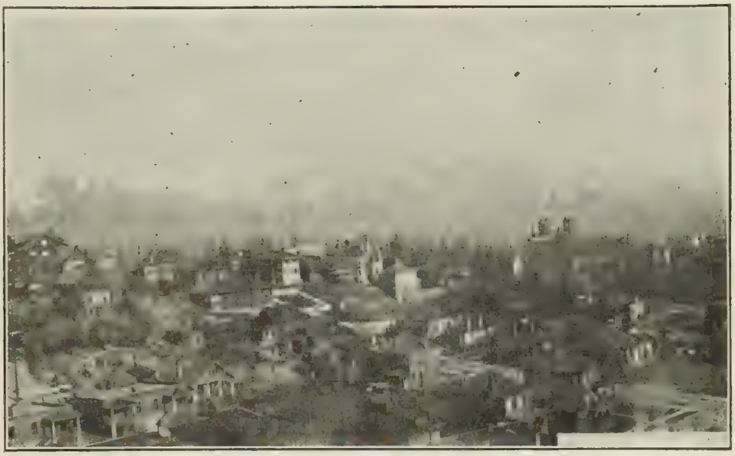


FIG. 2. SALT LAKE CITY WITH SMOKE CLOUD REMOVED

A plant consisting of three 100-hp. B. & W. boilers, fired with three American stokers was investigated and it was found that the boilers are set five feet under the front leader, which is far too low for smokeless operation with Utah coals. The combustion chamber is also too narrow, giving in all a very unsatisfactory condition for smoke abatement. Practically all methods of operation were tried from a thin fuel bed to the very thickest that could be carried and from a very light pressure in the retorts to a very heavy blast. If the fire is not disturbed, not much smoke is produced, but stokers throw the fuel to one side of the combustion chamber and soon it is impossible to burn the fuel sufficiently even to hold steam unless fires are spread evenly over the grate surface. The disturbing of the fire produces volumes of dense black smoke. With the present setting it is impossible to operate the plant in any way with satisfactory results as to smoke density. A Dutch-oven setting was worked out with the resetting of these stokers, dropping the stokers one foot to move them out in front 3½ feet. The management is going to equip one boiler with a setting and see what results are obtained. If the results are satisfactory, the remaining two boilers will be so equipped. If this is not satisfactor, some other method will be devised to overcome the difficulty.

TABLE III. RELATIVE SMOKE DENSITIES OF VARIOUS BOILER AND FURNACE EQUIPMENT

This is the way in which they were operated in Salt Lake City during the winter of 1919-20.

	H. R. T. Boilers Per Cent Smoke Density	Stokers Per Cent Smoke Density	Down Draft Per Cent Smoke Density	Up Draft Per Cent Smoke Density
Apartment houses			15.42	16.33
Business houses			12.95	15.36
Heating plants...	20.70	19.93	7.64	19.93
Hospitals	30.6	29.0	.	.
Hotels	15.75	.	7.53	13.30
Power plants	27.74	17.6	15.20	. .

A modern plant, having been built only a few years, was found to be one of the city's most offensive smokers. It consists of two 260-hp. B. & W. boilers and one 130-hp. B. & W. boiler. The boilers are fired with five Jones stokers. The boiler settings are very badly cracked and are full of air leaks, also one 4-in. pipe in which combustion chamber is letting in cold air. The pipes were put in to drain the water out when washing the boilers and were not plugged up during the operation of the plant, and hence they admit large volumes of cold air at a point where it should not assist in the combustion but only help to cool the boiler down. There are also bad leaks around back buckstays on the two big boilers. The front doors on the big boilers do not shut tight. This condition should be remedied at once. Asbestos is out between the headers and should be replaced. While the boilers are set too low to carry more than their rated load with Utah fuels, if these air leaks are remedied and stokers are operated carefully, this plant should give no objectionable smoke up to the rating of the boilers.

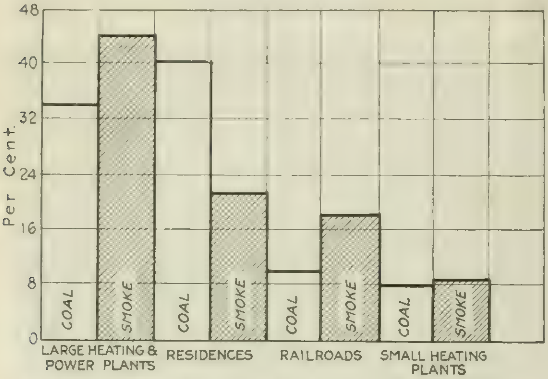


FIG. 3. SHOWING PERCENTAGE OF COAL AND SMOKE PRODUCED

In a boiler plant consisting of two 100-hp. locomotive-type boilers, fired with Type E American stokers, which came under the notice of the investigators, it was found that the fireman does not keep enough fuel in his furnace so that when the load comes upon him he has something to fall back upon. This necessitates the crowding of a lot of fresh fuel into the furnace whenever a heavy load comes upon the plant. The fireman has also made a practice of assisting the stoker at this point by throwing a lot of coal into the furnace directly; this results in enormous clouds of black smoke being emitted from the stack.

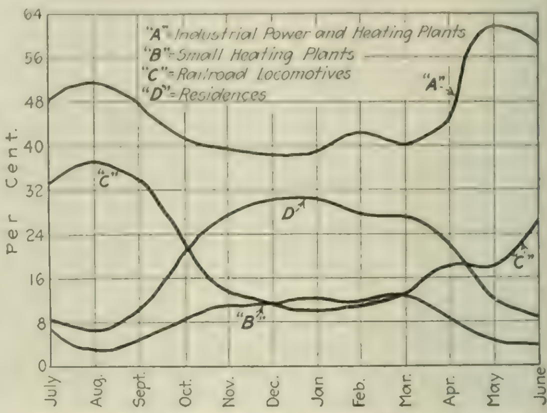


FIG. 1. CURVES SHOWING PERCENTAGE OF SMOKE DURING YEAR, FOR VARIOUS PLANTS

The feed water is fed into the boiler at city-water temperature, while the feed-water heaters stand idle outside and the water from the heating coils runs out on the ground or into the sewer. The flues are blown only once in two weeks, leaving an average of from one to twelve tubes entirely blocked with soot.

There seems to be no one willing to assume the responsibility of putting things into shape. It is likely that the only way that this plant can be reached is through the higher officials of this division of the railroad. Nothing can be done with the men in immediate charge.

Large power and heating plants have in the past been installed in Salt Lake City without necessary supervision on the part of the city. Some of these plants are in a rundown, not to say dangerous, condition and should be rebuilt or abandoned.

Standard methods of boiler and furnace setting will result in the smokeless performance of boiler plants using Utah coals.

Supervision of operation on the part of the city is imperative, as many plants which could operate without dense smoke are bad smokers through lack in this regard.

LOCOMOTIVES

Locomotive smoke to some has seemed the most difficult of control, but many cities in the Middle West have wrestled with this phase of the subject and the results have been more encouraging than was at first supposed to be possible.

In the last ten years standardized equipment has been developed as an aid to smoke abatement on locomotives. This equipment consists, briefly, of multiple-tip blowers, quick-opening blower valves and induction tubes located in the sides of the firebox, calculated to supply the necessary air for complete combustion. This equipment is simple, readily applied by ordinary boilermakers and has been discussed in detail in the proceedings of the Master Car Builders Association and in the annual conventions of the Traveling Engineers Association.

The railroad yards in Salt Lake City, however, serve to show that there are no physical difficulties in railroad operation in Salt Lake City comparable with the difficulties encountered in some other cities. The average smoke density of locomotives in cities without supervision of smoke performance is 49 per cent. The average smoke density of locomotives in Salt Lake City is 26 per cent. Locomotives can be and are operated in all classes of service with smoke densities below 7½ per cent, which generally brings this class of smoke down to a negligible quantity.

The railroad situation in Salt Lake City, when compared to the problem met with elsewhere, is an easy one and should be capable of vast improvement over present conditions.

RESIDENCES

While the residences burn nearly one-half the total coal consumed in the city, the fact that it is distributed so widely results in dissipating the smoke formed to a large extent so that the main effect of the residence smoke is the produtcion of a haze which hangs over the city in the winter and which is more noticeable on Sundays when the industrial smoke is at a minimum.

A house-to-house canvass indicates that there are 2,413 round sectional cast-iron hot-water and steam boilers; 707 square sectional cast-iron steam and hot water boilers; 4,600 hot-air furnaces; 15,150 heating stoves; 18,120 coal ranges; 8,000 gas ranges and 1,500 electric ranges in use in the city. This serves to indicate the relative importance of the different classes of smoke producers used in the residences. In attacking this part of the problem a series of experiments were conducted at the laboratory of the University of Utah with different domestic equipment, the results later being substantiated by tests run on equipment actually installed in residences.

With a reasonable amount of care and attention Utah bituminous coal can be burned in domestic equipment in nearly a smokeless manner. In starting a fire the smokeless method is much the best to use and in adding fresh coal to the fire the alternate method of firing is the most desirable.

CONCLUSIONS

Residence smoke can be greatly reduced by the education of householders in proper methods of firing, using the equipment already installed.

Smokeless apparatus is available for residences purposes in the case of new buildings or the replacement of old equipment.

From all available information it appears that the possibility of depending on anthracite as a source of smokeless fuel for Salt Lake City is very remote.

The use of coke for domestic fuel offers a solution of the residence problem. Utah has at least two coals suitable for the production of coke for domestic purposes. High-temperature processes produce a coke difficult to ignite and bring up a difficult problem in the disposal of gas. Low-temperature coke is a more suitable domestic fuel and the byproducts produced are easier of disposal.

Low-temperature coking is not yet on an established commercial basis in the United States, but gives every promise of being on such a basis in the course of the next few years. In view of the limited gas market in Salt Lake City and of the superiority of low-temperature coke as a domestic fuel, the low-temperature process seems well worth careful consideration as a future solution of the domestic smoke problem.

Natural-Gas Production Figures

The United States Geological Survey has just reported the 1918 production and consumption figures for natural gas. These figures show that a little over 720 billion cubic feet was produced and marketed that year. The value of this production at 21¼c. per thousand feet is a little over $153,000,000. As usual, West Virginia, Oklahoma, Pennslyvania and Ohio led in the production, ranking in the order named. Pennsylvania, Ohio, West Virginia and Oklahoma is the order of consumption, showing, as usual, the large export of gas from West Virginia to Pennsylvania and Ohio and the considerable export from Oklahoma to Kansas and adjacent territory.

There is a very wide range in the average price at which natural gas is sold by the producer in various parts of the country. The figure for Wyoming is 3.59c. per thousand feet; in New York 67.05c., and in Michigan 89.08c. per thousand feet.

There is a decided tendency toward an increase in the percentage of gas sold for domestic use and a corresponding decrease in the percentage used industrially. This is in line with the recommendations of the Conservation Commission, which has recently been studying the subject, and the natural result of the gradual increase in the price at which gas is sold tending to make its use industrially less advantageous than formerly. This report shows that the 7,100 producers supplied 2,500,000 domestic consumers and 16,500 industrial consumers. The average price paid by the former group is 31.35c. and by the latter 15.23c. per thousand feet. The total volume of gas used industrially is, however, still considerably greater than that used in domestic equipment, amounting to about 60 per cent of the total. Of this, manufacturing takes slightly more than the production of industrial power.

Although about 30 per cent of the wells drilled in 1918 were dry, the total number of wells productive at the end of the year had increased by about 1,000 over the number productive at the beginning of the year. The total productive Dec. 31, 1918 was 40,369. The land controlled by natural-gas producers at the end of the year was nearly one million acres less than at the beginning of the year, indicating a strong tendency toward a smaller acreage of wells. This in itself is a decided indication of the decadence of natural-gas production. The area controlled at the end of the year per productive well was 360 acres.

In blowing engines the pressures and temperatures are low and the lubrication of the cylinders may not require a special type of oil, but it is the best policy to use an oil suitable for the high-pressure type of piston compressor.

Steam-Engine Operation and Maintenance— Why Valve Gears Get Out of Order

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

A POUND in an engine may be caused by faulty or deranged valve setting. Fig. 1 shows an indicator diagram in which the admission line rises above the steam line, forming a loop at the end. This indicates that the compression rises to a higher pressure than the initial steam pressure. On a Corliss engine the higher compression will make the valve lift off its seat and drop back as soon as steam is admitted to the cylinder. The cause of it may be too much exhaust lap, or the eccentric may be set wrong. The latter is likely to be the case if the engine has a separate eccentric for the exhaust, which permits the regulation of the compression independently of the action of the steam valves. Another pound may be caused by too much steam load. This will be indicated on a diagram by the admission line having a very decided outward curve or slant, shown in Fig. 1. If there is play in the boxes, they will be forced against the pins with a violent blow instead of a gradual and easy motion due to compression alone.

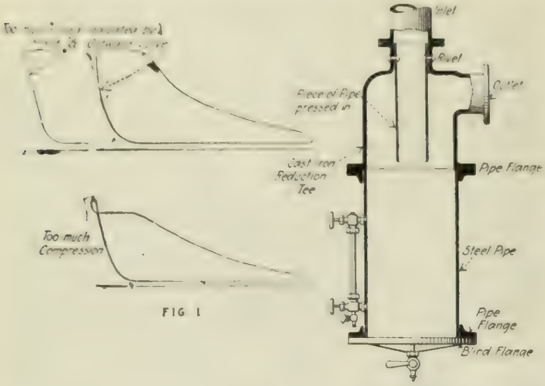


FIG 2

FIG. 1. TYPICAL INDICATOR DIAGRAMS SHOWING FAULTY VALVE GEAR. FIG. 2. STEAM SEPARATOR AN ENGINEER MAY MAKE ON THE JOB

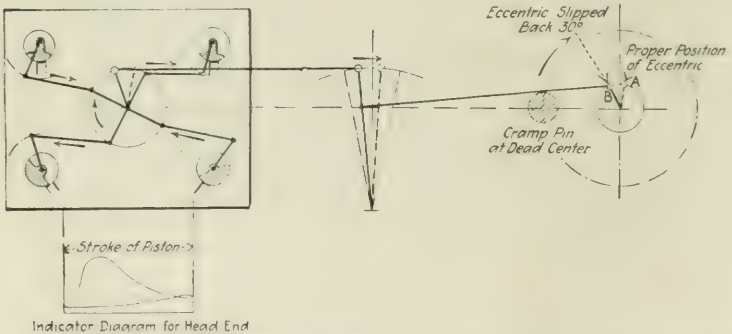

Eccentric Slipped Back 30°
Proper Position of Eccentric
A
B
Cramp Pin at Dead Center
Stroke of Piston
Indicator Diagram for Head End

FIG. 3. DERANGED CORLISS VALVE GEAR DUE TO SLIPPING ECCENTRIC

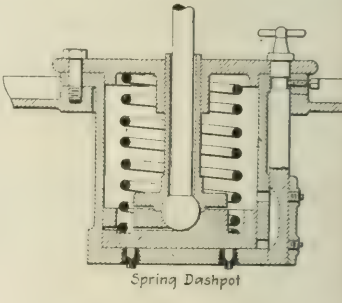


FIG. 4. SECTION OF SPRING-TYPE DASHPOT, NOTED FOR ITS RELIABILITY

Since on a number of engines the eccentric is held on the shaft by setscrews, it is no uncommon occurrence to have one slip, which causes a derangement of the valve motion, sometimes to such an extent that the engine will stop. The diagrammatic view of a single-eccentric Corliss valve gear in Fig. 3 shows what the effect will be if the eccentric slips back 30 deg. The crank is shown on the dead center at the beginning of the forward stroke, engine running over. For this position the correct place of the eccentric would be at *A*, but it has slipped back to *B*. The result of this is that the head-end steam valve, which should be in the lead position, is closed and the head-end exhaust valve is open. As the crank advances, the steam valve will open as soon as the eccentric is in the vertical position, and the exhaust valve will be on the lap. This is the mid-position for the whole valve motion. Continuing the motion of the crank for one revolution will result in a diagram something like the one shown in the detail.

Engines with releasing valve gears may become noisy under greatly varying loads. If a heavy load is instantly thrown off, as it is with elevators and pumps or in rolling mills, there is bound to be more or less noise in the valve gear. The dashpots will stick on a light load and are forced down by the hook or steam lever; a sudden increase in load will make them slam. This is about the most unsatisfactory service that can be imagined for a pair of dashpots, for which they must have plenty of reserve power. The old-time pots with two chambers, one to create the necessary vacuum and the other for cushioning, can be made to function well by careful fitting, but for very trying conditions a spring dashpot, like that which is shown in Fig. 4, is more reliable.

To insure that the valves get dry steam, it is well to provide a separator in the steam line. A separator that may be made on the job by the engineer from material which may be on hand, is shown in Fig. 2. The drawing needs no explanation, as it carries the names of all parts necessary.

Power Plants That Are Ornamental As Well As Useful

Two Examples of Successful Efforts To Locate Power Plants in the Midst of Architecturally Beautiful Surroundings Without Spoiling the Picture

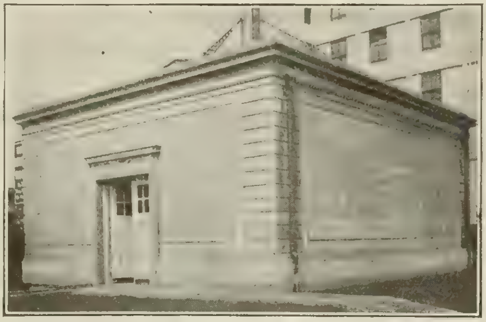
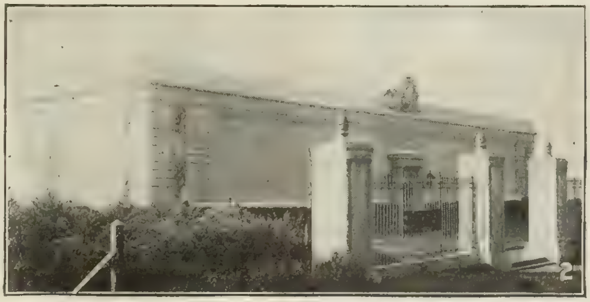
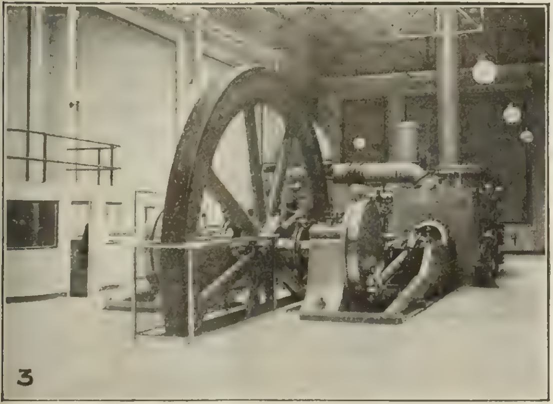
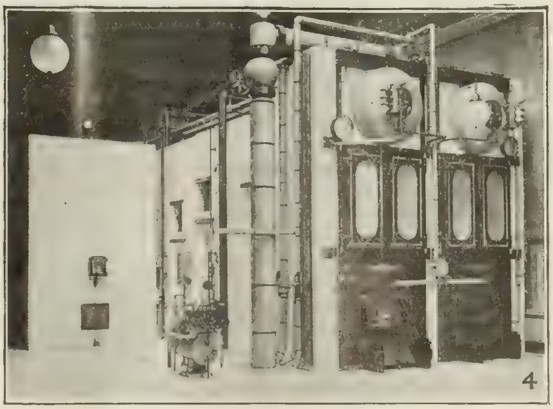


FIG. 1. SAN FRANCISCO CIVIC CENTER HEATING PLANT



THAT the power or heating plant need not be an eyesore is proved in the case of two plants that have been constructed in San Francisco. The one shown in Fig. 1 was built in the Civic Center and was designed to harmonize with the new City Hall, Library and Civic Auditorium, and the State Building now under construction. This is a central heating plant and serves all the Civic-Center buildings. It is built of concrete and has no windows with the exception of a few small glasses in the doors, a skylight providing excellent light during the day. It is so constructed that two wings can be added in the future. The building shown in Fig. 2 is often mistaken for a museum or mauseleum, there being absolutely nothing to indicate that it is the central pumping station of the Spring Valley Water Co. It is located west of Twin Peaks in one of the most exclusive residential sections of San Francisco and, for the purpose of harmonizing with the surrounding residences, was designed with careful attention to its outside appearance. There is a beautiful fountain at each end of the building, where the circulating water from the condenser is cooled. On each side of the front entrance there is an artistic electric-light fixture, which presents a most pleasing appearance at night. Over the front entrance is an inscription reading, "Let Thy Fountains Be Dispersed Abroad and Rivers of Waters in the Streets," and an ornamental concrete casting is at the top of the building immediately above. There is not a single window in the structure, all light coming from a skylight. The interior of the engine room is shown in Fig. 3. The front entrance leads to the railed platform over the office shown at the left. From this point a visitor overlooks an interior as artistically designed and finished as the exterior. The boiler setting is faced with white glazed brick, as shown in Fig. 4. Since oil is used as fuel, there is no dirt from smoke or ashes and the machinery and interior are always kept spotlessly clean. Artificial light is provided by electric lamps in large glazed globes supported from the ceiling. There is a beautiful lawn in front of the station, and extending across the front of the yard is an artistic iron fence with large ornamental concrete posts at the ends. The old idea that a power plant is a nuisance to the community in which it is located is rapidly being abandoned as the public becomes more familiar with such examples as are shown here.





SPRING VALLEY WATER COMPANY PUMPING STATION IN A RESIDENTIAL DISTRICT OF SAN FRANCISCO

Fig. 2—An exterior view of the station. Fig. 3—Interior view of the engine room. Fig. 4—Boiler room, showing glazed-brick settings

Electric Welding Machines—Direct-Current Constant-Potential Types*

Voltages and Efficiency of Welding Circuits—To Hold the Arc Reactance Is Necessary in the Welding Circuit—Machine Can Supply 40 to 50 Per Cent More Circuits Than Its Normal Current Rating—Operation of Different Makes of Welding Machines of the Constant-Potential Type

By L. W. WEBB
Master Electrician, United States Navy Yard, Norfolk, Virginia

WELDING machines normally group themselves into two main types, one for direct-current welding and the other for alternating-current welding. A large percentage of welding, both metallic-electrode and graphite or carbon-pencil, is done by direct current, with arc voltages approximately 20 volts for metallic arc and 38 to 45 volts for the graphite or carbon pencil. However, alternating currents can be used in many cases to equal advantage, but owing to the inherent low power factor of the welding circuits the application has been somewhat restricted.

In the elementary welding circuit with a metallic electrode, it is necessary to maintain a steady arc potential of approximately 20 volts. The earliest metallic-electrode welding was done from circuits of 550, 250 and 120 volts, by inserting a sufficient amount of resistance in series with the arc to limit the current to the proper value while maintaining approximately 20 volts at the arc. While satisfactory welding could be done with these higher voltages without the introduction of a reactance coil in the circuits, it was found desirable to insert reactances to smooth out the irregularities of the current caused by the sputtering of the arc and the inability of the operator to maintain a fixed arc length at all times. This reactance, owing to its ability to oppose rapid current changes, does assist in holding the arc stable and preventing its going out. The reactance also tends to prevent an abnormal rush of current, when first striking the arc, and the electrodes from sticking.

The wiring diagram, Fig. 1, represents an elementary direct-current metallic-electrode arc-welding circuit from a constant potential of 120 volts or higher. Taking a concrete example for the wiring diagram, using 100 amperes at 120 volts, the useful power output at the arc is found to be 20 × 100 = 2,000 watts, while the power output is 120 × 100 = 12,000 watts. This shows 10,000 watts lost in the resistances, lines, etc., which does no useful work and is dissipated in the form of heat. The efficiency of the welding operation from the power standpoint would therefore be 2,000 ÷ 12,000 or 16⅔ per cent. This would be even less when higher voltages are used, being in proportion to the voltage employed. For this reason special generators or motor-generators have been designed giving a constant potential from 60 to 75 volts for use as special arc-welding machines. These machines are usually designed to accommodate more than one operator and are often rated as high as 2,000 amperes at about 60 to 70 volts. Specially designed panels with a sufficient amount of resistance are usually supplied with the machines, so that welding currents varying from 60 or 80 to 200 amperes can be obtained as desired. Each individual panel usually contains, in addition to its resistance, the necessary reactance for properly taking care of welding conditions. The use of these machines also does away with the necessity of grounding the positive side of the line, as has to be done when welding from a 120-volt, or higher, power supply, except when the work is insulated from the ground. These sets can also be designed for use on any voltage or frequency by the proper selection of a suitable motor to drive the generator.

The number of operators a machine may be able to carry, due to the intermittent nature of welding, is at least 40 or 50 per cent more than the actual rating of the machine itself. The time consumed in changing electrodes, the natural fatigue of the operator and the making and breaking of the arc make the load factor of the circuit for welding about 50 or 60 per cent. Hence, a machine rated at 1,000 amperes continuous duty with 25 per cent overload capacity and 50 per cent momentary overload capacity could, without dangerous heating or sparking, accommodate at least ten operators, each normally using from 150 to 175 amperes when actually welding.

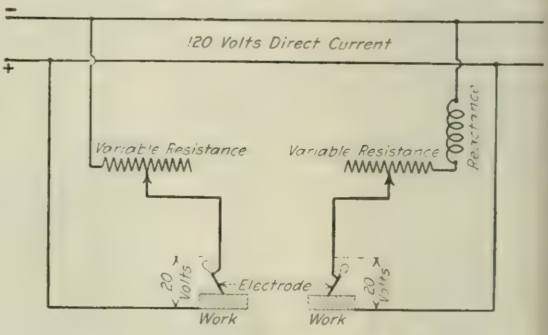


FIG. 1. ELEMENTARY WELDING CIRCUITS

These machines usually are wound with cumulative-compound fields, that keep the voltage either constant or about 5 per cent higher at full load to care for the drop in the feeders, etc. Where the shop layout is such that definite locations can be selected for individual outlets and the class of work is such that it will never be necessary to group the entire capacity of the machine at any one location, the generators are usually flat-compounded and individual circuits run to each outlet so calculated as to provide proper welding currents at this constant voltage. When the outlets are concentrated, they are usually fed from a bus-feeder system and the generators are overcompounded to take care of the drop as the load increases.

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*Future articles by the same author will deal with constant-current types and with factors affecting the operation of electric welding machines.

Fig. 2 shows a simple wiring diagram of a generator and welding outlet. The over-all efficiency of these motor-generator sets, depending on the size, will be approximately 75 per cent. For the 60-volt sets the efficiency of energy delivered to the arc, as compared with the 120-volt welding at 100 amperes, would be as follows:

Watts delivered to arc equals volts × amperes = 20 × 100 = 2,000; generator output in watts equals volts × amperes = 60 × 100 = 6,000; and motor-generator input in watts equals output ÷ (per cent efficiency ÷ 100) = 6,000 ÷ 0.75 = 8,000. Watts used in the arc ÷ motor-generator input = 2,000 ÷ 8,000 = 25 per cent, which is considerably higher than the 16⅔ per cent efficiency for 120-volt circuit.

While the majority of these machines are designed for 60 or 75 volts, owing to the higher efficiency in regard to power consumption, lower-voltage machines of 50 down to 35 volts are furnished. It can be readily seen that the closer the voltage approaches the arc voltage of 20 volts the smaller losses there will be in the external resistance and the more efficient the welding operation becomes from the standpoint of power used. However, with voltages lower than 35 the maintenance of a stable arc is very difficult, by reason of the inability of the operator to hold a fixed arc length as the metal flows off the electrode to the work and also because of sputtering of the arc, etc. Even with 35-volt supply it is often very difficult to do reliable welding, especially on overhead work or where long leads are used when the work is a considerable distance from the source of supply. As the cost of power used is generally only a small part of the welding cost, it has been found in many cases that it is more economical to use a voltage not less than 60 on multiple-operator sets, especially where four to ten operators are supplied from the one machine. With the higher voltage there is less time lost due to the arc going out, and it is easier for the operator to hold the arc, since slight increases or decreases in arc length are accompanied by less current changes than with the lower voltages.

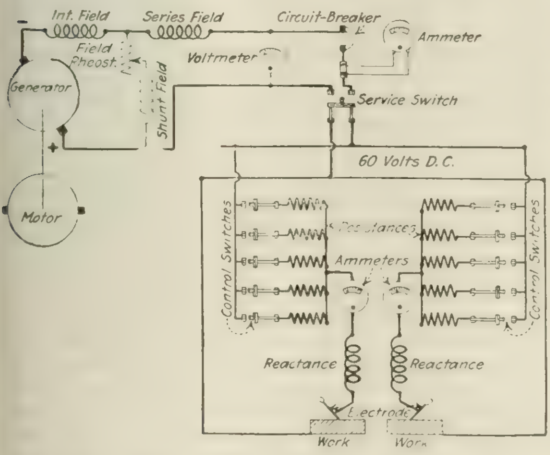


FIG. 2. WIRING DIAGRAM OF GENERATOR AND WELDING CIRCUIT

Multiple-operator sets, however, owing to their size and immobility, are really applicable only for stationary use at fixed centers of extensive welding activities. When it is necessary to provide machines for one operator, motor-generator outfits of the portable type or gas-engine-driven sets are preferable. These portable motor-generators or gas-engine-driven sets are sometimes constant-potential machines of 60 to 75 volts. However, specially designed machines of the so-called constant-current type are used to a large extent as portable machines. The machines, from an economical standpoint, as to over-all efficiency, are better suited than the 60- to 75-volt constant-potential machines, where the losses in the rheostat alone are approximately 50 to 60 per cent of the total energy input into the circuit.

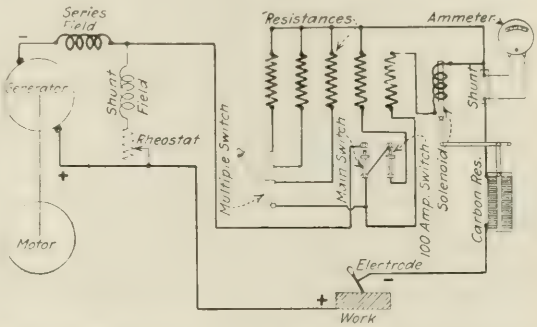


FIG. 3. WIRING DIAGRAM OF A LOW-VOLTAGE TYPE OF WELDING EQUIPMENT

With 60- to 75-volt constant-potential motor-generator sets of the multiple-operator type, the following advantages are claimed, as compared with an equal number of single-operator sets, the comparison being made between a machine capable of handling ten operators and ten single-operator motor-generator sets:

1. The first cost is lower, as well as lower depreciation and maintenance.
2. Simplicity and reliability of operation, as the machine can be permanently installed on stable foundations and requires very little attention or maintenance.
3. The over-all efficiency of the set is higher than that of ten single-operator machines, and the motor can be driven from 2,300-volt power, therefore doing away with a large part of line and conversion losses that the smaller machines would have.

The disadvantages, however, are that it is uneconomical, owing to the resistance losses in the welding circuits and to the fact that it is not easily portable and should be permanently installed to make it suitable for shop use, where the operators are relatively close to the machine. Also, as the number of operators working at any one time is reduced, the over-all efficiency of the machine is likewise reduced. There always exists the danger of grounding the wrong side of the generator to the work on the various outlets, especially when the work is being done on iron slab floors, etc., or a number of operators are working on the same piece of work.

A wiring diagram of the Wilson Welder and Metal Co.'s motor-generator is shown in Fig. 3. This is one of the lower-voltage, constant-potential types, for which the manufacturer claims high efficiency, both in the use of power and welding ability, calling it the "plastic arc."

This machine operates normally at about 35 to 40 volts, and therefore the rheostatic losses are slight compared to those in the 60- and 75-volt constant-potential systems. The welding current is automatically controlled by means of a solenoid operating a carbon-pile resistance. This method of control enables the operator to hold constant heat at the point of application by holding the volt-amperes at the arc constant for each setting. In the earlier types of machines this carbon-pile resistance was made large enough to care for all voltage drop in the circuit, but on the later types there is furnished a grid-type resistance controlled by multiple-point switches for the larger current variations, the smaller current variations being handled by a smaller solenoid controlled carbon-pile resistance, claim being made that the arc inequalities are smoothed out much quicker in the new type than was possible in the older type.

The efficiency of the welding operation from a power standpoint for this type of equipment, on the basis of a 100-ampere welding current, is approximately 35 per cent, which is a relatively higher over-all efficiency than that of the 60-volt constant-potential set. However, there are found many places, especially where the work is far from the machines, where these machines will not work satisfactorily, owing to the lower voltage and adjustments have to be made to the shunt fields to raise the voltage to approximately 50 or 55 volts; then the over-all efficiency is approximately the same as that of the 60-volt sets.

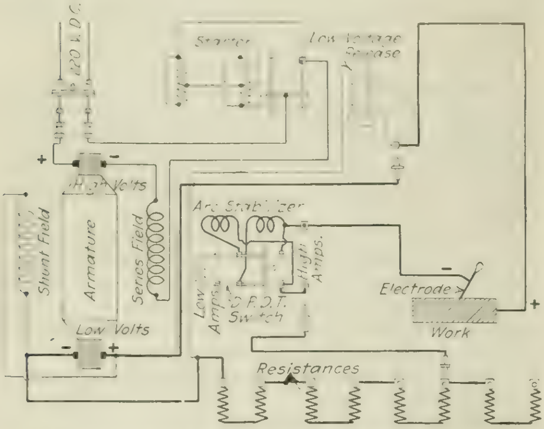


FIG. 4. WIRING DIAGRAM OF A DYNAMOTOR TYPE OF WELDING EQUIPMENT

Although a separate reactance is not used in the welding circuit, the series winding of the solenoid which adjusts the carbon pile for current changes does supply the necessary reactance for stabilizing. It will be found that without this added reactance proper welding could not be done at 35 volts. The action of the solenoid regulating the carbon pile is as follows:

The welding current passing through the carbon pile and the solenoid winding when the arc is struck, creates a pull upward on the solenoid plunger. This slackens up the pressure on the carbon pile and allows it to expand, thus increasing the resistance in series with the arc, and prevents too high a rise of current at the moment the arc is struck. As the current thus tends to decrease, the amount of pull upward on the solenoid plunger likewise decreases, which allows the springs acting against the pull of this solenoid to again recompress the carbon pile, and causes the current to increase. The resultant forces between the spring compression on the carbons and the pull upward on the solenoid, as well as the heating up of the carbons, determines the final amount of compression of the pile, the resistance of same and final current. In the older type of panel this spring adjustment was made variable by the use of a small motor operating through gearing and controlled by the operator with a push button and separate wiring. On the latest type of panel the solenoid is the only means of automatic adjustment of the welding current while operating.

A wiring diagram of the Lincoln Bonding Co.'s dynamotor type of welding generator operating at about 50 to 55 volts constant potential is given in Fig. 4. Its main advantages over the motor-generator type are that it is extremely light and, therefore, particularly adapted for portable use, and it can be easily let down through small hatchways and carried about by two men. The over-all efficiency of this type of machine is also higher than that of the constant-potential motor-generator type of the same voltage rating. When operating under the same conditions as a motor-generator set, the efficiency of power input to total energy delivered to the arc would be approximately 15 to 20 per cent higher. The reactance coil or stabilizer on this machine is constructed so as to have two independent windings, and so connected to a double-pole, double-throw switch that when using low welding currents the coils are connected in series, giving high reactance, and when using the heavier welding currents the coils are connected in parallel, giving low reactance. This varying of the reactance has been found to be very advantageous, as it is especially desirable to have high reactance values with low welding currents, so that the arc can be easily maintained stable, and high reactance values are not necessary with the higher welding currents, as they allow too long an arc length with careless operators. The two armature windings on this machine are independent of each other, therefore its operation does not affect the supply circuit from which it is taken, as some other forms of dynamotors or balancers would. It has an accumulative wound field in series with the main-line current, which maintains practically constant voltage on the generator end with various loads, the shunt field being connected directly across the low-voltage armature without any rheostat in circuit. Experience has shown that good welding can be done with this machine with current ranging from approximately 100 to 225 amperes.

(In the next article of this series, wiring diagrams of various types of so-called constant-current welding machines will be given and the operation of the machines explained. Comparisons will be made of the different methods of control.)

A Correction

The article on "Circumferential Cracks in Crankshafts" published on page 45 of the July 13, 1920, issue of *Power*, under the signature of John F. Whitney, was contributed by John F. Whiteley, to whom it should have been credited.

Care and Maintenance of Fire-Prevention Systems—II

By C. H. JENKINS

Superintendent of Surveys, the Underwriters' Bureau, Middle and Southern States

A CONNECTION from the city water supply, where it can be used, makes a good source. The capacity is unlimited, and if the pressure is good the combination is desirable. Where in use, the pressure should be watched and at regular intervals drain-valve flowing tests made. With the drain valve wide open and a full 2-in. stream flowing, the pressure should not drop many pounds. An excessive drop indicates that something is wrong somewhere and should be followed up until found. Ordinarily, a drop of 10 to 20 lb. with an initial pressure of 60 to 70 lb. is not excessive. The gravity tank, Fig. 1, is considered one of the most reliable sources of supply. One advantage is that, unlike a city water connection or a pump, it is not dependent upon other apparatus for operation and is entirely under the control of the property owner. There are two features of maintenance which stand out as needing the most attention and giving the most trouble: If not properly watched, the water will get low or leak out entirely; the water easily freezes in cold weather if not kept warm.

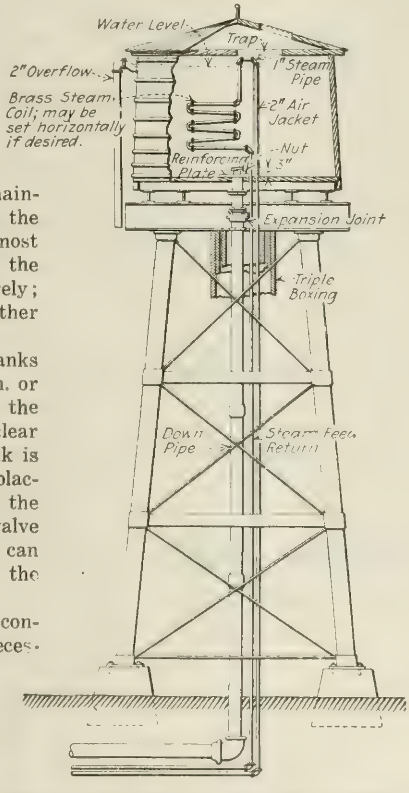


FIG. 1. THE GRAVITY TANK FOR SUPPLYING THE SPRINKLER SYSTEM WITH WATER

The present method of filling tanks is to fill them through the main 6-in. or 8-in. down pipe. By doing this, the water goes in at the bottom and a clear waterway through the pipe and tank is assured. This is arranged for by placing a bypass around the check in the connection from the tank with a valve in it. By opening the valve, water can be forced around the check up into the tank.

If no high-pressure supply is connected to the system, it becomes necessary to install a special filling pump and connection. Water should be run into the tank at least once a week until it overflows. The overflow should be piped to a place where the water can be seen when it comes out. Though this is done, the tank should be climbed occasionally and examined. A case comes to mind where a tank showed full by an overflow test after the filling pipe had been opened only a few seconds. Upon examination, however, it was found that the tank was nearly empty. At some previous time, when it was full, two inches of ice had formed on top of the water. The filling pipe in this case was a separate pipe and fed in at the top. Each time the tank was overflowed, the water was simply poured in on top of the ice and in a short time ran out of the overflow. The main body of water, through evaporation and leakage, became lower and lower. No one knew what was happening. An examination of the tank disclosed the condition.

Hoops are often found broken or giving way. In one case, a new wooden tank, three hoops near the bottom were found broken, leaving the tank in a rather dangerous condition. They had evidently been drawn up too tight while the tank was dry, and when water was turned in the wood swelled, putting too much strain on them. For safety, if for no other reason, frequent examinations should be made.

The heating apparatus often gives trouble. A heavy layer of ice on top of a tank will at least impede the flow of water from it. It is probably a fact that a vacuum high enough to prevent water flowing out could not be obtained. Enough vacuum could probably exist to make the flow pulsating and uncertain and destroy the constant, steady pressure so desirable in fire-protection work. At any rate such a condition should not be allowed. The old-style heating arrangement was to carry a live-steam pipe up over the edge and into the tank. In cold weather live steam was occasionally turned into it and the water warmed. The sketch shows a brass coil set in the tank; this arrangement is better. The steam-feed line is carried up through the tank, sometimes through an air jacket formed by a 2-in. pipe made tight to the floor of the tank. This jacket prevents the steam from condensing too quickly, most of the condensation being formed when the steam reaches the down pipe or coil. This arrangement usually gives good results.

A much better method of heating, especially on tanks of moderate size, is the hot-water, circulating heater. It is shown in Fig. 2. It is only a small hot-water heater, the water warmed by a steam coil. It can be placed in a small shed under the tank trestle or in a building, but it should be located near the tank drop pipe. The inlet to the heater is taken from the 6-in. or 8-in. drop main from the tank. The outlet runs through a separate pipe directly into the tank and has several outlets at different levels. As the water warms in the heater, it naturally rises to the tank and cooler water is drawn to the heater from the drop pipe. This forms a circulation of warm water through tank and drop pipe. The heater can be turned on when cold weather sets in and left on all winter. It must be examined occasionally to see that it is working right. Sometimes the trap does not carry off condensation from the steam coil and it becomes cold, or a valve may unaccountably become closed. With a moderate amount of attention they will not give much trouble.

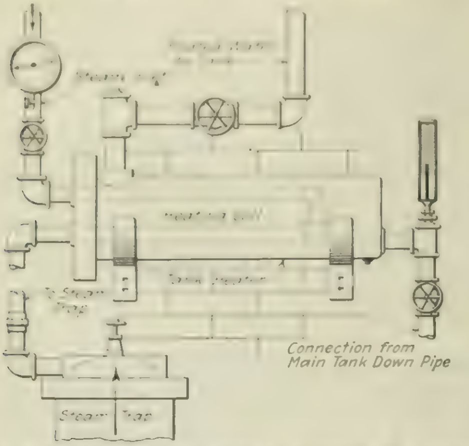


FIG. 2. THIS TYPE OF HEATER IS BETTER THAN THAT SHOWN IN FIG. 1

In moderate climates cypress or cedar makes the best tanks. If good spruce lumber free from knots can be obtained, it makes a good tank. In severely cold climates cypress does not seem to last. Tanks will last longer if not painted. There is, however, usually a desire to improve their appearance or to use them for signs. A moderate amount of paint on the outside does no particular harm, but they should not be painted inside. Steel tanks are being widely used, especially for the larger sizes. These should be kept well painted both inside and out. This is especially necessary if they are near sea water or exposed to steam exhausts. Steel trestles or supports need the same attention.

Tanks should be cleaned out occasionally, as there is sediment in most water which forms an appreciable deposit after several years. It is a good plan to have a telltale or indicator on the tank so that if anything goes wrong the height of water will be noticed at once. Do not place too much reliance on such a device. It should not be made the excuse for omitting a frequent examination. Often they get struck or do not work properly. Many little things, such as a drain valve not tightly closed, may empty a tank.

The pressure tank, Fig. 3, is a cylindrical steel tank made of boiler plate riveted. Two-thirds of the tank is filled with water and the other third with air under pressure; the usual pressure maintained is 75 lb. With a tank properly made and installed, it should not be necessary to pump air pressure more than once or twice a month. There are only two serious things that are likely to happen: An air leak may occur, or water may leak out somewhere through the system. On account of the rather high pressure a careful watch must be maintained. A small air leak will let the pressure down over night. The air gage should be watched and the water level frequently tested. The best plan is to visit the tank once a day. Ordinarily, it will be found all right, but if anything does go wrong the device gets out of service quickly.

On most gage glasses, for the purpose of testing the water level, there are two small valves, one at the bottom and one at the top of the glass, and two globe valves in each connection top and bottom. It is better to open the two small valves and leave them open, using the globe valves for testing. The small valves usually operate hard and begin to leak after a short time. Water should not be left in the gage glass. After testing the water level by opening the two globe valves, they should both be closed and the water drawn out of the glass by opening the small cock at the bottom. In testing, open the top valve first, letting air pressure into the glass.

Tanks should be kept painted with a good grade of lead paint both inside and out. If the water contains sediment, clean out the tank once in five or six years.

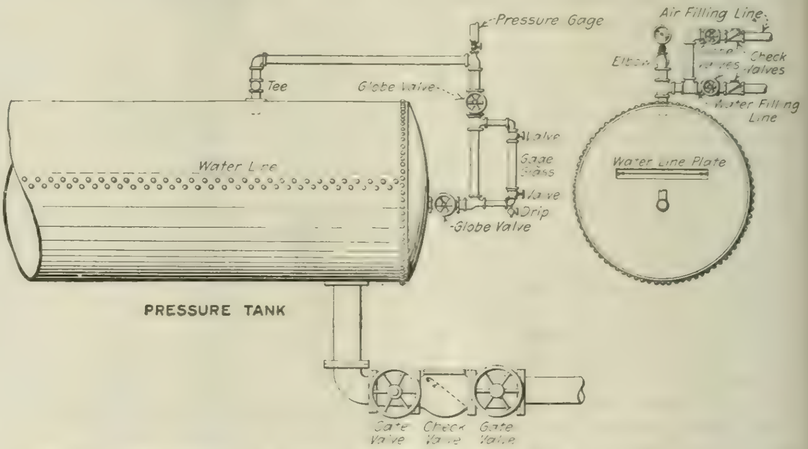


FIG. 3. THE PRESSURE TANK AS CONNECTED TO THE SPRINKLER SYSTEM

THE FIRE PUMP NEEDS ONLY ORDINARY CARE

Some engineers and mechanics look with more or less distrust upon the fire pump. To be sure, they are not the well-adjusted, smooth-moving machine that the steam engine is, but they are substantial and well built. It is all right, if necessary, to turn steam directly into a cold pump of the modern fire-pump type. For tests it is not recommended, but they are built to stand it if needed on short notice. They need only ordinary care. They should be turned over once a week and occasionally, say three or four times a year, run to pump water. They should be given oil frequently in all the working parts and a liberal supply of oil kept near-by. Look over the nuts and pins occasionally and see that they are properly adjusted. One loose key in the valve motion or rocker shaft may stop the pump when it is badly needed. Keep the packing at the piston rods fresh and in good condition. Always keep boiler steam

Weekly Inspection Report on Sprinkler Systems

LIST OF VALVES

NOTE.—All gate valves to be secured open with leather straps fastened with padlocks riveted or sealed. Padlocks, if used, to have common keys held by responsible parties. Each valve to be inspected by turning valve one-half turn to insure its being wide open and in good working order. Drain valves to be strapped closed in a similar manner.

No. 1. Location.................................. Open................ Secured...............
No. 2. Location.................................. Open................ Secured...............
No. 3. Location.................................. Open................ Secured...............
No. 4. Location.................................. Open................ Secured...............

COLD WEATHER VALVES

NOTE.—These control sprinklers in places which are cold in winter. In cold weather they must be kept shut (entryways, vestibules, etc.)

No. 5. Location.................................. Open................ Secured...............
No. 6. Location.................................. Open................ Secured...............

OUTSIDE VALVES

NOTE.—All post indicating gate valves to be fitted with handwheel or socket wrench permanently secured to spindle. To be secured and inspected in the same way as inside valves.

No. 7. Location.................................. Open................ Secured...............
No. 8. Location.................................. Open................ Secured...............
No. 9. Location.................................. Open................ Secured...............
Give numbers of any valves found closed, part closed, not strapped..
Cause for condition found in?. ....

DRY SYSTEMS (Air valves)

No. 1. Location..................... Alarm conn. in order?...... Air pressure..... Condition........
No. 2. Location..................... Alarm conn. in order?...... Air pressure..... Condition........
No. 3. Location..................... Alarm conn. in order?...... Air pressure..... Condition........
Give number of any air system not found in good order........... Cause for condition..................

ALARM VALVES

No. 1. Location...................... Cock open....... Strapped....... Tested....... In order........
No. 2. Location...................... Cock open....... Strapped....... Tested....... In order........
No. 3. Location...................... Cock open....... Strapped....... Tested....... In order........
Give numbers of any alarm devices out of service.......... Cause...

GRAVITY TANK Full?............ Contents frozen?............ Telltale in order?...........
PRESSURE TANK Water level?.......................... Air Pressure?.........................

STEAM PUMP

NOTE.—Pumps should be given a thorough test with rated number of hose streams at least twice a year, spring and fall. They should be started once a week and water discharged through relief valve or otherwise to make certain pump is in order.

Valves in steam connection from boilers to pump wide open.
Minimum steam pressure for pump should be 50 lb.
Tested through......hose streams. Condition................. Supply of oil on hand.................

ELECTRIC PUMP

NOTE.—Pumps should be given a thorough test with rated number of hose streams at least twice a year, spring and fall. They should be started once a week and water discharged through relief valve or otherwise to make certain pump is in order.

Any interruptions of current supply........ Condition of contact points on all switches.................
Automatic controller in order?........ Pressure maintained? ....

AUTOMATIC SPRINKLERS

Any corroded, bent, whitewashed, gilded or painted, covered with dirt or grease, obstructed by clothing, partitions, shaft hangers?..

Is there a clear space of at least two feet below level of sprinklers, free from stored goods or other obstruction? ....

Note any exceptions.

IF DESIRED, OTHER GENERAL CONDITIONS CAN BE ADDED AS FOLLOWS:

INSIDE STANDPIPE AND HOSE

Water on pipe?.............. Hose attached?................ Hose in good order?.................
Nozzles attached to hose........ Spanners handy?........

FIRE PAILS In place?................. Full?..................

CHEMICAL EXTINGUISHERS

NOTE.—These should be used and recharged at least oncea year.

In place?................ Date tested and charged?..

FIRE DOORS

Closed and fastened nights, Sundays and holidays and all times when not in use?.....................
Will all fire-doors close easily?........ Note any fire-doors in need of repairs.........................
Automatic attachments in order?........

SHUTTERS

Closed and fastened nights, Sundays and holidays and all times when not in use?.....................
Will all shutters close easily?...... Note any shutters in need of repairs...........................

HYDRANTS AND HYDRANT HOUSES

NOTE.—Each hydrant should be given a thorough test by flushing at least twice a year, spring and fall. One turn to open should be sufficient at other inspections.

Hydrants open easily?................ Free from snow or ice and easily accessible?...............

HOSE, PLAY PIPES AND SPANNERS

In their proper place and ready for use? ....Condition? ....
(Each hose house can be numbered and reported upon separately.)

ELEVATOR AND STAIR DOORS OR TRAPS

In order and kept closed when not in use.
Note any exception.................... Condition of latches or other hardware.....................

CLEANLINESS

Oily waste well cared for?........Basements clean?......Yard kept free from combustible material?..... Belt inclosures clean?........Clothes closets and water closets clean?........Shafting and bearings well cared for?........Clean under benches?.......Note any suggestions as to possible improvements in cleanliness

Date .... Signed ....

pressure right up to the throttle valve of the pump. As an auxiliary supply a fire-engine connection is usually attached to the supply lines at the street level. This is a 4-in. pipe with a check valve against the other supplies and two hose connections on the outside to which the fire department can connect its hose lines and pump into the sprinklers. These need little attention, except that in some localities it is difficult to keep the brass caps on the outlets. When the caps are off, it seems to be a favorite diversion for children to drop stones and other things down the pipes. Of course these may stop up the waterway. Cast or malleable iron caps can be used, as they have no value as junk and will probably be left in place. Water may sometimes leak past the check valve and get up into the connection. In cold weather it will freeze. On all such connections there should be a drip cock which can be tested occasionally.

CARE OF THE VALVES

The valves are one of the most important parts of a fire-protection system. If one is shut, water cannot get through to the sprinklers. Fig. 4 shows a common type of valve used on these systems. One advantage of this valve is that it indicates plainly whether it is open or shut. As shown, it is open. When being closed the stem moves, in, and when the valve is shut the end of the threaded stem is about level with the top of the yoke. When open, the stem projects out beyond the yoke a distance equal to about the diameter of the pipe.

To avoid having valves operated by ignorant or unauthorized persons, it is a good plan to seal or strap them open. This can be done by passing a light leather strap through the wheel, around the yoke and then riveting the ends together. In case of emergency the strap can be cut with a pocket knife. Instead of a strap a wire can be used and the ends fastened together with a seal. There are on the market some patented seals which cannot be used again if once fastened on the wire. An ordinary freight-car seal can be used. The wire, of course, should not be so heavy that it cannot be broken in a hurry. Sometimes straps and padlocks are used, and the keys left in charge of several reliable persons. The idea is not to fasten them securely, but rather that when a person sees a valve sealed in a certain way he will know that it should be left alone and will not tamper with it.

It is a good plan to have on the sealing device a tag with a statement printed on it that the valve is to be kept open.

In some establishments the valves are numbered, and in the office of the master mechanic or superintendent there is a row of pegs numbered to correspond, one for each valve. If it is necessary to close a valve, the tag, when removed, is hung on the peg with the corresponding number and stays there in plain sight until a new tag is given out and the valve reported open and sealed. The old tag can then be filed away or destroyed. This system prevents the valve being left shut after the men have finished working on the piping.

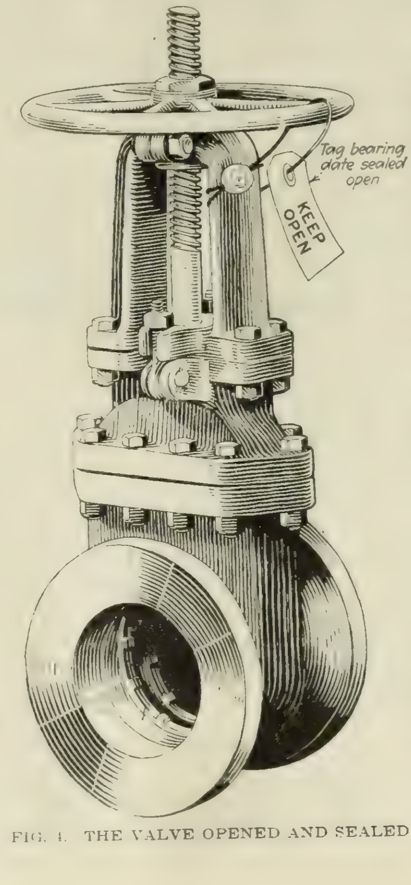


FIG. 4. THE VALVE OPENED AND SEALED

It may seem from the foregoing remarks that it requires a good deal of detailed inspection work to take care of a fire-protection system. But this is not so once the system is thoroughly understood. All necessary examinations can be made in one trip over the premises. Remember that thousands of dollars worth of property may be dependent, in case of fire, upon the fire-protection system.

Complete inspections should be made once a week. In doing this it is a great help to have an inspection blank or form to follow. With the different appliances all noted in order, nothing will be missed and no time will be lost in thinking about what to take up next. On page 215 is a general form suggesting a possible inspection blank. As shown, it deals with all the apparatus which could be used. In plants where there are no dry valves, alarm valves, or other such devices, the parts referring to them may be omitted. From this form a blank can be made up to suit any individual property and copies made for the mechanical man in charge.

[In many, if not most, factories the chief engineer of the power plant is also factory fire chief. The responsibility is no light one, even though state and municipal departments usually specify equipment and recommend procedure as to drills, constructions, exits, etc. The sprinkler system is the first aid source in case of fire, and to make pay the large investment which it constitutes, must be ready to function in all its parts at any time or season. Obviously, the chief engineer cannot personally attend to all the details; he must therefore select with consideration the subordinates with whom he shall share the responsibility. *Power* encourages its readers to pass this copy around to the men in the plant who have to do or may have to do with the sprinkler system, that they also may have the advantage of reading such a practical article on a subject about which so little is written from the point of view of the power-plant man.—Editor.]

W. A. White, inventor of the low-pressure oil-feeding apparatus with which the White Star liner "Olympic" is equipped, offered to recondition the "Leviathan" and convert her into an oil burner for $10,000,000. He says there is one feeder the size of a pinhole for each of the 150 fires on the "Olympic," and fuel is sprayed by powerful fans after is has been heated to 180 degrees.

Effecting Efficient Operating Methods in Hydro-Electric Plants

The Result of Long Experience in a Number of Different Hydro-Electric Stations Located in Various Parts of the Country

By L. W. WYSS
Chief Operator, Twin Falls Station, Peninsula Power Company, Iron Mountain, Michigan

TWIN FALLS STATION, PENINSULAR POWER COMPANY, IRON MOUNTAIN, MICH.

STREAM flow, load conditions, and reservoir capacity, together with other conditions, have an important bearing on the operation of hydro-electric stations. Operators must meet ever-changing conditions, selecting from day to day operating methods that will be of benefit to the system as a whole. There are, of course, many hydro plants where an expenditure for improvements would result in more efficient operation. However, the following methods may receive special considerations, as most of them do not call for any expenditure, but only operating vigilance.

Because of correct design backed by experience, the safety of modern concrete dams is not jeopardized by carrying a higher headwater elevation than designed for. In view of this, when the station operators anticipate low water, every possible inch of storage should be obtained consistent with local conditions. The water may run over the top of flash boards or gates in such cases, but the extra storage may represent several tons of coal, which justifies breaking established precedents.

USE OF STORAGE RESERVOIR

Even though the pondage is not large enough for seasonal storage, advantage can be taken of its limited capacity by loading the plant to lower the headwater in anticipation of spring floods or freshets, as well as for light-load periods which may exist each day from midnight until morning or on Sundays and holidays.

When work is done on a transmission line or any plant equipment which will curtail the station load, the pond should also be pulled to avoid wasting water if the total river flow is used.

AVOIDING HIGH TAIL WATER

At some plants during high-water periods the high tail water may curtail the station output. In such cases advantage may be taken of the light-load periods when full load cannot be obtained for the plant to waste all or part of the excess water. To accomplish this the headwater elevation is lowered during light loads and regained during the time that full load is available at the plant. To do this to advantage, the benefits derived from the lowered tail water must offset the disadvantage of low headwater, consequently plants with large reservoirs will be best adapted to this method of increasing the output while all turbine gates are wide open.

When advantage is taken of storage water during low river flow and more than one reservoir is available, it may or may not be advisable to draw them proportionately. This matter should receive careful consideration. In the case of two plants of about the same capacity and effective heads, one may have double the storage of the other; this larger reservoir is the logical one to use storage water from, as a given amount of storage used will lower the larger pond only half as much as it would the smaller one.

If the dams were 34 ft. high and the smaller pond were drawn 4 ft., the station output would be curtailed approximately 12 to 15 per cent, while using the same amount of water through the turbines as with a full head. Using the same amount of storage water from the larger pond would pull the head only two feet, while the load would be curtailed only about 6 to 7 per cent, using the same amount of water through the turbines as with a full head.

When two or more hydro stations are operating on the same river, consideration should be given to the fact that any plant will receive the benefit of all storage reservoirs upstream. Before starting any additional or auxiliary steam equipment during low-water periods, it is well to analyze the situation thoroughly. Such analysis will often show that the water situation is not as seriously unfavorable as it appears, therefore, the extra steam equipment will remain idle and the hydro plants have a chance of pulling through the drought without help.

VALUE OF CO-OPERATION

Co-operation of power-plant operators along a stream is beneficial even though the ownership of plants is not allied. The upstream plant with reservoir can, of course, take every benefit by using the water to best advantage unless compelled to give a certain steady flow for the downstream interests. Too often the latter plant owners demand river run, thus working a hardship on the upstream plant. An investigation may prove in some cases that steady river run from the upstream plant is not as beneficial for the downstream plant as co-operation with a view to handling the river flow for the mutual interests of all water users on the river.

When a power system is operating two or more plants and is required to discharge river run for other interests from a certain plant, which is usually the downstream plant, the river flow should be estimated and the operators at this plant given the authority to manipulate their governors to carry a steady load while the other plants hold the speed normal and take the major variations in load. This does not mean that the governors at the "river run" station fail to function so as to take care of load swings due to such fluctuating loads as railways, mine hoists, etc., but that a nearly constant hourly load be carried without the usual light-load periods which occur on most systems for a few hours at a time during weekdays, Sundays and holidays.

The downstream plants may receive the following benefits from the upstream plant: (1) Benefit of upstream storage reservoir, giving more steady river flow throughout the year. (2) The upstream plant may hold water back every Sunday or on holidays which the downstream user might have to waste owing to light load. This water can then be used to advantage during the working days. (3) When repairs are made to dams, gates, etc., the downstream plant may be aided by the upstream plant holding water back. (4) The upstream plant with reservoir capacity may be able to take the high peak out of a large flood which might in extreme cases prevent wrecking a defective downstream dam. The upstream plant can only receive concessions regarding the deviation of natural river flow, but this deviation may prove valuable.

REMOVING THE HAZARD OF CARRYING A FULL HEAD IN WINTER

It is often necessary to keep the headwater elevation low during the severe winter months because all the waste gates are frozen fast, and it would take considerable time to chop them loose in the event of losing the load due to transmission-line failure. If the total river flowage is used, it will pay to avoid running with this low ineffective head by using one of the following methods of keeping gates free. (1) Employing one or more men to keep gates free; (2) use of steam or electric heating equipment; (3) use of compressed air to keep water bubbling and circulate the warmer water to the surface to prevent freezing; (4) circulating water with pump from the bottom of the dam to the surface.

Other means of wasting water in emergencies are to block the generators to prevent rotation while water is wasted through the turbine gates, or to use a water rheostat to load the generators, thus wasting water.

PREVENTING ICE TROUBLES

It has been found advisable at some hydro-electric plants troubled with anchor and frazil ice to shut down partly or completely to allow the intake channel to freeze over with ice, thus avoiding further troubles for the rest of the winter, as anchor and frazil ice do not form under an ice cover.

When protection cannot be obtained in this way, it may be necessary to remove the trash racks to operate at all when frazil ice is forming. The operating results of turbines should then be watched, and as soon as one is materially affected with clogging ice it should be taken out of service, the head gate closed and the turbine thawed out with steam. It will then be available for operation, after which another can be thawed out.

When troubled with frazil ice, it is a good idea to either have the racks totally submerged in the water or, in case they project, have the surrounding air heated, as either of these will help prevent the ice from sticking to the racks.

The most unfavorable conditions result from allowing trash racks to become so badly clogged that the elevation of the water is lower inside the racks than outside. This will lower the plant efficiency as well as the full-load output to a considerable extent; cases are known where this loss was over 10 per cent.

At some of the older installations having restricted trash-rack area with resultant excessive velocity through them, it may be advisable to install thin racks of curved horizontal cross-section in place of the thick iron installed when the plant was built. It is also advisable to have the forebay, penstocks or flumes free from obstructions of any kind. These obstructions may be caused by irresponsible persons dumping refuse in the headrace, obstructions left from construction work, caving of banks perhaps resulting from streams flowing into the forebay during rainy weather or from headgates not being completely open.

When the total river flow is used, all leaks in the dam should be stopped in some way. Most of these leaks appear at the waste gates, and perhaps new gaskets will be required. Cinders are best for stopping leaks. They can be dumped directly above the leaks, or guiding spouts can be made to carry them to difficult places.

USE OF GOVERNOR LOAD LIMITING DEVICE

On an interconnected system the hydro-electric plant turbines should run with gate openings as near as possible to the high-efficiency point. It is hazardous to block the governors in this position, as a runaway would result from loss of load.

Some governors are provided with a load-limiting device which can be set to limit the turbine gate opening at any desired point. Primarily, these devices are designed to guard the generator from overloads when the effective head is at maximum. However, they find a wide field of usefulness when they are set to limit the gate opening at the most efficient point. The speed-control device is then adjusted so that regardless of small load fluctuations the governors will remain at rest. This will not prevent the governor from functioning properly in the event of loss of load. The value of this method can be appreciated when consideration is given the fact that maximum efficiency of most turbines is reached at about 0.85 to 0.9 gate opening, and that further opening results in a pronounced drop of efficiency. For dispatching reasons, or to keep a constant river flow for downstream plants, it may be necessary to run hydro turbines at constant loads; this is another service which the load-limiting device will render. It might be advisable in some cases to equip old governors with load-limiting devices.

SHALL THE STEAM STATIONS ALWAYS RECEIVE FAVORABLE LOAD CONDITIONS?

Load dispatching on interconnected systems is often such that the hydro-electric stations do not receive load conditions which enable them to run efficiently. This is principally because the steam-plant efficiency is given first consideration because the coal rate per kilowatt-hour is watched closely, and therefore the steam plants select loads suitable for high efficiency.

Looking at the matter from another angle, if the steam plants take the major load variations, thus allowing the hydro-plant turbines to run near the high-efficiency point with sluggish governors or a load-limiting device, the additional load of which the hydro plants relieve the steam plants may save coal even though the steam-plant efficiency is lowered slightly.

Take a system of 500,000 kw.-hr. output per 24 hours. The hydro-electric turbines running at about 82 per cent efficiency deliver 250,000 kw.-hr. to the system. It may easily be possible to raise their efficiency to 90 per cent with favorable load conditions, in which case they could deliver about 274,000 kw.-hr. to the system instead of 250,000, using the same river flow. This would relieve the steam plants of 24,000 kw.-hr. each day, which would doubtless save considerable coal even though the diversity of load does not permit running as efficiently.

The steam-plant efficiency would not in most cases be lowered as much as the hydro-plant efficiency is raised, as the steam turbine has a relatively flat efficiency curve as compared with a water turbine, and modern methods of regulation enable the steam-plant crew to attain good efficiencies even though the load is not steady.

SOME HINTS PERTAINING TO STATION OPERATION

If full load is available at a hydro-electric station during high-water seasons and the load is limited by the heating of the generators, it is, with few exceptions, advisable to make arrangements so that the turbines can run at full load. Perhaps it is wattless current heating the generators, in which case remedial measures may lie in correcting the power factor with available steam-driven generators, synchronous motors, or the installation of synchronous condensers. It may also be advisable to install ventilating equipment for the generators, or in extreme cases to rewind them for a higher kva. rating.

In stations that have a choice of either turbine-driven or motor-driven auxiliaries, the turbine-driven units should be given running preference over the motor drive during high water when the station is running fully loaded, while on the other hand, it is more efficient to run the motor-driven ones during low-water periods, as these small turbines waste water.

The maintenance of the power-plant machinery and switch gear should be attended to in such a manner that no equipment will ever be idle while load and water are available unless another hydro plant on the system can handle that load The maintenance of turbines should receive careful consideration. It is advisable to check their performance periodically. The quantity gage seems to be well adapted for these checks.

DURING LOW-WATER PERIODS

When tandem units are used, it may be advisable to open only the wicket gates of a part of the turbines on the lineshaft if that is possible, as higher efficiency will result. To insure efficient and reliable operation of hydro stations, the personnel of the operating force should receive careful attention.

It is true that steam stations are more complicated than hydro stations, but this does not necessarily mean that the hydro-electric station chief and operators have less responsibility, because the average hydro station has only one or two operators on shift and their individual responsibility is often greater than in a steam station where there are numerous men with divided responsibility. The hydro crew is often called upon to chop gates free of ice or to repair transmission lines under severe weather conditions. Also the hydro chief generally must maintain his plant in first-class condition without the help of skilled repair men, while the steam-plant chief has these besides boiler-room foremen, boiler inspectors and machine-shop facilities.

A Word on Specifications to the Refrigerating-Plant Operator

BY B. E. HILL

A great mistake is made by prospective purchasers sending out for quotations on equipment intended to accomplish a certain result. For example, the writer had his attention brought forcibly to this some years ago in the purchase of a 100-ton double-pipe brine cooler to be installed in one of the Western plants of a large packing company.

Quotations were received from five of the leading manufacturers of double-pipe brine coolers, and the lowest of the five quotations, when compared with the cost per lineal foot of pipe per ton, was considerably higher than the other four, but as compared with the cost for a 100-ton brine cooler, the cost was considerably below the other quotations. The lowest bidder won. The writer, however, installed a brine tank and submerged the double-pipe brine cooler, connected the suction of the pump to the brine tank, discharged the brine into the double-pipe brine cooler and delivered it to the coils located in coolers containing meat products and returned the brine back to the brine tank, thus utilizing the double evaporating surface of the cooler inside and outside.

The objectionable part of this installation is the submerging of the pipe in a brine tank, which makes it more difficult to detect and repair leaks, but as the evaporating capacity is so greatly increased, the objectionable feature is absorbed.

In the purchase of equipment to obtain specific results, the engineer should write the specifications. For example, suppose a 100-ton ammonia condenser is required. The first thing to be considered is a location, next the available space which, if small, will limit the number of types to choose from, also the available water supply, its temperature, etc. After these details have been thoroughly gone over and the type of condenser required to do the work is decided upon, together with the size of pipe and lineal feet per ton of refrigeration necessary to hold the condensing pressure to the minimum, proceed to write specifications for quotations, stating the number of stands, number of pipes high in each stand, length of pipe, kind of pipe, how the joints and connections are to be made up, and if the stands are to be made up in sections at the manufacturers' works, being made up with split return bends and erected by the purchaser; how the headers are to be made, if they are to be extra heavy, connections screwed and welded, sweated or made up with litharge, style, type or make of valves to be used and, if possible, a blueprint covering all details of construction sent to the manufacturers.

This method of purchase places the manufacturers on an equal basis; they are all figuring on the same quality and quantity of material, which puts them on their merits and will prevent the skimping and skinning process that so often happens when the purchaser simply specifies an equipment to do a certain amount of work, which in this case is a condenser capable of handling 100 tons of refrigeration.

One manufacturer may figure on wrought iron, another on steel, another on standard weight pipe, another on extra-heavy, etc., together with the numerous ways of making up these condensers; and still another will reduce the surface to such an extent that he will only "get by," by the "skin of his teeth" with a clean surface and new pipe, but when a little scale forms on the outside and oil accumulates on the inside, together with a collection of noncondensible gases, the water supply falls off, warms up or both, the boss will begin to complain on shortage of output, no efficiency, burning too much coal, using too much ammonia, and finally he decides he has a third-rate engineer. And maybe he is right.

The "live-wire" engineer must know what he wants and proceed to specify what is needed to get results. In nine cases out of ten, if he can half-way prove to the boss that he can spend ten dollars and get back fifteen in a reasonable length of time, the boss will spend the money. The engineer must first gain the confidence of his employer and to do this he must deliver the goods.

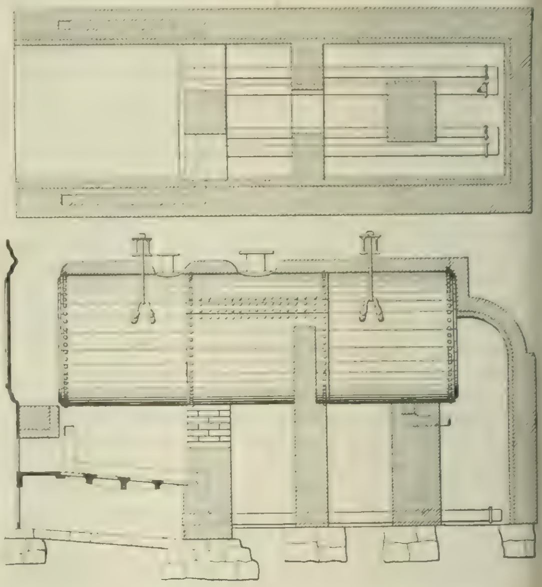
Preheated Air to Burn Volatile

Preheating a portion of the air required to burn the coal in a boiler furnace and admitting this air above the fire at a temperature sufficiently high to ignite the gases near the point of liberation, coupled with masonry construction to mix the gases and the preheated air, are the means employed toward securing smokeless combustion in the furnace designed and patented by I. W. Foltz, 175 West Jackson Boulevard, Chicago. Air is admitted to the ashpit as usual, and much of it passes up through the fuel bed. A portion of this air, 10 to 18 per cent, depending upon the resistance of the fuel bed, passes through an airtight channel or duct embedded in the floor of the combustion chamber. The entrance is at the face of the bridge wall if conditions are favorable, or in the side wall farther forward in the ashpit. The duct then comes out into the combustion-chamber floor back of the bridge wall, passes to the rear of the setting, returns by way of the bridge wall into the side wall, and then passes forward and out over the fire near the front of the furnace. A duct of this character made up of firebrick or tile and high-temperature cement, is placed on either side of the furnace.

In its passage through this duct it is claimed that the air is heated to temperatures of 750 deg. and above. By introducing this highly heated air at the point where it is most needed, it is possible to reduce the excess air passing through the fuel bed. This is accomplished by partly closing the damper, or preferably one of the ashpit doors. A high bridge wall with a pier at the center built up to the boiler shell, wing walls farther back and a pier in front of the blowoff connection, as shown in the accompanying illustration, are the means used to mix the gases and the air. In laying out the furnace, the grate surface, cubical contents of the combustion chamber, the flue area and the dimensions of the stack and breeching are all considered, but approximately, the openings over the bridge wall are 25 per cent greater than the flue area. The size of the duct depends upon the coal-burning capacity of the furnace.

One of the installations to which the foregoing applies was made in the plant of S. Karpen & Bros. Live steam is supplied for power purposes and process work by four 150-hp. return-tubular boilers, 72 in. x 18 ft., equipped with hand fired inclined stokers having a 2-ft. coking arch and a single deflection arch back of the bridge wall. A smoke flue over the rear of the four boilers runs directly into a stack 66 in. in diameter at the top and 125 ft. high above the boiler-room floor. A draft of about 0.24 in. was available over the fire. Coal, hand-fired, was the principal fuel used. Recently, the coal obtainable has been of inferior quality, and its combustion was not improved by introducing on the top of the fuel bed the shavings and the wood refuse from the factory.

Normally, the four boilers, operated above rating, were needed to carry the load in winter and three in the summer months. The demand for steam was so urgent that it was difficult to burn sufficient fuel to carry the load. It was a question of forcing the boilers and smoking badly, which was the cause of constant trouble with the smoke department. The fires had to be cleaned three times on a shift of eight hours, there was trouble from large clinkers, and considerable unburned coal found its way into the ashpit.



PLAN AND ELEVATION OF BOILER SETTING

In search of relief one of the furnaces was rebuilt after the design shown in the accompanying drawing, and shortly after, all four boilers were so equipped. The ducts on either side were made 5 in. square, and the brickwork within the furnace was rearranged as indicated. There have been no boiler tests, before and after, to show the results of the change, but improvement has been evident to the firemen.

Firing is lighter, there is no difficulty in carrying the load, and in the opinion of the chief engineer a reduction to two boilers during the summer would be possible if coal could be used exclusively as fuel. An intense fire is maintained with one ash door closed and the damper only partly open. The general improvement is attributed to more perfect combustion, complete burning of the volatile and reduction of excess air to a point approaching theoretical requirements.

Hydro-Electric Development, as Affected by the Recent Water-Power Legislation and the North Atlantic Super-Power Survey

THREE-FOURTHS of the possible 59 million horsepower of water power in the United States has been under Federal restrictions preventing its development, according to Franklin T. Griffith, of Portland, Ore., chairman of the National Electric Light Association's Committee on Water Power Development. A large part of the restrictions are removed by the new water-power law. Coal is jumping to undreamed-of prices and is extremely hard to get. It will unquestionably be higher and scarcer in the future. Every ton of coal that can be replaced by water power in making electricity will help ease the shortage.

To the person who lives in an apartment or home in the East, release of water power for his city means some measure of insurance against sudden darkness through delayed fuel shipments. In a few favored localities, sufficient hydro energy may be available to act as a slight buffer against steadily rising costs of making electricity from coal that often comes as high as ten to twenty dollars a ton. Indirectly, everyone benefits from more stable power for factories, street lighting, illumination of hotels, theatres and public buildings, and electric-railway operation. And all factories which make their own power from coal will be benefited by lessened pressure on the country's insufficient mining and transportation facilities.

One authority, Philip Torchio, of the New York Edison Co., figures that one-twelfth of the coal used outside of the far Western States in a recent year could be replaced by water power (3¾ billion heat units from coal, 300 million possible from water power). As demands for power and light grow, the need for this hydro energy becomes greater.

NEW ENGLAND AND THE MIDDLE ATLANTIC STATES

In New England three-quarters of the possible water power is now utilized; comparatively little additional development is to be expected. A million and a half of the potential two million horsepower is developed. These figures credit Maine with generating equipment to care for three-quarters of her million water horsepower, and New Hampshire but 76,000 of her possible 295,000. Vermont has generating installations capable of developing 208,000 hp.—even more than her estimated 200,000 maximum potential horsepower which can be counted on for six months of the year.

Massachusetts also has facilities for handling a large part of her possible water power—268,000 of the estimated 375,000 maximum. Connecticut has 161,800 hp. in hydro installations, with 165,000 estimated possibility. Rhode Island is conceded but 16,000, of which she is using 12,700.

The United States Forest Service in 1912 estimated New England's water power maximum at 1,605,000 hp., while the Geological Survey in 1915 estimated 1,921,000, with equipment for generating 1,441,000.

New Jersey's hydro-electric installations have a capacity for producing 44,830 hp.; her maximum potential water energy is estimated at 125,000 hp., 35.8 per cent of which is cared for. Delaware and the District of Columbia have a possible 13,000 hp. each and have installations capable of developing 9,000 to 10,000 respectively. Maryland has 145,000 maximum potential water horsepower, and is utilizing 5,500 of this amount (The Geological Survey in 1915 estimated that 27,000 hp. was developed). Contemplated projects on the Susquehanna will give her 110,000 in addition.

Virginia has developed 201,000 of her potential million horsepower from water, and a 20,000-hp. project is planned on the New River. The maximum potential horsepower in each case represents the estimated amount of water power which can be assured during six months of the year.

NEW YORK STATE

New York State has developed more water power than any other state in the country, with installations of one million horsepower capacity and possibilities for three million. These figures are below those of the Geographical Survey estimate of 1915, which supposes a potential 4½ million water horsepower, with 1,320,000 at work. She will, it seems certain, soon be surpassed by California, which is now a close second and can draw upon great sources of power in the mountains.

While some of the Empire State's water will be affected by the new Federal water-power law, yet state and international factors have greater bearing. The treaty with Canada restricting the amount of water that can be diverted from Niagara, and international regulations as to the St. Lawrence, are among the chief deterrents.

An electric power company executive who is quoted in the 1920 report of the National Electric Light Association's Committee on Water Power Development said:

> The bulk of New York State's undeveloped power, about 2 million horsepower, is on the international boundary streams—the Niagara and the St. Lawrence rivers—control over which is assumed by the Federal Government.
>
> Development of Niagara power is restricted by an international treaty limiting the diversion of water from the Niagara River to 20,000 cu.ft. per second, all of which is now utilized. The development of both the Niagara and St. Lawrence rivers is retarded by international questions.

Another New York utility executive says in the committee report:

> The ratio between the developed and undeveloped power in this state is particularly low in view of the great industrial development throughout the state, within easy transmitting distance of very attractive power sites. The reason for this is partly because a considerable portion of the undeveloped power is on the Niagara and St. Lawrence Rivers, ownership of which is disputed by the state and federal governments, and development of which is at present limited by international treaty.
>
> The development of power on streams which are neither interstate nor international boundaries has been hindered by the lack of suitable legislation to make such development possible. Although bills have been introduced in the legislature at nearly every session during the last twenty years, neither party has had sufficient majority over the other to succeed in enacting any constructive legislation which would definitely start development on either basis. What development there is has been effected entirely on private initiative by the process of buying riparian rights, one at a time, and at the seller's price.

Another New York central-station man points out that the larger portion of the undeveloped power from streams within the state is in, or connected with, the State Forest Reserves, which cannot be entered for practical purposes, without a change in the constitution of the state. General economical development of the power possibilities on other streams in New York State cannot be carried out without regulation of flow by reservoirs, to acquire lands for which will require the right of condemnation.

At Niagara Falls less than 10 per cent of the flow is available for power under the treaty with Canada. Of the flow of 210,000 cu.ft. per second, but 20,000 cu.ft. is used, although leading engineers have figured that 60 per cent, or 126,000 cu.ft. per second, could be used without detracting from the beauty of the falls. John L. Harper, chief engineer of the Niagara Falls Power Co., who has carefully studied the problem, says:

> To secure this diversion we have worked out a plan for placing concrete booms in the upper river so as to divert the water from the channel and spread it over the falls to cover completely the rocks that now show through at the edges because of the erosion and wearing away of the channel at the middle of the falls. By the diversion of 60 per cent of the river flow there would be available 3,600,000 hp., and the remaining 40 per cent under the conditions stated would not only discharge ice during winter, but improve the scenic beauty during summer.

THE FAR WEST

Federal legislation governing the use of public lands and reservations is of primary importance to the Western States, in which lie nearly all the public lands, and in which approximately 70 per cent of the undeveloped water power of the nation is found, it is reported by Mr. Griffith's N.E.L.A. water-power committee. In the Western States—California, Oregon, Washington, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming—94 per cent of the possible hydro energy is not yet used. Owing to delay of the construction program during the war, this section of the country finds itself today facing a situation ranging from actual shortage of power to meet demands as in California, to an impending shortage to meet growing demands as in Oregon and Washington.

California leads the Western States, even though far behind its needs, with a present development of 942,000 hp., which is a tenth of both the entire developed water power of the country and of California's possibilities. Her electric-power plants use no coal. Water and oil are employed for all her electricity. Washington shows the largest maximum potential water horsepower of any state in the Union, but it ranks among the Western States below both California and Montana in the amount of developed horsepower, 3.8 per cent of its possibilities. Idaho's entire supply of electricity, except a negligible amount from a few small isolated plants, comes from hydro plants.

The notable success in electrification of a large part of the Chicago, Milwaukee & St. Paul R.R. was facilitated by the use of inexhaustible, comparatively inexpensive water power of the Northwest.

NORTH ATLANTIC SEABOARD SUPER-POWER SURVEY

One recent Washington development which may speed the utilization of Niagara and other sources of energy in the northeastern section is the provision for a Super-Power Survey, with an appropriation of $125,000, which went through with the Sundry Civil Expense Appropriation Bill, one of the last measures passed by Congress this year. It provides for a "special investigation of the possible economy of fuel, labor, and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries."

With any such movement to link up electrical lines, there will undoubtedly come strong pressure to employ to the maximum all available water power. Results obtained from similar projects in the West warrant most encouraging hopes for successful North Atlantic interconnection. One continuous trunk line extends from Southern Oregon, through California, to the Mexican border. Water furnishes the bulk of the power, and electricity is transmitted for great distances at high voltage. The highest-voltage transmission on record, according to the N.E.L.A. committee report, is 150,000 volts over a distance of 240 miles from Big Creek to Los Angeles. The longest high-voltage transmission is over 539 miles from Mono County, Califoria, to Yuma, Arizona, at 87,000 volts and 55,000 volts, by the Southern Sierras Power Co. The Pacific Gas and Electric Co. has in contemplation the building of a 220,000-volt line from its Pitt River plant into San Francisco, while other Western companies are planning similar lines for the near future.

These high voltages over considerable distances in the West show what might be done in the East if similar conditions obtained. The Southern Sierras' 539-mile line, for example, is about as long as the distance from Washington to Boston and nearly twice the distance in a straight line from Niagara to New York. But conditions are far different. All the electricity produced at Niagara or any other large generating center in the East could be used close to its source—if not now, at least within a few years. But if there were interconnection and New York City had a fuel panic, a serious emergency might be averted by temporarily drawing on Niagara. Or a source giving current for factories in Buffalo in daytime might turn out a night surplus which could help light the Great White Way.

The Super-Power Survey has been placed under the direction of William S. Murray, of New York City, consulting engineer, who will report to the Geological Survey. This movement is largely an outgrowth of the development which has been taking place for some years in central-station practice, where interconnection has been adopted whenever feasible in the interest of increased service from a given total plant cost, and of insurance against loss of service through interruption of any one station.

But 9,823,540 hp., or 16.6 per cent, of the country's maximum potential water power has been put to work. Coal and oil shortage and cost are certain to favor the rapid development of the "white coal," now that some governmental restrictions are removed and authorities in Washington are lending a charitable ear to the call of water. It is inexhaustible, except where deforestation cuts down regularity of flow of mountain streams; and the law which opens up water power on goverment reservations does not permit lumbering operations.

Many electric light and power producers, particularly in the East, have no streams to draw upon. But every company with available water power will take full advantage of any help the new law may give, in an effort to keep costs of making electricity from mounting to prohibitive heights.

An Expert in the Design of Large Power Stations

SEVERAL engineers were seated recently around a table in the dining room of the Engineers' Club, New York. One of them, a man of considerable prominence, told of a problem that was confronting his company in the matter of adopting certain designs, the solution of which depended upon a thorough technical investigation and analysis. He was in search of a consulting engineer qualified to solve the problem.

Instantly one of his companions replied: "Engage George Orrok. He will give you an engineering answer that you can feel assured is pretty near correct." The unanimous approval with which this suggestion was received by all those around the table indicated the standing of the man mentioned. George A. Orrok is one of a few men whose experience is closely interwoven with the development in design of the large central power station. Entering the field over twenty years ago as a draftsman for the New York Edison Co. at a time when the central - station industry was in its infancy, equipment was crude and inefficiency reigned supreme, Mr. Orrok applied himself to problems of plant design and was soon made chief draftsman. Recognition of his services came a few years later in his appointment as mechanical engineer of the company, and in this capacity he became closely associated with Thomas E. Murray, consulting engineer and vice president of the New York Edison Co. in the design of such notable power plants as the Waterside Stations of that company, the Two Hundred and First Street Station of the United Electric Light and Power Co., the Gold Street Station of the Brooklyn Edison Co., the Third Avenue and the Williamsburg Stations of the Brooklyn Rapid Transit Co. and the Hales Bar hydro-electric plant of the Chattanooga & Tennessee River Power Co.

Mr. Orrok's success is due to a real love of engineering. The road to success was by no means easy. Illness compelled him to give up his studies in the Massachusetts Institute of Technology in his junior year, and later, when he was actively engaged in the practice of his profession, he was again forced by illness to leave the work which he cherished. A few years in the country, however, aided by his indomitable will, brought back his health, and he was able to again take up a consulting practice.

GEORGE A. ORROK

His time was not entirely occupied in the construction of power plants, however. A variety of engineering work on the design of engines, boilers, condensers, turbines, dry docks, ships, etc., has also received his attention. He is well known in engineering circles as an author and lecturer and has contributed many articles to the technical press. His book on "Engineering of Power Plants," written in collaboration with Professor Fernald, is regarded as an authority on power-plant design. Mr. Orrok was born in Dorchester, Mass., in 1867 and attended the Mather School in that city and the School of Mechanic Arts. In 1885 he entered the Massachusetts Institute of Technology but, as previously mentioned, was forced to give up his college course on account of illness. After spending several months in surveying and investigating mining properties in Georgia, Tennessee and Wisconsin, he returned to Massachusetts and engaged in teaching at Bridgewater, West Springfield and Easthampton. In 1890 he left for Utah and taught for two years at the Ogden Military Academy and the Agricultural College. In 1892 he returned East and entered the employ of F. S. Pearson as draftsman and was engaged on work for the West End Street Railway, Dominion Coal Co., Metropolitan Street Railway Co., Brooklyn Heights Railway Co. and a number of others. He spent about two years in Nova Scotia as resident engineer in charge of construction on various kinds of work for the Dominion Coal Co., the

People's Light Heat and Power Co. and the Halifax Tramways Co., and in 1898 entered the employ of the New York Edison Co.

In 1910 he spent several months traveling through England, Scotland, France, Belgium and Germany on a study of the European engineering practice in connection with power plants and other work. From 1911 to 1914 Mr. Orrok held the position of Consulting Professor of Steam Engineering at the Brooklyn Polytechnic Institute, delivering two lectures every week. He also delivered a course of lectures on the Development of Power at the Sheffield Scientific School. He possesses a fine library of engineering and other books and spends much time in reading and studying. He is a member of the American Society of Mechanical Engineers, serving as Manager from 1911 to 1914; American Society of Civil Engineers; American Institute of Mining Engineers; Society of Naval Architects and Marine Engineers; past president of the Brooklyn Engineers Club, a member of the Technology Club and Engineers Club, of New York, and the Cosmos Club, of Washington, D. C.

Mr. Orrok's hobby is life in the country. He is an enthusiastic angler and camper and a student of nature, particularly of botany and bird life. At least two days of each week are spent on his farm in Connecticut, where he whips the stream for trout and tramps through the woods, keeping the sparkle in his eye and his body and mind in condition so that he can give to his work a full measure of energy and enthusiasm.

Operation and Adjustment of Turbine Machinery-IV
A Few Points on Handling a Turbine

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

TURBINES are not difficult to handle and are often simpler than the auxiliary apparatus connected with them. Like watches or automobiles, both simple to operate, they will give better service when handled in the proper manner. It is necessary not only to use care in starting and running, but also to understand the nature and peculiarities of such machines, so that they can be handled with every possible advantage instead of suffering from bad effects of improper manipulation.

It is often possible to start a machine without warming it up or opening the drains, and bring it up to speed rapidly. A small sized machine could stand such treatment for a while without perceptible effect, but a large, sensitive turbine would be sure to dance a jig that might end expensively.

There is some logic in not wasting time and energy in warming up and bringing to speed slowly, and we are naturally impatient of long, tedious processes. Few men who realize what the conditions are in starting up begrudge the time and care. Rapid heating means unequal expansion strains in the casing, which tend to strain joints and promote leakage. Drum-type rotors tend to run out of true when heated in one place by the steam; wheel hubs expand more rapidly than the shaft, so as to lighten their grip, while the hubs make contact from one to another, and in some cases tend to produce a spring in the shaft. Turbine wheels become distorted, and large diaphragms are liable to crack.

If the drain fails to carry off the water, vibration occurs and often actual damage results.

High-Speed Rotor a Sensitive Element

A spinning top can be picked up and tossed around when properly handled without disturbing its gyroscopic condition, but a misplaced touch would soon make it roll on the ground. A high-speed rotor is also a sensitive element and should not be subjected to sudden shocks of steam, water, change of speed or change of temperature. Always treat it with consideration, so that its balanced forces will not be taxed by any unusual strains.

Each machine has its own personal traits, and the ability to turn just the proper steam on the packing rings and throttle valve while the various other valves are properly adjusted to the correct amount at the first trial, so that the machine will be started and brought up to speed in a smooth, straightforward and positive manner, is an accomplishment that requires some little practice.

Study the Characteristics of the Machine

The "personal acquaintance" has its greater and more important use. Repairs and adjustments must sometimes be made quickly and well and often under conditions of high temperature, bad light and insufficient room. It is the man who knows where to find the proper tools and rigging; how to start the "inaccessible bolt;" where good fits and bad joints are encountered, that puts the job "over the top." Judgment and knowledge of the engineer come into play when it is necessary to keep the machine running with a hot main bearing or to decide how long a faulty governor can be trusted. Such duties can be executed by studying the characteristics of the machines.

An alternating-current generator is one of the simplest machines to handle. There are no delicate adjustments involved, and about the only duty outside of keeping the machine clean is to watch the brushes and see that they function properly. An alternator, like all other electrical machinery, becomes hot when overloaded, therefore the running temperature of the machine should be noted at intervals.

A direct-current generator which runs at several thousand revolutions is, on the other hand, a somewhat delicate piece of electrical machinery. Not many years ago it was regarded in the light of an impossibility to run such machines so fast. Such generators are now being turned out for some services and give the highest class of service. The secret of successful operation lies in the proper adjustment and design, which are done in the factory.

There is little danger that a machine which gives good operation will ever become unsatisfactory if properly taken care of. The life of a machine lies in the brushes and commutator, and the engineer must inform himself regarding the proper grade of brushes and general treatment in operating. Most machines of this character are fitted with soft graphite brushes. Do not put oil or grease on a commutator with these brushes. Wiping the commutator with a clean canvas cloth is necessary only at long intervals. If the commutator becomes worn so as to start bad commutation, it should be ground to a true service without further delay.

Regular Inspections Should Be Made

While in regular operation it is seldom necessary to keep a man in constant attendance on each machine. Turbines are so automatic in their operation that actual attention is required only at long intervals. Some types will run for several days without actually requiring the touch of an operator. The engineer's presence is necessary in operating the turbine as a means of insuring reliability of operation. Maintaining the vacuum, watching the cooling water, bearing temperature and the action of the valve gear are the chief duties. The auxiliaries usually require more attention than the turbine itself. By making regular inspections at intervals of half an hour, one man can look after many machines. These inspections can often be duly scheduled and recorded with advantage.

It is the usual practice to clean thoroughly once a week; many machines are shut down on Sundays only and in some cases less frequently. Everything should be wiped out thoroughly and the brushes and packing glands and other small parts given attention.

Once a month the valve gear should be closely looked over, noting the points of wear. Trip the emergency valve by overspeeding. After the machine has been standing overnight or a similar interval, a quantity of oil should be drained from the lowest point of the oil system. The poorest-quality oil together with any water or sediment will thus be removed. If an amount equal to one-tenth of the contents of the oil system is thus drained off and replaced with new oil, results will be better than changing the entire amount of oil at six-months' intervals. In the former case the quality will be uniformly good instead of allowing it gradually to deteriorate. The oil strainer should be examined once a month. There is seldom sufficient dirt in the system to require cleaning so often, but the reason for this examination is that the presence of small particles of brass or babbitt metal will indicate that there is cutting of the gears or bearings before this condition would otherwise make itself known.

At this time each brush should be lifted from its holder and both holders and brushes wiped carefully. If the commutator slots are undercut, they should be cleaned if dirt is present. Cleaning should be done with a piece of wood or fiber—*never* use steel or other hard material, as it tends to roughen the edges of the bars. If dirt is not present, this operation is best omitted.

Once a year the strainer in the steam line should be inspected to see if there is danger of it rusting to such a point that it would crumble and come through to the turbine blades. The oil pipes should be removed and sediment cleaned from the system.

Valves, shaft packing, bearings and governors will usually give early and unmistakable signs when special attention is needed. The man on watch should report unusual behavior of such parts so that they can be attended to in time. Many conditions occur in operating that could not be enumerated. Many points that have been touched upon will be taken up later in a more thorough manner, as an extended treatment would be necessary to put them forward in a comprehensive way. In operating it is necessary to take full notice of all warnings or symptoms that the machine may give, and it will follow that keeping it in good condition is a matter of reasonable prevention rather than an elaborate cure.

Reminiscences of an Engineer

By W. D. Forbes

It has always seemed strange to me that so many steam engines have appeared, lasted a certain time and then become lost to view. The first small unit that impressed me (it is now out of the running) was the Peter Brotherhood three-cylinder engine. I first saw it about 1873 in Vienna; it made quite a stir in the engine world. The history of its design as it was told me by the nephew of Mr. Brotherhood some years ago is interesting. It is as follows:

While in church, the sermon not being interesting, Mr. Brotherhood fell to making sketches in a hymn book and drew the back of the head of a lady who sat just in front of him. Her hair was done up in three coils and when these were copied a cylinder was drawn in each coil and the original fundamental design of the engine was finished. This engine was made up of three 4-in. cylinders, set radially. It ran at a very high speed for its day, turning up to over six hundred revolutions per minute.

The workmanship was the finest I ever saw in an engine, and it had to be. The pistons were ground in, and the moving parts were of the same weight, making for balance. The cylinders were long, and the brasses on the crank end were made to cover a little less than one-sixth of the crankpin, they all meeting, of course, on the one common crankpin. The heating of these brasses was the only cause of trouble that I met in running any of this design of engine.

Wells' "Balanced" Engine

A year or two before the Centennial, 1876, a Mr. Wells built what he called a "balanced" engine. In the cylinder of this engine were two pistons. The one nearer the front end was fitted with two piston rods and connections having, of course, stuffing boxes, and the back piston had a single piston rod, which passed through a stuffing box in the front piston and through a second stuffing box in the cylinder head. The crank had three pins; two were connected with the rods of the front-end piston, and the pin between these two was connected to the rod of the back piston, the two outside pins being in line with each other and the third pin being in the same plane. This made it possible for the engine to catch on its center as would a single cylinder unit.

I ran an engine of this type, the first, I think, ever made, at over 600 r.p.m., while resting on a common deal table, and neither the table nor the engine was fastened down in any way, showing a fine balance indeed. Some years later Justin R. Wells took up the manufacture of this engine and quite a number were sold; the last I saw was in the steam yacht "Giralda," and it was doing good work.

About this time, I believe, I was shown an engine in England which I was to'd ran 1,000 turns per minute. It was called the Tower spherical engine. I was not shown a drawing or told how the engine was designed, but drawings of it came out later in *Engineering*, of London. The engine was designed on the idea of supporting spheres at their central lines, with a segment cut from each which left a space for steam. This engine ran without noise and with almost no vibration, but it did not seem to take in the market as was hoped.

A small engine and boiler were put on the market in the middle seventies known as the Baxter. It was a most satisfactory combination and I think it was about as well designed a power plant as I ever saw. The engine was set on top of a vertical boiler, not in the usual way of being just perched thereon, but the cylinder was set vertically into the boiler with the result that the heat of the boiler kept the cylinder hot, which made for economy; in fact, it was a boiler-jacketed cylinder. I got very good results from one of these engines, so good in fact that the builders doubted the results at first. I think the engine and boiler were made in Paterson, N. J.

When the electric light came into being a number of horizontal engines appeared which were in some cases widely sold. The main trouble with about all of these electric-lighting engines was the governing, and some were made that were wonders to look at. One designer of these governors told me that all would work well in his shop, but not one would govern after being sold.

Before the electric-light era out West there were made, and perhaps still are made, the oil-well engine, and they were sold at a price that was so small that often they were left in the fields when a dry hole was drilled, as it did not pay to haul them to new fields over the very bad roads and rough country. These engines were a sight, decorated in a way that provoked mirth in those who knew fine engine work. For instance, the cylinder back head was supplied with rough nuts for the studs and these nuts were often gilded and decorated with pictures of ladies with the most remarkable physical developments.

THE STRAIGHT-LINE ENGINE

The "straight line" engine was a delight to see run, and it was more than a pleasure to go where it was made and meet that prince among men, Prof. John E. Sweet. Why this engine did not sell better is something which surprised many.

The number of freak engines that a man has seen who has been in the engine line for the last forty years would total a considerable figure. It was rather a poor week if at least one was not brought to an engine builder. Some of these were turned into other channels and did very good service as blowers or water meters.

Besides the various engines I have named there was a host of others, some of most excellent design and workmanship, which faded away, some because of poor management and others from lack of funds. Now we have the steam turbine, which is gaining ground all the time even in small sizes, although the economy of the latter is not all that is wished. Although the internal-combustion turbine does not look like a possibility, it would be a bold man who would say that anything in the mechanical line might not be accomplished.

I know there are many who consider steam as a back number for power, but if I had stock in a good boiler works I would not sell it just yet. In fact, I am of the opinion that we will see more and more boilers and steam engines used, and the advance, I expect will be in the more economical use of fuel under the boiler and also a great advance in the steam engine whether it be of the old or new type.

As the cost of fuel rises we shall all have to cut corners as never before. There are small steam prime movers that are far more economical than those now used in this country, and only the cheap fuel obtainable here has kept them out of our market. However, with the advance in fuel cost these economical engine designs will find favor in the sight of the engineering world and purchasers will be willing, in fact forced, to buy these designs of coal-saving engines, but I know from my own experience that the American market will not take them despite their superior economy so long as cheap fuel is obtainable.

THE CROSS-VALVE ENGINE

The readers of *Power* may be able to give some further information as to an engine which was most interesting to me away back in 1883 or 1884. I lost sight of it as I left Bridgeport soon after it was set up. The engine was built by a man named Webster and I think he called it "a cross-valve engine." The steam valves were set vertically on the side of the cylinder and they were of the Corliss type with some new idea of doing away with the dashpots. The exhaust valves were o the same type, but set horizontally; these valves were worked by the piston striking them, in fact by tappets The steam valves were driven by an eccentric. The engine was horizontal and I think was supposed to be about 75 hp. and made some 60 r.p.m. The interesting thing about the design was that the two exhaust valves were placed so that when the piston was at the end of the stroke the valves were back of the piston.

This, then, was the idea of the present "Uniflow" engine. The steam entering at the crank end of the cylinder was exhausted at the back end of the cylinder thus making a continuous flow of steam. At that time the late President Morton of Stevens was making city light tests and the Webster engine was one of those supplying power. Prof. Richards, of Yale, was indicating the engines of the lighting company and the Webster engine interested these gentlemen and severa others. All objected to the system of actuating the exhaust valve, but the continuous-flow idea did not seem to interest any save a Mr. Wilmot, who was a manufacturer and not an engine man.

He liked the continuous flow idea and called on m several times with a view of my interesting some of my friends in experimenting further, but I left Bridgepor and as far as I know nothing further was done by Webster in engine building.

The difficulties in the way of providing proper lubrication for compressed-air machinery are largely due t the extreme high and low temperatures to which th lubricant is exposed, and, in the case of the compressor to the fact that oil when in contact with heated ai may deteriorate and become a source of trouble unles proper precautions are taken.

EDITORIALS

Overcoming The Cinder Nuisance

ANYONE who has had experience with large boilers that are operated much above rating is familiar vith the cinder nuisance. Large quantities of half-ourned particles of coal and some ash are carried by he high-velocity gases through the boilers and up the tack. These particles may be solid coal, but usually ire more open and porous, like coke. The effect of this inder shower on neighboring property is oftentimes erious and leads to suits in court. These cinders also ncrease the quantity of dust in adjacent streets and ead to unnecessarily high laundry bills. The cost of he cinder nuisance is often very indirect.

Many attempts have been made to install various orms of cinder catchers with more or less success. A few years ago *Power* described a wet-cinder catcher hat was installed at the Waterside Station of the New York Edison Company. This was effective in catching inders, but the metal parts were quickly corroded and he cooling of the chimney gases had a serious effect on he draft. The water was therefore cut off and the quipment used as a less-efficient cinder catcher. Various similar devices, consisting of baffles and cinder oppers together with cyclone separators, have been ried with a measure of success in many plants.

However, all such dry catchers permit a certain mount of cinders to pass through and up the stack. The gases are diverted downward by placing a baffle n their path. The cinders are supposed to continue ownward into the hopper, but to do so must pass hrough the current of gases, which now has an ncreased velocity in passing through the constricted rea under the baffle. This stream of gases picks up certain amount of the cinders and carries them along nstead of allowing them to settle.

What promises to be a satisfactory cinder catcher is ow being tried out in a New England plant. It is esigned so that the cinders are properly separated rom the gases and are allowed to drop into the cinder oppers without getting into the gas current again. Furthermore, it is claimed that this new cinder separator causes less loss of draft than any of the older orms of baffles. Its performance will be watched with nterest.

Cinders are removed in various ways from cinder oppers. When gravity cannot be employed, possibly the team-jet conveyor is the cheapest and simplest. These inders are said to have a heat value per pound about fty-five per cent of that of the coal used. They therefore form a low-grade fuel that should be utilized in the lant. In some places they are mixed with fresh coal nd again fed into the furnace. It has been proposed mix the cinders with some bituminous coal, to pulverze the mixture and to burn it as powdered coal under ne of the boilers specially arranged for this purpose. This latter method may be possible in large stations, but n small plants the best plan seems to be to wet down the inders and mix them in with the fresh coal.

Future Prospects of Increasing Thermal Efficiency

ONE of the great problems before the nations of the world today is the more economical production of power. Practically every civilized country is considering this question on what might be termed a national scale. Fuel is mounting higher and higher in cost and becoming more difficult to obtain, and since a very large percentage of power must be produced from fuel, it is paramount that the most economical means be employed in power production. With all of our boasted high efficiency in power-plant machinery and its operation, twenty per cent is about the best over-all thermal efficiency that is possible with our most economical turbo units. Seventeen or eighteen per cent is a fair average under the best operating conditions. Figures based on reports obtained from over three thousand central stations give an average of three pounds of coal per kilowatt-hour—the most economical plants are operating on about one and one-half pounds. Taking the figures for the most economical stations will give an over-all thermal efficiency for the plant from the coal pile to the switchboard of around fifteen or sixteen per cent. This being the case, the question naturally arises, What are the future prospects of increasing the thermal efficiency?

It has been estimated that with steam at three-hundred pounds, and five-hundred and twenty degrees superheat, used in a turbine operating on twenty-nine inches of vacuum and eighty per cent Rankine cycle efficiency, a kilowatt-hour may be produced on eight pounds of steam. Even this, which is a theoretical condition and not an average operating one, when it is possible of attainment, will utilize only about twenty-five per cent of the heat in the steam, which does not include the boiler-room losses. Experience with steam at seven-hundred degrees Fahrenheit indicates that very difficult mechanical problems must be solved before much higher temperatures can be used.

The tremendous heat losses in all central stations are in using the steam after it has been exhausted down to the pressure at which it goes to the condenser. From the temperature at which the steam enters the turbine down to exhaust pressure the thermal efficiency is nearly one hundred per cent. However, when we attempt to convert the heat in the low-pressure steam into power, the largest portion of it is thrown overboard in the circulating water. The problem therefore reduces itself to one of better utilizing the heat in the exhaust steam.

Where a turbine can be used between a high-pressure boiler and a low-pressure heating system, it operates at a thermal efficiency of approximately ninety-five per cent. This being so, and being done, why not apply this scheme wherever possible? If, instead of concentrating several large units in one great station in our large cities and industrial centers, these stations were divided up and distributed, in a number of locations advantageous for supplying a heating load in winter and operating condensing in summer, for about seven months of the year the thermal efficiency of the turbines would be around ninety five per cent. Even if for the remainder of the year the plant was operated condensing, the average yearly thermal efficiency would be raised from seventeen or eighteen per cent for straight condensing operation to forty or fifty, and probably higher, for the combined power and heating load. There is also the possibility, by a wide use of the absorption system of refrigeration, of using a large percentage of the exhaust steam the year round. Such a project would still allow the installation of units of the most economical size, but instead of being concentrated in one plant, they would be installed in several plants. These plants being tied together electrically as well as on the exhaust system, would require very little more reserve capacity than at the present time. Of course it is doubtful if heat and refrigeration could be supplied to any other than thickly settled communities and industrial centers. Even under these conditions the exhaust-steam requirements would exceed the demand for power.

In this project, as in any other, there is the all-important question of the increased revenue paying a reasonable return on the additional capital investment necessary to install and maintain heating equipment. This in certain districts has already been done, but the high price of coal has made possible the installation of fuel-saving means that a few years ago could not be considered from a financial standpoint. There is also the question of the heating load synchronizing with the power load. Experience teaches that no one particular method of power generation offers a complete solution of the problem of supplying cheap power. The proposition suggested in the foregoing, like all others, will have to be analyzed for each locality, but the possibilities it offers for fuel saving make it worthy of more serious consideration in the future than it has received in the past

There are tremendous possibilities for coal saving by electrifying our railways, developing our water powers, etc., but after this is all done our method of utilizing the heat in fuel will be just as uneconomical as it is now unless we adopt some method in power generation radically different from that employed in our large power stations at the present time, although this represents the highest development in the art. The problem of the future is not alone the economical utilization of power, but a more economical generation.

Electric Arc Welding Machines

ELECTRIC arc welding at present is in about the same state of development as the electrical industry was some twenty or twenty-five years ago; there are as many schemes for performing the same function as there are concerns manufacturing equipment, and each has its own advocates. In general, electric arc-welding equipment can be divided into two classes, constant-potential and constant-current machines, but the methods of applying these principles are numerous. This lack of standardization is due probably more to an absence of what the requirements actually are in a welding circuit than anything else. Although extensive experiments have cleared up many of the doubtful points, there are still many features open to discussion.

In its simpliest form an arc-welding circuit consists of a constant-potential source with sufficient resistance in the circuit to reduce the voltage at the arc to about twenty volts and also to stabilize the arc. However, such a scheme in general is inefficient on account of the losses in the resistance. To eliminate some of these losses and other features, many so-called variable-voltage constant-current generators have been developed. In these the terminal voltage automatically varies in an opposite sense to the current, to overcome the inherent unstable characteristics of the arc. There have also been developed a number of alternating schemes of both the constant-potential and constant-current types.

While all this development has been going on, the application of electric arc welding has been making tremendous strides, and at present welding machines have become part of many power-plant equipments; or, if not a part of the actual plant equipment, their use has become very general about the plant.

To give *Power* readers a general idea of the operation of a number of arc-welding machines that are now in use, a series of four articles, by L. W. Webb, will be published in this and subsequent issues. All the machines described possess advantages and disadvantages, which depend more upon local conditions as to their use than upon any merits or demerits in the individual machines themselves. One point brought out by Mr. Webb that is of particular interest is that supplying a large percentage of the power input of the machines at the arc should not alone be the deciding factor in selecting an equipment, as a machine operating at a considerably lower efficiency may show a lower cost of work produced than a machine of higher power efficiency, simply because its characteristics make it possible for the operator to do good welding at a higher rate.

Following Up on Repairs

THE importance of following up closely on power-plant maintenance work, also on inspections of equipment, is well shown in a brief paper elsewhere in this issue by Frederick L. Ray, for many years chief operating engineer in public-utility plants.

The author mentions, among other things, the timely renewal of steam-turbine blades. It happens that a turbine now and then loses a blade or part of a row without interrupting its service. The dismembered parts clear and fall away, doing no damage other than to the wheel to which they belonged. This is usually the case where the blades and diaphragms are sound and reasonably free from erosion. Turbine blades do not have to become considerably pitted to seriously impair the efficiency of the machine; if the edges, particularly, are "bitten away," as the operator aptly expresses it, the economy of the turbine is badly affected. If removed soon enough, such blades give little or no trouble and the cost of lowered efficiency does not become excessive.

Mr. Ray also calls attention to the importance of reasonably frequent inspections of the thread where the piston rod screws into the crosshead on old engines. The number of accidents from failures of these parts in the author's own experience, together with others, again directs the mind to the subject of fatigue of metals. The mechanical world is not getting the facts on fatigue fast enough. The slow failure, or weakening of metals in machinery and structures is of tremendous importance, and engineers must know more about it if they are going to control.

CORRESPONDENCE

Where Should the Beginner Start?

What has become of all the first-class firemen within the last five years? This I believe must be a pertinent question, considering the number of inquiries heard for some time past, and it leads one to consider the subject in its different phases.

I may have been more fortunate than others, judging by the many times I have heard, "Does anyone know where I can get a good fireman?" Because of the many complaints registered against men in the boiler room who claim to be firemen, and judging by some I have seen in different plants, I can readily believe that many of the complaints are justified.

I heard the chief of a large office building say that he would not allow a boiler to be cut in or out excepting when he was there to see that it was properly done, and that he found it necessary to oversee other details of operation that would have been subordinated to the firemen if they had been competent.

At a meeting of our association two members told of attempts made by their firemen to cut a dead boiler onto the line, one being frustrated by the timely appearance of the chief and the other by virtue of there being a non-return stop valve on the boiler. Another engineer told of his fireman removing the manhole dogs and trying to force in the manhole plate with 40 lb. pressure on the boiler. These men were hired as good firemen and were receiving the pay of first-class men.

Many of the younger firemen entered various branches of the service during the war, and many left to work in munition factories for the higher wages offered, but the bottom has dropped out of that industry and although we should be getting some of them back, they do not generally seem inclined to come.

I have had reasonably good success in breaking in likely young fellows who were interested in power-plant work and who were willing to study and learn, and I find that they can be readily molded into my ways and methods. New men must be broken in for power-plant work to take the places of those dropping out, and the question arises whether the new beginner should start in the boiler room, as at present, and advance to the engine room, or whether it would be better practice to start him in the engine room and advance him to the boiler room. It seems to me that the latter practice would be the better.

A young fellow entering the engine room first would be right in his element, if he is of the right sort. He likes to see the wheels turning and to start and stop the engines and operate the switchboard, all of which is pleasant and agreeable to a beginner.

In the engine room there is more to engage and hold his interest, and to him, the job looks more responsible and perhaps more dignified than shoveling coal and cleaning fires. This view of the situation, of course, is a fallacy, and he has yet to learn that the man with the scoop shovel, if he is a good fireman, is performing work that calls for better judgment and requires more experience to acquire the necessary results and efficiency than the engine-room work.

I believe that seven out of ten young fellows starting in the engine room would stick it through the boiler room, while not more than three out of ten starting in the boiler room would stick long enough to reach the engine room.

Many of our most successful engineers have started in the boiler room and by perseverance have risen to high positions; but the old order of things has changed materially with modern practice, and I believe this subject warrants consideration if we are to get and keep the right material with which to make the future engineers.

Considering another side, Is the beginner today worth more as a beginner in the engine room or the boiler room? The engine-room equipment has reached a high state of development and needs relatively little care or attention that cannot be delegated to a bright beginner under the supervision of the chief or a watch engineer.

Here he can gradually absorb a general knowledge as to the use of steam and its application in changing heat into work. He will also have an opportunity to study combustion and the generation of steam and will have ample chance to get the rudiments of boiler-room practice and the principles involved in the efficient burning of coal. Then, when he finally advances to the boiler room, it will be with a realization that he is being promoted, and he will be better able to appreciate the qualities necessary in the making of a first-class fireman.

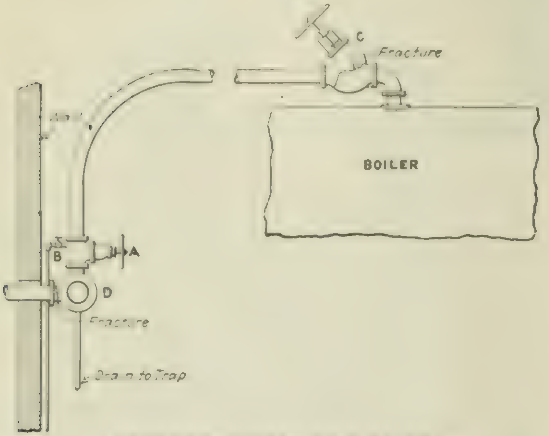
The price of coal has steadily advanced to a point where careless and wasteful methods in its use are giving us all serious concern, and we must look to proficiency in the fireroom to keep this waste down to a minimum. One sure way to defeat this purpose is to put the coal pile in charge of inexperienced beginners. The duties assigned a beginner in the engine room do not present the opportunity for wastefulness, nor do they call for as much responsibility as in the boiler room.

Given your choice between an experienced and an inexperienced fireman, which would you choose? If you had a position open for an oiler or engine-room attendant, would you hire an experienced operating engineer or break in a beginner? J. A. LANE.

Windsor, Conn.

Water Hammer Fractured Valve

One morning recently a rather serious accident happened at the Vicksburg (Miss.) Light and Traction Co.'s plant. The operator was ordered to put in water and fire up No. 4 boiler. The 7-in. gate valve *A* had been closed in order to make some repairs on a 7-in. lead. The drain valve *B* was left shut. After the water was up to the proper height and before the fire was started, the operator opened the 7-in. gate valve *A*, neglecting to open the drain valve *B* first. About three minutes later a serious water hammer was heard and the automatic stop check valve *C* was fractured, as shown, throwing the top half, together with its bend, up through the roof and breaking off the neck of a 10 x 6-in. cast-iron tee that was bolted to the 10 x 7-in. tee.



WATER FRACTURED STOP VALVE

Although no one was injured, it shows conclusively that it is dangerous to place valves in vertical lines, even though drains are provided. All the steam and water from the other boilers delivering steam to the 10-in. header *D* escaped through the breaks and the whole plant had to be closed down until repairs could be made.

H. T. Fryant.

Memphis, Tenn.

Character of Sulphur Dioxide

An article by H. J. Macintire on refrigerants, in *Power*, June 8, page 914, has been called to my attention. I understand, of course, that Mr. Macintire merely attempts to hit a few of the high spots in his subject. Such brevity, however, invariably leads many writers into making general statements that may convey erroneous impressions. In his article I particularly refer to the sentence, "Sulphur dioxide and ammonia are deadly in small quantities if relief is not immediately obtained."

I am basing my right to be critical on my former experience as chief chemist for a concern manufacturing domestic electrical refrigerating machinery using sulphur dioxide as the refrigerating medium and my present work as production manager of a plant manufacturing anhydrous liquid sulphur dioxide. My reason for being critical is that I dislike to have wrong impressions disseminated about a chemical that has been condemned too freely, when my experience shows it to be quite well-behaved and not obnoxious to handle or work with. In fact, it is decidedly not a dangerous chemical.

To refer to the sentence quoted, it is not logical to put ammonia and sulphur dioxide in the same class. The use of the term "deadly" is rather sweeping and does not apply to sulphur dioxide. To the average reader the expression "small quantities" might mean anything. The last of the sentence, from the way it is worded and the apparent idea of the whole sentence, brings to mind immediately a picture of first-aid kits and stretchers. The author probably had good intentions, but this sentence is certainly misleading to a harmful degree.

I would appreciate hearing from Mr. Macintire regarding the points I have brought up.

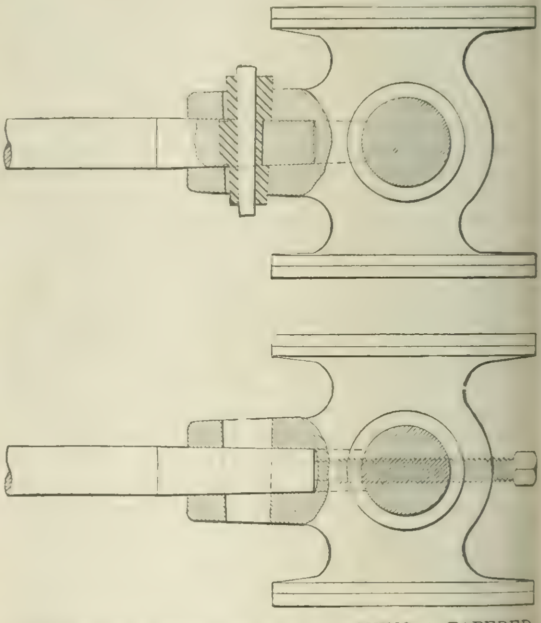
H. V. Highley,
Ansul Chemical Co.

Marinette, Wis.

Removing a Tapered Piston from Crosshead

Loosening a piston rod from a crosshead, when a tapered end and key is used, as mentioned on page 897 of the June 1 issue, is sometimes more of an undertaking than one who has never had the work to do might realize.

At times it is necessary to heat the crosshead before the taper can be started, and then a special key and followers or gibs are used, as shown in the top view of the illustration. I have had to build a fire of waste and oil under a crosshead, of the double-guide type, carrying a 10-in. rod, and sledge the key with a 14-lb. hammer to start it.



TWO METHODS EMPLOYED IN REMOVING A TAPERED PISTON ROD

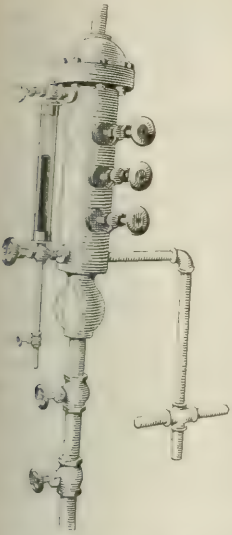
On small engines we put in a false wristpin with hole tapped for a setscrew and start the rod with the jack so formed, as shown by the bottom view.

C. W. Peters.

New York City.

Plugs in Water-Column Connections

In the June 22 issue of *Power*, page 1014, Charles W. Carter, Jr., comments on my using brass plugs in water-column connections. In reply I would say that Mr. Carter is slightly misinformed. The water column in question was not connected to the boiler as illustrated, but as shown by the accompanying sketch. We always remove the plugs when washing out the boilers, and we find hardly enough dirt or sediment to soil the fingers. It will be observed that there are two globe valves in the water-column blow-off. I used to have but one valve with the consequence that when it began leaking, I could not put in a new disc or repair it until the boiler was shut down for washing out. In the meantime, if it was very bad I had to disconnect the pipe and plug it up or put in another valve below the one that was leaking. The last time it was necessary to use a second valve. I left it connected and have had no trouble since.



WATER COLUMN PIPING

Hasbrouck Heights, N. J. **Geo. J. Little.**

Industrial Unrest

After reading Mr. Peters' article, "Industrial Unrest," in the issue of June 29, and reading again my article to which he refers, I cannot refrain from writing the following:

If Mr. Peters is working on his job sixteen hours a day it seems to me that a raise of 100 per cent in salary would be a very insignificant increase, as he is undoubtedly doing two men's work, as practically all fair-minded people, including those who go to make up the governing body of this country, have recognized eight hours as being the best and most logical duration for a work day.

He states that it is no farther to the "boss's" office han it is to his office. That is a fact, but after a man as gone to the boss's office two or three times and ailed to get an audience, then the relative distance hanges. I resent the inference that I may have been vanting in courtesy, as there is no statement in my rticle that justifies him in the assumption that I was r that I advocate such a thing. While I did not even int that I went to any boss dirty, greasy or in filthy othes, I will admit that I have done such a thing and as welcome, because the grime came from the performance of duty and it was necessary to go at that rticular moment. As to going to him in my overalls at were "paid for," I have done that, and really expect do it again, and can see nothing discourteous in ing it. They are my uniform, and there is no more ason for changing than there would be for a soldier tting on officers' clothes when he had to be in the esence of his superior.

I am sorry that Mr. Peters overlooks the point I intended making, which was simply that there is not enough confidence between employee and employer and that, to a great extent, it is of the employee's making and could be easily remedied if the two would get together in a heart-to-heart talk. The illustration used was to show that when one has a chip on his shoulder it is easier to talk to the boss, and he will generally be found fair. After reading my article this is all that I can see in it, and as Mr. Peters says he wants the young men to see both sides of the issue I would be glad to have him tell what the other side from mine is, for his article does not present any other side that I can see.

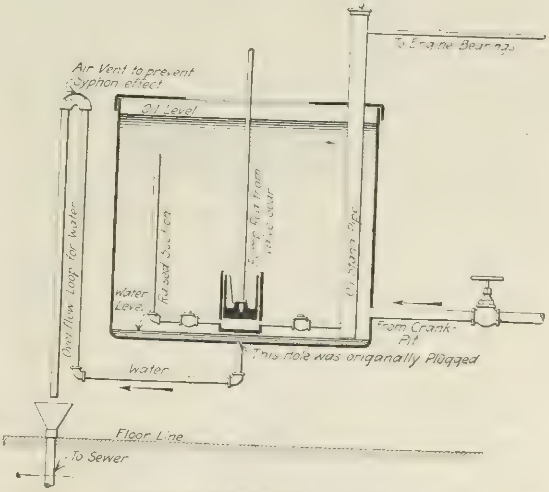
I talk to my "boss" daily, not in overalls or with dirty hands or face, for I expect to wear overalls about as few times per year as any engineer in this city, but I contend that they are honorable, serviceable and very convenient. I also stick to the statement that a man is no better than he thinks he is; that "as a man thinketh in his heart, so is he"; and because a man by merit, pull or accident happens to be my superior in position does not make him my superior personally, and the right kind of "boss" is generally treated with courtesy in any event.

H. A. Cranford.

Memphis, Tenn.

Improves an Oil System

Here is a sketch showing some improvements I made to an oiling system, which have given satisfaction for several years. The engine came equipped with an oiling system as shown by the sketch. The suction of the pump caught all the water and sediment and soon made an emulsion of the whole oil-tank contents. Every little while I had to change the oil, filter and separate out the old oil in a separate apparatus.



IMPROVEMENTS IN OIL SYSTEM

I raised the suction opening and added the complete overflow, and the water now flows out over the loop, carrying with it the sediment that settles to the bottom; while the raised suction gets the pure, best oil from near the surface. **R. Manly Orr.**

Vancouver, B. C., Canada.

B.t.u. vs. Kilowatt-Hours per Ton of Coal as Measure of Efficiency

In commenting on power statistics issued by the United States Geological Survey, the writer, in the May 4 number of *Power*, took exception to the use of kilowatt-hours per ton of coal as the measure of station efficiency of public-service corporations furnishing miscellaneous services besides power. It was suggested that thermal efficiency be used as a measure of the station's economy or that public-service corporations be divided into two groups: One purely power service companies, the efficiency of which could be expressed in kilowatt-hours per ton of coal, and the other group stations furnishing power and other services for which some other standard might be adopted for efficiency measurement. An example was given to show that in the case of two plants, one furnishing power only and the other power and heat, the first could produce five times as many kilowatt-hours per ton as the second and yet be only one-fifth as efficient, when the comparison was made on the basis of the heat utilized.

It was stated also that the large differences in efficiency shown by the data furnished were not actual, the apparent difference being due largely to the standard adopted for measurement of station efficiency, kilowatt-hours per ton of coal, regardless of the kind of service furnished. R. S. McBride takes exception to the foregoing comment as follows:

> Mr. Misostow evidently was under a misapprehension as to certain facts with reference to these figures. He apparently believes that a considerable amount of fuel reported in these figures was used for purposes other than power production.
>
> As a matter of fact it is doubtful whether more than 10 per cent of the fuel used in any state by these companies reporting was consumed for such auxiliary uses as are mentioned in Mr. Misostow's comments. It seems very unlikely, therefore, that anything more than a negligible percentage of error could be introduced from this cause, even if all the companies reporting made the mistake of including in their reports all fuel, instead of only that fuel used for generating current. . . . There is no doubt that some of the exhaust is used for auxiliary purposes, but under the circumstances no large difference is probably caused by this fact.

The United States Geological Survey has done good work and has the public's confidence. The best intending public make use of the material published, and often for purposes entirely different from those for which the data have been collected. Data so furnished are expected to be impartial, adequate and entirely reliable, and in cases where the information is not as they wished it, due to no fault of the department, explanatory remarks should be furnished for the guidance of the public.

As no material could be more reliable or impartial than that furnished by the United States Geological Survey it is to be regretted that the data have not been compiled in such form as to be usable for establishing fuel cost per kilowatt-hour and for the establishment of rates, or in cases of emergency for apportioning fuel to the various public-service companies. Such data might also be used as a guide for directors of a corporation in judging of the ability of their engineer to utilize fuel to the advantage or disadvantage of the company.

As to super-stations (the significant future of which is only size and location) solving the power problem, this is an old dream, and a dream it will remain. The super-station of today will be a commonplace of tomorrow, as it has been in the past, but as long as the stations are built with condensers at one end and long transmission lines at the other we must continue to dream until these two monsters consuming the major part of the energy in the fuel are eliminated. Then a real and sane solution of the power production problem may be accomplished.

Chicago, Ill. HENRY MISOSTOW.

Burning Screenings Under Adverse Conditions

I have just read the editorial on "Burning Coal Under Emergency Conditions," in the July 20 issue of *Power*, and I hasten to tell your readers of a solution of such a problem in an Iowa city in a boiler plant having the McNillan furnace under return-tubular boilers, set about 54 in. from the grates, and with a chimney having a height of a ten-story office building. This plant has been using for years the local coal as found around Des Moines, and last winter during the coal shortage, when the Government directed to Iowa several thousand tons of anthracite screenings and buckwheat and also coke breeze, the engineers as well as the manufacturers in this part of the country were in a serious dilemma.

After many trials on the part of many good firemen, in this particular plant under discussion, there came one who wanted to try his hand at burning the anthracite screenings. As soon as he had seen the general construction of the furnace, he filled the side openings full to overflowing with the screenings and fired all the time through the front door, firing but one shove of coal at a time, and that well spread. No failure in steam was noted, and the building was kept in operation continuously by the maintenance of a clean, clear thin fire, using the shaking grates only slightly so as to remove the small amount of ash that resulted.

I wish someone would tell how to burn these coals with good results in marine types of boilers, also with water-tube boilers that are set high from the grates.

Cedar Rapids, Iowa. ROYAL H. HOLBROOK.

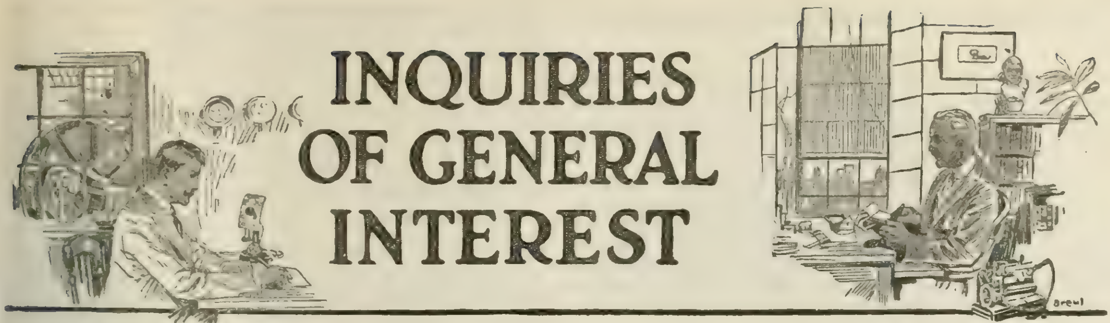
Cleaning Apparatus for Generator Winding

On page 878 of the June 1 issue of *Power* I notice a description by F. C. Williams of a cleaning apparatu for generator windings. I wish to say that the apparatus as described by Mr. Williams is not only contrar to the rules of the Underwriters, but it is exceedingly dangerous to mix air and gasoline for suc purposes.

A vapor of gasoline in air is highly explosive, an any flame such as might happen through sparking o the machine or through defective operation of controlling apparatus might cause an explosion costing fa more than a first-class air-compressing outfit.

Chicago, Ill. H. E. WEIGHTMAN.

Do not assume the idea that the steam after passin through the engine is wasted. It is not, because i represents the largest percentage of heat delivered b the boiler, and much of the heat can be retained.



INQUIRIES OF GENERAL INTEREST

Disadvantages of Excessive Lap of Corliss Valves—What are the disadvantages of excessive lap on the steam valves of a Corliss engine? F. E. A.

Excessive lap reduces the rapidity and amount of movement of the valve at the point of opening, and also diminishes the range through which the engine will cut off.

Overtravel of Value—What is meant by overtravel of an engine valve? R. L.

The overtravel of a valve is the distance the outside edge of the valve passes by the inside edge of the port; or in other words, the amount of movement that takes place in excess of the movement necessary for completely uncovering the port.

Head and Back Pressure of Refrigeration System—What is meant by the head pressure and the back pressure of an ammonia compression system of refrigeration? H. B. C.

The head pressure in an ammonia system is the pressure at which the gas leaves the compressor. The back pressure is the pressure that is maintained in the expansion coils and the return system to the compressor.

Operation of Injector—How is an injector enabled to force feed water into a boiler and overcome the same or a greater pressure than the pressure of steam supplied to the injector? C. G. T.

The steam supplied in passing from the high pressure in the boiler to the low pressure in the injector chamber expands suddenly, and part of its heat energy is converted into energy of motion. When condensed by contact with the cool water the steam gives up part of its heat to raise the temperature of the water, but retains enough of its kinetic energy to carry along the water against the boiler pressure.

Isothermal and Adiabatic Expansion—What is isothermal expansion and adiabatic expansion? W. E. L.

When a gas expands it performs work. If expansion takes place at a constant temperature the gas is said to expand isothermally, and in order to have a constant temperature during expansion it is necessary to supply heat from some external source to compensate for the heat converted into work. This might be done in a steam engine by means of a steam jacket around the working cylinder.

A gas expanding in a non-conducting cylinder is said to expand adiabatically; that is, "no heat passing through," and its temperature will fall during the expansion, since no heat is supplied to take the place of that converted into work. This condition is probably never realized in practice, but is approximated when expansion takes place suddenly, as there is then little time for conduction of heat.

Equalizing Cutoff of Corliss Engine—How is the same point of cutoff obtained for opposite ends of the cylinder of a Corliss engine? C. R. T.

Make a mark on the crosshead and corresponding marks on a guide when the piston is at each end of its stroke, and another mark on the guide to indicate where the mark on the crosshead will stand when the piston is at one-quarter stroke from each end of the cylinder. With the wristplate hooked up and the governor blocked to the average running height, place the piston at one-quarter stroke from either end and adjust the length of the governor reach rod to the valve on the same end, so the valve will be just tripped when one-fourth stroke is reached. Then turn the engine over slowly and observe whether cutoff takes place as the piston is brought up to one-fourth stroke from the other end of the cylinder. If cutoff takes place too early, lengthen or shorten the governor reach rod to the valve of the same end so that it will not take place until after one-fourth stroke or if cutoff was found to take place too late, gradually adjust the length of the reach rod so the valve is just tripped when the piston is brought up to one-fourth stroke. If there is a single reach rod from the governor with a link connection between the valves, adjustment should first be made of the rod that has direct connection with the governor. When adjustments are made, test the equality of cutoff when the governor is blocked a little higher and also when blocked a little lower. On account of variation of angular position of the governor connections, it is impossible to make adjustment that will obtain exact equalization for all positions of the governor, but when made for any particular position, equalization for the average load can be made by adjusting the cutoff of one end of the cylinder checked by indicator diagrams.

Horsepower Constant of Engine—What is the horsepower constant of an engine having a cylinder 22½ in. in diameter and 42-in. stroke with piston rod 3 in. in diameter and running 85 r.p.m.? W. L. G.

The horsepower constant for each end of the cylinder is the number of indicated horsepower developed by 1 lb. mean effective pressure, and therefore, to express horsepower constant, the usual formula

$$hp. = \frac{P \times L \times A \times N}{33{,}000}, \text{ becomes } hp.c. = \frac{1 \times L \times A \times N}{33{,}000}$$

By substitution, the horsepower constant for the head end of a 22½ x 42-in. engine, running 85 r.p.m., is found to be

$$hp.\ c. = \frac{1 \times \frac{42}{12} \times 22\frac{1}{2} \times 22\frac{1}{2} \times 0.7854 \times 85}{33{,}000}$$

$$= 3.584\ hp.\ per\ lb.m.e.p.\ for\ H\ end.$$

Allowing for a 3-in. diameter piston rod, the horsepower constant of the crank end is found to be

$$hp.\ c. = \frac{1 \times \left[\frac{42}{12} \times (22\frac{1}{2} \times 22\frac{1}{2}) - (3 \times 3)\right]}{33{,}000} \times 0.7854 \times 85$$

$$= 3.52\ hp.\ per\ lb.m.e.p.\ for\ C\ end.$$

The h.p.c. for use with the average of the m.e.p.'s of both ends would be, 3.584 + 3.52 = 7.104 hp. per lb. average m.e.p. of both ends.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Experience in Power-Plant Operation*

By Frederick L. Ray†

Accidents cannot always be prevented, for hidden defects will develop to the breaking point before they can be detected. Proper inspection, however, will prevent most accidents, and careful planning for the future will eliminate 90 per cent of what inspection fails to find.

The cost of maintenance work can be lessened by doing the work before the life of the material is gone; but a great cost can be burdened on a property by replacing machinery just because it has been in service for a certain number of years. We are justified in replacing the axles of the high-speed interurban cars after they have been in service for a given number of miles, for we know by experience that there is an average life of an axle beyond which we should not go because of the danger to life and property if they should break, but we would not be justified in replacing all the tubes of a boiler just because they have been in service twenty years, for they may give many more years of service. Even if one should give way, it seldom results in more than the loss of the one tube.

The renewal of a few rows of blading in a turbine at an expense of, say, $2,000 may easily prevent an accident in which perhaps it will ruin all of the blading and cost many thousands of dollars, with possible interruption of service.

How much better it is to take a boiler off at stated intervals, thoroughly testing, cleaning and repairing so that when it goes on it will be in first-class order, than to keep operating it until the efficiency drops to 30 per cent or a tube splits wide open, with possible loss of life and interruption to service.

BELTS FOR ASH HANDLING

There have been many installations of belts for the handling of ashes, but in my experience every installation has been a failure. One that I have in mind is where there were sixteen boilers. A system of 24-in. wide belts was put in to deliver the ashes to an elevator. This system consisted of five different belts, four of them running parallel with the boilers and delivering to a cross-belt which delivered to the elevator. This system was operated about one year, then discarded, and the wheelbarrow used in its place. During the period of operation about $7,000 worth of belts were used with about 30 per cent efficiency in labor while operating the belts. There was excessive maintenance of other parts in the few months' use of this system, besides the belts, so that all together it was an expensive experiment.

The chief trouble with the system was to keep men from pulling hot ashes on the belt. Many methods of quenching the ashes were tried, but in spite of all we could do by threats and discharges, the men would burn the belts so that in a short time they had to be renewed. While we were working on the belts or machinery, the laborers would be idle, waiting for the system to start. Sometimes the basement would be nearly full of ashes, and then it would take several days to get cleaned up again.

On account of the small capacity of the ashpits it was necessary to use two crews, night and day, on this work, which required about twenty-five men. After the belts were taken out and wheelbarrows used, we decided to get more capacity in the ashpits. The capacity was increased to a twenty-four-hour run, after which one crew of nine men took care of all the ash handling, using wheelbarrows, where formerly we had twenty-five men on the belt system.

Another serious trouble here was the burning of stoker dump grates because of the shallow ashpits and the failure of the belt conveyor. As the capacity of the ashpits was increased and the method of handling ashes made more efficient, this trouble disappeared.

ENGINE CROSSHEAD FAILURES

Cast-iron crossheads on engines that have been in service for fifteen to twenty years should be closely watched, for there is likely to be a failure of the threads in the crossheads where the piston rod screws in.

On taking charge of some old engines, I have found conditions that were startling. One illustration will suffice. On an engine of 26-in. diameter cylinder operating at 150 lb. steam pressure we found the threads in the crosshead practically broken off, just a few threads holding, so that the least shock from water or foreign matter would have stripped the rod out of the crosshead, with the result that we would have had a serious engine wreck and possibly loss of life. Piston rods should be screwed out of the crosshead often enough to make sure that they are in good condition.

CONDENSER SUCTION PIPE

Long lines of suction piping on jet condensers often cause considerable trouble with the pumps attached to this line, as a small leak of air into this line will cause serious trouble. I have had two systems of piping that were the cause of much trouble. One of these lines was a 20-in. riveted sheet-iron pipe with wrought-steel flanges partly under ground but about one-half of it exposed in the basement and in close quarters. To this line four marine-type jet condensers were connected. As soon as we began to have trouble with the condensers, our first thought was of the suction line, and there we usually found the trouble.

In another plant there were five marine-type jet condensers connected on to an underground suction line made up of bell and spigot pipe with lead-packed joints. We could not get any of the condensers to work satisfactorily. Investigation was started, and before we completed the work we had dug up, calked and packed every joint on this pipe. After this was done and the condensers overhauled they would pull the required vacuum without any trouble.

Our method of discovering the leaks was to put in a blind flange as close to the source of water supply as possible, and by having a water connection we could pump up about 40 lb. pressure on the line and keep on making these tests until everything tested tight. The suction pipe to any kind of a pump should be tight, but where it is used for condenser purposes it must always be kept very tight.

FEED-WATER TREATMENT

Water for boiler purposes should be as pure as it is possible to get it; in fact, distilled water would be best. Water softeners, either hot or cold process, will give water that will enable a plant to operate satisfactorily, even with a very bad water before treatment. Care must be exercised in starting a softening plant where the boiler has been in service a number of years using bad water, for every time the water is started in too soft the scale will be thrown from the tubes and great damage done by burning them.

As an illustration, a softening system had been operating for some time, using a certain amount of lime and soda ash to take care of a creek water. It happened that it rained for about a week, with the result that the hardness in the creek was reduced considerably, but there was no change in the amount of lime and soda ash used. The water was therefore made very soft with a surplus of soda ash going into the boilers, which resulted in throwing down much scale which lodged in the lower tubes, a large number of which were burned and several boilers put out of commission, interrupting service.

The remedy was to stop the treatment for several days. The tube trouble was stopped. Water-softening systems are like everything else about power plants—they must be closely watched by someone experienced in their operation.

INCREASING CAPACITY OF ASHPITS

In a certain plant I found the ashpits under a chain-grate stoker with capacity for only about four hours' run. Two crews of men were needed to handle coal and ashes, one day and one night, working ten-hour shifts. These ashpits were worked over so that the capacity was increased to a thirteen-hour run. After the change was made a crew of eight men and a foreman did all the work in a ten-hour shift, saving the wages of seven men. This is a case where the saving in labor paid for the cost of making the improvement in four months' operation.

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*From a paper before the Central Station Electric Association

†Union Traction Company of Indiana.

Record of Large Turbo-Generator Armature Breakdowns*

By F. D. NEWBURY
Manager Power Engineering Department, Westinghouse Electric and Manufacturing Company

THE following statement is a complete record of armature breakdowns that have occurred in Westinghouse turbo-generators of 15,000 kva. or larger polyphase rating. The record covers every turbo-generator of this size that had been placed in operation up to January, 1920, by this company. These generators, without exception, are mica insulated, with mica insulation between the strands and between conductors as well as between coil and core.

The first of this company's generators larger than 10,000 kva. were placed in operation in 1913. These machines were of approximately 20,000 kva. capacity, two-pole in the case of 25 cycles and four-pole in the case of 60 cycles. The design of such large two- and four-pole units in 1911 and 1912 was highly experimental, and while these units met the standard temperature-rise guarantee of 50 deg. C. by thermometer, it has since been found that the true copper temperatures of the strands nearest the air gap at the center of the core have been at least 200 deg. C. rise in some cases. Experience has shown designers how to avoid these high local temperatures to a considerable degree (mainly by reduction of eddy-current losses), and this is mentioned here only to bring out the significance of the record of trouble due to heating.

It is also important to note the inclusive and representative nature of the record. It covers all generators built of a given size and type, and it is therefore safe to draw general conclusions that will be applicable to all generators of the same class.

During these seven years' experience there have been 22 cases of major armature trouble involving 12 different installations or designs and 16 individual units. By major armature trouble is meant trouble serious enough to result in the failure of one or more armature coils.

The classification of armature failures as to cause is in some cases a difficult matter. The events leading up to the trouble may be unknown, and the evidence is very often burnt up. It has been thought best, therefore, to separate these cases into three classes as follows: (1) Where the manufacturer has accepted responsibility; (2) where the operating company has accepted responsibility; (3) where the cause is unknown or in dispute.

1. Eight cases were chargeable to design, workmanship or other cause for which the manufacturer accepted responsibility.

    (a) 5 cases (of these 8) were caused by defects in manufacture that developed shortly after installation.

    (b) 3 cases (of these 8) concerned details of design that led to failure after four or five years' operation. Two of these cases (in one design) involved high local temperatures caused by eddy currents in the top strands of the coil.

2. Eleven cases were chargeable to operating hazards for which the operating company accepted the responsibility.

    (a) 4 cases (of these 11) were caused by fire originating outside of the armature winding. In three of these cases the fire started in the cables just outside of the generator; in the fourth case the fire started in a series transformer accidentally open-circuited.

    (b) 4 cases (of these 11) occurred in one installation and were caused by abnormal voltage surges that caused the outside surfaces of the insulation to catch fire. In addition to these four cases that resulted in coil failures, as many more fires started that were put out before such damage was done. This trouble disappeared after the generator neutral was grounded.

    (c) 1 case (of these 11) was caused by ice or water carried into the generator from the air washer.

    (d) 2 cases (of these 11) were caused by enforced operation under conditions that were known to be unsafe. One case involved unsafe overloads and the other case involved continued operation after it was known that the armature needed minor repairs.

3. Three cases involved unknown causes or the cause was in dispute. In two of these cases the operating company believed armature-coil heating to be responsible.

This classification of armature breakdowns shows that out of 19 cases, where causes were agreed to, 11 cases were caused by operating hazards for which the generator can in no way be held accountable. The majority of these cases were caused by fires of external origin.

If all of the cases in which armature heating was involved (even by suspicion) are grouped, there are only 5 cases out of 22 breakdowns. Two cases (involving one of the first designs) were caused by design proportions; in two others temperature was not the primary cause of breakdown, but the operating companies believed it to be a contributory cause; and in the fifth case enforced overloading was the primary cause.

The writer's opinion, based on a careful study of operating experience and a detailed knowledge of internal temperatures and coil and insulation design, is that breakdowns caused by armature heating are in reality due to abnormal local temperatures that have values of the order of several hundred degrees; and that temperatures of 100 deg. or 150 deg. ordinarily discussed in connection with guarantees have very little to do with the problem. This statement, of course, applies only to windings completely insulated with mica within the slots.

HIGH-VOLTAGE MACHINES RELIABLE

This record of breakdowns brings to the surface another fact that is interesting and important and that is reassuring to the companies operating high-voltage units. If these generators be classified according to voltage, it is found that there are twice as many generators wound for 11,000 volts or higher voltage as there are generators wound for lower voltages. But these twenty-two cases of armature breakdown are equally divided between these two voltage classes. This means that the percentage of armature breakdowns in the high-voltage generators under discussion is only one-half that of the lower-voltage machines. This record would be very different with treated-cloth insulation (in large high-voltage generators) that is subject to cumulative heating on account of dielectric losses increasing with temperature; or with partially closed armature slots, still used by some European designers.

This record does not prove that high-voltage generators are necessarily safer or less subject to breakdown, except in so far as breakdowns may be caused by voltage surges that are independent of generator voltage. Obviously, a 10,000-volt surge would be dangerous in a 2,400-volt generator, but would be harmless in a 13,000-volt winding. The record does prove that 11,000- and 13,000-volt windings are just as reliable as low-voltage windings and, further, that breakdowns are generally caused by trouble unrelated to line voltage.

The facts brought out by this record may be summarized as follows:

1. The majority of armature breakdowns are caused by operating hazard originating outside the generator.

2. Armature heating in armatures completely insulated with mica is a minor cause of breakdown.

3. High-voltage generators, with mica insulation and open armature slots, are as reliable and probably are more reliable than large, low-voltage generators.

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*This article is based on a discussion of a paper, "Classification of Large Steam Turbo-Generator Failures," by Philip Torchio, presented at the A.I.E.E. convention, White Sulphur Springs, June 30, 1920, and published in *Power*, July 13, page 76.

Federal Power Commission Plans Detailed Organization

Plans for the detailed organization of the Federal Power Commission were agreed upon at a meeting of the commission in Washington July 27. The commission will be composed of the following subdivisions: Engineering, accounting, statistical, regulatory, licensing, legal and operation. The engineer officer is to be in immediate charge of the engineering division, with the title of chief engineer of the commission. For purposes of administration the country has been divided into five districts.

District No. 1 will have its headquarters in Washington and will consist roughly of the territory east of the eastern shore of Lake Michigan, the Illinois-Indiana boundary and east of a line drawn so as to include the Ohio River basin and proceeding irregularly southward to the Gulf at Mobile.

District No. 2 has its headquarters at St. Paul and includes that territory west from District No. 1 to midway in the Dakotas and north of Muscatine, on the Mississippi, and Sioux City, on the Missouri.

District No. 3 has its headquarters at St. Louis. It includes the Mississippi basin south of District No. 2, and all of Kansas, Missouri, Arkansas, Louisiana, Texas, and portions of Mississippi, Nebraska and New Mexico.

District No. 4 has its headquarters at Denver and includes the greater part of the states of Montana, Wyoming, Utah and Colorado and parts of North Dakota, South Dakota, Nebraska and New Mexico.

District No. 5 has its headquarters at San Francisco and includes, in addition to the Coast States, Idaho, Nevada and Arizona.

Federal Trade Commission Reports on Cost of Mining Coal

The sixth report of the Federal Trade Commission's series on the cost of producing coal in the United States, covering the States of Maryland, West Virginia and Virginia, which produce about 18 per cent of the total annual production of bituminous coal in the United States, presents information for the period from August, 1917, to December, 1918, based on monthly cost reports filed by the operators on forms prescribed by the commission and covers about 68 per cent of the output of Maryland during 1918, 89 per cent of the output of West Virginia and 77 per cent of that of Virginia. Information is also presented for certain districts in Maryland and West Virginia for 1916, 1917 and 1918, based partly on the information obtained by the commission's agents directly from the operators' books and partly on cost sheets submitted by the operators. This latter information covers from 14 to 53 per cent of the total output for the respective districts concerned.

The report shows that wide differences existed in 1918 between the conditions met by the operators in the fifteen mining districts of Maryland, West Virginia and Virginia for which statistics are given, and is of particular interest at the present time for comparison with the series of monthly bulletins on current 1920 costs, which are being issued by the commission. The basic 1918 figures are shown in the report in detail, and the various elements comprising the costs of operations such as labor, supplies, general expenses, as well as sales realization, in each district in 1918 are distributed through a wide range.

In 1918 for the production of over 90,000,000 tons mined in these three states by the 541 operators covered by the report, the average annual total f.o.b. mine costs as revised by the commission ranged, by districts, from $1.63 to $3.09, and the average sales realization ranged from $2.45 to $2.88 per ton of 2,000 pounds. In Maryland (which is a single district and includes also the Upper Potomac, Cumberland and Piedmont District in West Virginia) these average costs and sales realization in 1918 were $2.37 and $2.82 respectively, resulting in a margin of 45c. per ton. In West Virginia the average costs in 1918, by districts, ranged from $1.63 to $3.09 and the sales realizations from $2.45 to $2.88. If the Putnam County District be omitted, which had the high average cost of $3.09 and an average sales realization of only $2.76 per ton, the range of average costs for the remaining districts of West Virginia was from $1.63 to $2.35 per ton, and the range of margins was from 39c. to 92c. per ton. In the two districts of Virginia for which figures are given, the average costs in 1918 ranged from $1.93 to $2.48, the sales realizations from $2.58 to $2.81, and the margins from 33c. to 65c. per ton. The "margins," as elsewhere explained, are not the same as "profit."

The labor costs of the 71 operators in Maryland and in these three districts of West Virginia in 1918 were from 88 to 118 per cent higher, and the total f.o.b. mine costs in 1918 were from 92 to 109 per cent higher, than those in 1916. The sales realizations in 1918 were from 97 to 123 per cent higher than those in 1916. Of the amount paid for coal by the purchaser, based on each dollar of sales realizations during 1916-18, the item of most general interest is the proportion that labor received. That part of the amount paid by the purchaser which went to labor varied considerably from district to district, for these 71 operators in most districts, from period to period. It was highest (64 cents out of each dollar) in the Upper Potomac, Cumberland and Piedmont Districts of Maryland and West Virginia during the period June-December, 1918, and lowest (26 cents out of each dollar) in the Pocahontas District of West Virginia during the period April-May, 1917.

The detailed information contained in this report supplements that in the monthly bulletins which the commission is issuing at the present time, where necessarily averages only can be used in comparisons. The report further furnishes a safeguard against making too wide generalizations from the averages shown in the monthly bulletins.

Welded Boiler Explodes

At 11 a.m. on July 16, a small boiler of the firebox type exploded in a sawmill near McMinnville, Tenn., killing the fireman and a laborer, the former instantly, and badly scalding the owner and two others. The explosion was especially violent, completely demolishing the engine and mill equipment, and occurred without warning.

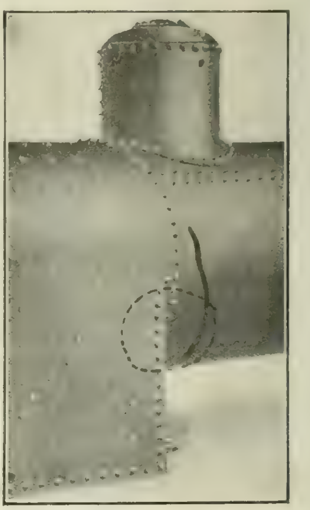
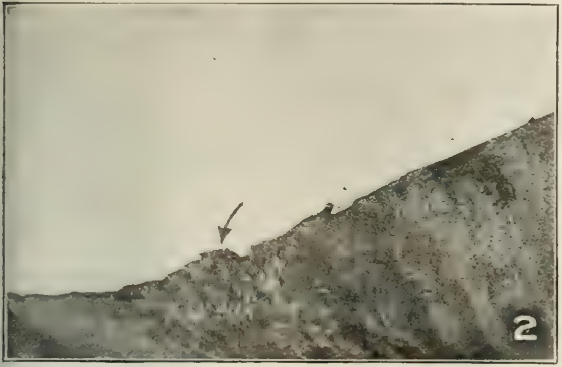
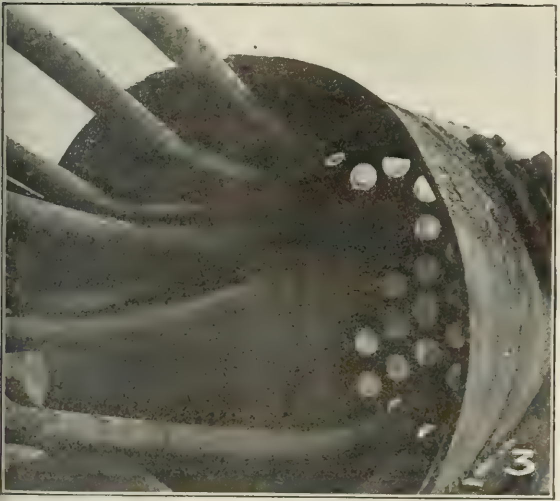


FIG. 1. SHOWING LOCATION OF CRACK AND CORRODED AREA

A few minutes before the explosion the owner noticed about one inch of water in the glass. The safety valve was popping off, and the gage showed 125 lb. The owner instructed the fireman, a green hand, to turn off the injector, and when the glass stood half full, he turned off the injector himself. Two or three minutes afterward the explosion occurred.

Fig. 1 shows the type of boiler, the heavy irregular line indicating an old internal crack in the shell almost two feet long. Within the area inclosed by the dotted line the plates and staybolts showed evidence of having been badly corroded. Only four inches of this long crack was visible from the outside, and this portion was welded electrically about a year ago to prevent leakage. In welding, metal had simply been "spotted" over the crack, adding nothing to the strength of the sheet. The average thickness of the sheet over the entire length of the crack was something less than one-sixteenth inch. The condition of the sheet at this point may be seen in Fig. 2. The remainder of the metal in the boiler was in good condition, and the crown sheet showed no evidence of low water. The fusible plug was intact, although filled with shot lead.





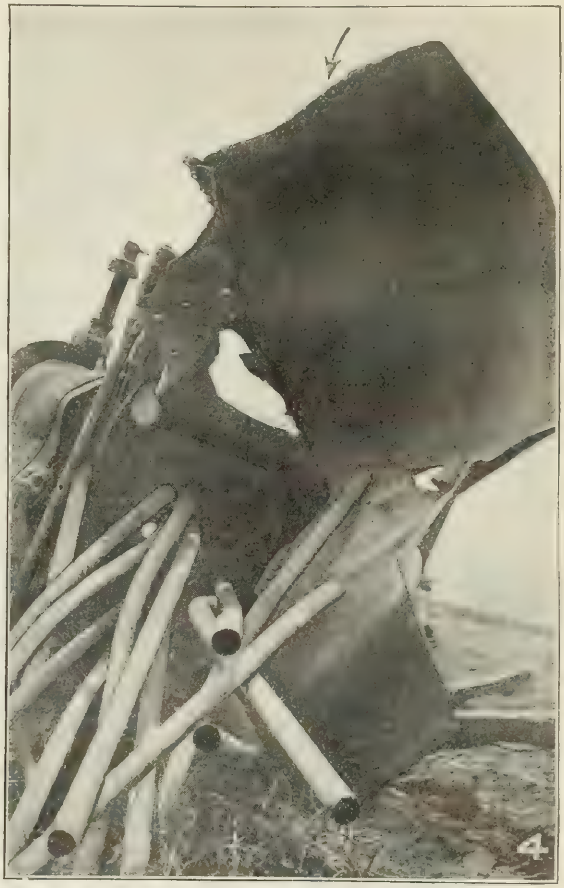


FIG. 2. THE WELD IN WHICH THE METAL WAS ONLY SPOTTED. FIG. 3. REMAINS OF FRONT END. FIG. 4. FIREBOX END, ARROW INDICATES LINE OF INITIAL RUPTURE

The initial rupture apparently occurred at the point where the repair had been made by welding. The shell was torn entirely in two, and the two halves hurled one hundred feet away in opposite directions. The fracture followed the girth seam nearest the crack, but the violence of the explosion caused the shell to tear in several other places, and as part of the metal, including the steam dome, could not be found, it was impossible to trace exactly the entire course of the fracture.

This occurrence demonstrates the extreme hazard involved in operating even the smaller-sized boilers without experienced help and expert inspection, and of attempting by the welding process a repair of the kind described. The owner of the plant was inclined to the belief that the initial failure could not have been at the crack, actually stating that the failure of the sheet at this point would have relieved the pressure and therefore have rendered an explosion impossible. Such statements point to the necessity of rigid state inspection laws, and of operation of boilers only by competent men. There are undoubtedly hundreds of boilers in daily use in as hazardous condition as this one was, the lives of the workmen and the safety of the equipment hanging by a very slender thread.

Power Index Ready

The index for *Power*, Vol. 51, from January to June, 1920, inclusive, is now ready for distribution. Following the usual practice, this index will not be sent to every subscriber, but will be mailed to any subscriber on request, free of charge.

A corporation for the development of a power plant on Rock Creek, Missoula, Mont., is being formed. The incorporators are Judge F. C. Webster and John and Vincent Shaughnessy, all of Missoula. The new company will be incorporated for $500,000, and a majority of this amount is to be spent in the erection of a hydro-electric power plent at the mouth of Rock Creek, east of Clinton. According to Judge Webster, it is the intention of the new company to erect a plant that will generate about 20,000 hp., the greater part of which will be used by the De Smet irrigation district for pumping purposes.

The Electric Propelling Machinery of Future U. S. Capital Ships

The present naval program of the United States consists of two new classes of battleships and battle cruisers, which will compare with the ships of the type of the "Tennessee" as follows:

TABLE I. COMPARISON OF NEW AND OLD BATTLESHIPS AND CRUISERS

	Tennessee	New Battleship	New Battle Cruiser
Length, over all, feet	624	684	874
Beam, feet	97	105	90
Draft, feet	31	33	31
Displacement, tons..	33,000	43,200	43,500
Speed, knots	21	23	35
Main battery	Twelve 14-in. guns	Twelve 16-in. guns	Eight 16-in. guns
Shaft horsepower	30,000	60,000	180,000

The new battleships are to be electrically driven, and the main propelling equipment of four of them—the "Indiana," "Montana," "South Dakota" and "North Carolina"—will consist of two Westinghouse 28,000-kva. turbine generators and four 15,000-hp. Westinghouse propeller motors. The turbines are to be of the complete expansion, impulse-reaction type and will develop their full rated load at 265 lb. steam pressure, 50 deg. superheat, and 28½ in. vacuum. Electric power will be generated in the form of three-phase 60-cycle, 5,000-volt alternating current.

The statistics of the new battle cruisers given in the table indicate that these vessels are to be very unusual in many respects, but their most remarkable feature is the enormous power of their turbines—180,000 hp., or 160,000 kva. These figures do not, however, give an adequate conception of the magnitude of this power. Not only is it greater than that of any ship ever designed—for the power of the British cruiser "Hood" is 134,000 hp. and that of the "Leviathan" 90,000 hp.—but it is greater than that used by most cities of over half a million inhabitants. For example, the combined capacity of all of the central-station and electric-railway power houses of Pittsburgh is less than 150,000 hp.; of Baltimore, less than 160,000 hp.; and of Philadelphia, about 200,000 hp. There are, in fact, but two or three steam-power plants in the world that have greater capacity than the engine rooms of these battle cruisers will have, so that, from the standpoint of power engineering alone, the construction of these vessels will constitute an achievement of the highest order.

Two of these vessels, the "Ranger" and the "Constellation," will have the following equipment: Four Westinghouse main turbines to develop 49,750 brake hp. each, with steam at 265 lb., 50 deg. superheat, and 28½ in. vacuum; four 40,000-kva. Westinghouse generators, directly connected to these turbines and generating three-phase 51.3-cycle 5,400-volt alternating current; eight wound-rotor Westinghouse motors (two to each propeller), which are to be rated at 22,500 hp. each and will be the largest in the world.

Recent German Production of Coal and Products

The Bureau of Foreign and Domestic Commerce, Department of Commerce, issues the following table showing the production of coal, coke and briquets in Germany during the first quarter of 1920, compared with the production in the same periods in 1919 and 1913.

Products	January-March, 1920* Tons	January-March, 1919† Tons	January-March, 1913‡ Tons
Anthracite....................	30,699,793	29,113,702	47,558,449
Soft coal....................	25,009,552	21,054,443	20,917,977
Coke	5,712,810	5,395,251	7,991,860
Anthracite briquets...........	1,057,268	953,095	1,436,225
Soft-coal briquets...........	5,256,611	4,304,248	5,048,260

* Exclusive of Saar district, the Pfalz, and Alsace-Lorraine. ‡ Inclusive of Alsace-Lorraine. † Exclusive of Alsace-Lorraine.

In the first quarter of 1919 the production of anthracite in the Saar district and the Pfalz was 2,407,475 tons, and of coke 208,118 tons. In the same period of 1913 the production of anthracite in Alsace-Lorraine, the Saar district, and the Pfalz was 4,397,744 tons, and of coke 431,435 tons.

The Federated American Engineering Societies

The object of the Federated American Engineering Societies is to further the public welfare wherever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions.

The organization is not a new one, but will be a successor to the existing Engineering Council, whose work will be amplified and carried out on a much more extended plan as to scope and membership.

The basis of representation, where a state organization exists and where there are also strong local organizations and affil'ations as provided for in the constitution, places the State Council or organization representative of the engineers and allied technologists in the state on an equal plane with all the engineers and technologists in the state The by-laws provide that "Any society or organization of the engineering or allied technical professions whose chief object is the advancement of the knowledge and practice of engineering or the application of allied sciences and which is not organized for commercial purposes, is eligible for membership."

The Federated American Engineering Societies will function through the American Engineering Council, which wil meet either annually, or bi-annually, as it will determine This American Engineering Council will consist of representatives from the member societies on the basis of one representative for from 100 to 1,000 members and an additional representative for each additional 1,000 members o major fraction thereof. From this body of representatives will be formed an executive board of thirty, consisting o six officers and twenty-four other members selected in par from the national societies and the remainder from th local, state or regional organizations or affiliations. Th plan reported by the committee on constitution and by-laws provided that the representation on the executiv board should be based on the ratio of the total numbe of members in the national societies to the total number o members in the local, state and regional organizations o affiliations. The organizing conference, however, change this to the ratio of the number of representatives fron the national societies to the number of representatives fron the local, state and regional organizations or affiliations on the American Engineering Council. This executive boar will meet monthly or as often as may be found to be necessary to properly transact the business of the America Engineering Council. There will be an executive office who will also be the secretary of these bodies and who wil be entrusted with carrying out their instructions.

The Joint Conference Committee is unqualifiedly of th opinion that an opportunity has been created for bringin about a solidarity of the engineering and allied technica professions that has never heretofore been available, an that the success of the movement will depend on the wholehearted support of each American engineer and of eac technologist, who, if determined that this movement shal succeed, will obviously not bother with the details or th form of organization, in his effort to secure the end designe

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Development of the Bridge River power site near Lillooet, Vancouver, B. C., calling for an eventual expenditur of $30,000,000 is in its initial stages, surveying and preliminary work now being carried on. Plans call for a tunnel a mile and a half long under Mission Mountain, discharging into Seaton Lake, six miles from Lillooet. Th fall will be 1,400 ft., and it is estimated that 400,000 h can be developed.

Collapse of a retaining wall in the boiler room o Nokomis flour and feed mill in Minneapolis, July 2 caused the death of one employee of the mill and seriou injury of another. The wall gave way under a pressur of 200 tons of coal against it. City firemen and employee of the mill worked two hours frantically digging to releas the unfortunate men.

The Coal Reconsignment Evil

ALL responsible operators throughout the country have deplored the development of a situation that has made it possible for the speculator to step between the coal producer and the consumer and to load on prices way beyond those prevailing at the mines. The lamentable lack of open-top car supply, existing since the beginning of spring, preventing the operators from shipping the coal required by the Nation, is the factor that has paved the way for the play of speculative prices wherever they have appeared.

One factor that has worked to the advantage of coal manipulators in this emergency has been the practice of the reconsignment of carloads of coal, for which the railroads are responsible. Under this practice carloads of coal obtained by speculators at a low price have been started out to an original consignee, later on the specuator—in the meantime having obtained a better price elsewhere—causing the shipment to be reconsigned to another destination. In many instances carloads of coal n this way have been reconsigned two and three times, with a higher price tacked on at each point.

The bituminous-coal producers have time and again protested against this practice of reconsigning cars. The option of resorting to its use has been entirely with the railroads. On July 12, at a conference of bituminous operators in Washington, a protest against reconsignment of coal cars was voiced, the Interstate Commission being asked to limit it to the "greatest possible extent, in order to eliminate existing abuses." On the following day Chairman E. E. Clark, of the Interstate Commerce Commission, n a letter to Daniel Willard, head of the Association of Railway Executives, urged that the railroads bring down the reconsignment of cars "to the unavoidable minimum."

Under the reconsignment of cars coal has been held at different points along railroad lines, as well as at terminals, for days at a time during the coal-shortage emergency, depriving consumers of a supply that has been badly needed. Industrial concerns, public utilities and other consumers have had to wait for coal while these reconsigned shipments were standing in cars upon the tracks.

Although the speculators have been able to obtain only a relatively small proportion of the coal output, the effect of their activity has been to further disrupt a situation that for months has affected the nation's coal output. With an unprecedented demand everywhere, many bidders have been willing to pay whatever price was necessary in the open market so as to get coal.

URGES ENFORCEMENT OF ORDERS PROHIBITING REASSIGNMENT OF COAL CARS

Suggestions for relieving the acute coal crisis in New York State and New York City, and in New England have been offered to the Interstate Commerce Commission and he United States Shipping Board in letters addressed to hose bodies by Senator William M. Calder, of New York, hairman of the special Senate Committee on Reconstrucion and Production. The suggestions arose out of informaion received by the committee in the course of its recent hearings.

In his letter to the Interstate Commerce Commission, Senator Calder says in effect that allegations have been made that priority orders issued by the commission in he past have been ineffective. It has been charged, the letter says, that cars diverted to the coal trade by recent priority orders are held in transit for speculative purposes, making most urgent the enforcement of orders by the commission prohibiting more than one reassignment of coal ars. Much confusion exists in the public mind as to the urport of the order some time since issued by the commission, requiring shippers to secure permits for the export f coal according to information given to the Senate committee. Senator Calder calls the attention of the Interstate ommerce Commission to representations that he has received as to the necessity for curtailing shipments of coal abroad in order to conserve the supply of cars for omestic needs. It has been pointed out, he says, that such curtailment "would reduce the price of coal in this country, would relieve the domestic shortage of coal and would release cars for general industry." As typical of many communications received by the committee, he encloses a copy of a telegram urging restriction on exports received by the Senate committee from Louis J. Hill, chairman of the Board, Great Northern Railroad, which reads in part:

> Regarding exportation, we feel conditions require this country's needs be taken care of before coal is shipped to foreign countries. If it were possible to mine a surplus of coal, it would be desirable to find an export market, but with the serious shortage in practically every state, the needs of this country should be adequately taken care of before exporting coal. We feel exorbitant prices being paid by agents of foreign countries for export coal have had an unusual effect on price and distribution in this country.

In conclusion Senator Calder invited members of the Interstate Commerce Commission to appear before his committee with a view to clearing up issues at present in doubt.

To the Shipping Board Senator Calder points out that some coastwise shipping is reported to be lying idle awaiting charter, and that this situation is accentuated because the present cost of transporting coal to New England by water is "some two dollars greater than the cost of all-rail coal transportation." As a remedy he suggests a reduction, during the present emergency, in water coal rates to New England, in place of the increase in rates which the committee has been advised is impending.

PENALTY FOR HOLDING CARS

Tangible results in the campaign to eliminate the speculator and bring down excessive prices where they exist in the open market, are already in evidence. One of the immediate developments in this move is the order just issued by the Interstate Commerce Commission restricting the reconsignment of open-top coal cars.

The commission's penalty of $10 a day on loaded cars held beyond 48 hours at any destination is expected to stimulate rapid unloading of cars and in that way release much-needed equipment now in the hands of speculators.

While backing the Interstate Commerce Commission's reconsignment order, the bituminous-coal operators represented in the National Coal Association, embracing two-thirds of yearly output of soft coal, feel that the prohibition against the practice should go further, so as to make it apply to shipments to tidewater, either for export trade or transshipment by vesssel to American seaboard ports. Means to bring this about are being considered by the committee of soft-coal operators engaged in export trade appointed by Col. D. B. Wentz, president of the National Coal Association, last week.

COAL EXPORTATION FOR 1920

Figures gathered by the Geological Survey indicate that the total amount of coal dumped at tidewater for the first six months of 1920 has approximated 23,000,000 tons. Of this amount, approximately 5,000,000 tons was destined for coastwise shipment to New England. Of the remainder, approximately 10,000,000 tons was exported across the Atlantic. The remainder, approximately 8,000,000 tons, was used for bunker coal. In view of the fact that transatlantic shipping was considerably higher in 1918 and probably in 1919, than it is at present, this figure of 8,000,000 tons for bunker coal cannot be materially greater than it has been in the past.

The Geological Survey, under date of July 26, 1920, further states that for the first six months of this year we have exported to Canada a total of 4,595,000 tons. There was a total export for the same period of 1919 of 5,700,000 tons, in 1918 of 7,740,000 tons, and in 1917 of 6,400,000 tons. It is interesting to note that these figures are compiled from the Canadian import figures, and they are undoubtedly very nearly correct.

New Publications

EXPORTERS' GAZETTEER OF FOREIGN MARKETS. By Lloyd R. Morris, Research Editor of the *American Exporter*, New York City. Cloth; 6 x 9 in.; 808 pages. Price, $10.

The object of this book is to furnish a reference guide to imports and exports, in [illegible] trading products, climate and other local conditions of foreign markets. A handy and valuable feature of the arrangement of the work is that all the commercial and industrial statistics and weights and measures have been converted into the American systems. The countries of the world have been grouped in alphabetical order by continents and other major geographical divisions so that adjoining markets are found together. Detailed information is given under each country upon area, population, commerce, production, industries, railroads, telegraphs, telephones, postal, weights, measures, commercial language, local advertising media, principal shipping routes, customs tariffs, consular regulations and consular representatives, cable rates, mail time, postal rates and regulations respecting parcel post, money orders and reply coupons. Tables showing the value of foreign trade over a number of years are given for each country. The value of imports and exports by commodities and countries and value of its imports from and exports to the United States for ten or more years are also given. In the book are included a number of charts, a map of the world, a map of New Europe and line maps of each of the markets.

Personals

Earl M. Anderson, of Carlinville, Ill., has been made assistant electrical engineer of the power house of the Standard Oil Co., at Schoper, Ill.

E. A. Pahenney, of Golden, Col., has been elected chairman of the Rocky Mountain Geographic Section of the National Electric Light Association.

Edward W. Harry has resigned as electrical engineer for the National Tube Co., to become chief electrical engineer with the Pittsburgh Steel Co., at Monessen, Pa.

Lloyd Herley, electrical engineer with the California Railroad Commission, has left the commission to take up the work of rate research engineer with San Joaquin Light and Power Corporation.

T. D. Ramm has resigned from the St. Paul Gas Light Co., where he was general superintendent of the electrical division, to become connected with the Pennsylvania-Ohio Electric Co., Youngstown, Ohio.

Roy M. Green, professor of highway engineering at the Agricultural and Mechanical College of Texas, has resigned that position to become president and manager of the Western Laboratories at Lincoln, Nebraska.

E. E. Leason has assumed the duties of advertising manager of the B. F. Sturtevant Co., Boston, Mass. Mr. Leason has been connected with this company for ten years and is well qualified to fill his new position.

W. J. Kaup has resigned his position as chief engineer with the Crucible Steel Co. of America, and will devote his time to consulting work entirely. Mr. Kaup was formerly with the Westinghouse Electric and Manufacturing Co.

Prof. M. E. Cooley, dean of the engineering Department of the University of Michigan, was elected president of the National Society for the Promotion of Engineering Education at a recent convention held by the society at Ann Arbor, Mich.

William Tietze has severed his connection with the Citizens Heat, Light and Power Co., of Canby, Minn., and has assumed the position of chief engineer of the B. F. Nelson Manufacturing Co., paper manufacturers, of Minneapolis, Minn.

O. M. Booher, who for the last twelve years has been manager of sales for the Indiana Railways and Light Co., Kokomo, Ind., has resigned to become general manager of the Kokomo Brick Co. Mr. Booher was very active in committee work of the Indiana Electric Light Association.

C. G. Bigelow, for the last three years advertising manager of the B. F. Sturtevant Co., Hyde Park, Boston, and previous to that for five years manager of the Chicago office of the same company, has resigned to become advertising manager of the Graton & Knight Manufacturing Co., of Worcester, Mass. Mr. Bigelow has had a wide experience in technical work which will qualify him for this new field.

T. H. Arnold has resigned as chief electrician of the Mining Department of the Arizona Copper Co., Ltd., with headquarters at Morenci, Ariz., to accept the position of electrical engineer for the Southwestern Portland Cement Co., of El Paso, Tex., and Victorville, Cal. Mr. Arnold graduated in electrical engineering at the Pennsylvania State College in the class of 1905 and has had a wide experience in the application of electric power to mining and industrial enterprises.

M. O. Leighton and **Major C. T. Chenery**, members of the American Society of Civil Engineers, and **A. C. Oliphant**, associate members of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, have formed a copartnership under the name of M. O. Leighton & Co., with offices at 700 Tenth St., Washington, D. C., for the purpose of engaging in general engineering practice and industrial representation before the Federal departments. Mr. Leighton and Major Chenery will continue for the time being as chairman and secretary respectively of the National Public Works Department Association, while Mr. Leighton and Mr. Oliphant will continue service in the Washington Office of Engineering Council pending the displacement of that body by the Federated American Engineering Societies.

Col. Edward B. Ellicott, Chemical Warfare Service, U. S. A., has received honorable discharge after two and one-half years' service and has become associated with A. M. Castle & Co., iron and steel merchants, Chicago, as chief engineer. In addition to being in charge of the erection of the new plant of A. M. Castle & Co., of Washington, at Seattle, and also the additional buildings to be erected in Chicago, he will be engaged in the operating and manufacturing activities of the company and its associated interests. Previous to entering the service Colonel Ellicott was city electrician of Chicago for eight years, and chief electrical engineer of the sanitary district of Chicago for eleven years, developing the hydro-electric power plant. During a leave of absence from Chicago, granted at the request of the Exposition officials, he became the chief mechanical and electrical engineer of the Louisana Purchase Exposition at St. Louis.

Society Affairs

The American Association of Engineers has passed the 20,000 membership mark. The association for some time has had the largest organization of engineers in the world.

The Montana Assembly of the American Association of Engineers elected William J. McMahon of Butte as president. Mr. McMahon is chief mining engineer for several mining corporations owned by the Anaconda Company. C. A. Bowden, chief draftsman of the Anaconda Copper Mining Company of Butte, was elected secretary. He is also secretary of the Butte Chapter

At the Pan-Pacific Scientific Congress to be held in Honolulu, Hawaii, from Aug. 2 to Aug. 20, the Chicago Chapter of the American Association of Engineers will be represented by Miss Florence King, a consulting engineer and patent attorney of Chicago, who is the only certified woman member of the American Association of Engineers. Miss King is sailing at once for Honolulu and will attend all the sessions of the congress.

The Executive Committee of The American Association of Engineers has selected to constitute the National Railroad Council of A. A. E., sixteen railroad professional engineers. They are: George W. Hand, C. & N. W., Chicago, chairman; W. W. K. Sparrow, C., M. & St. P., Chicago; W. Evans, C. & A., Chicago; K. B. Lattimer, C., B. & Q., Chicago; W. C. Bolin, B. & O., Chicago; F. C. Shepherd, B. & M., Boston; S. H. Brenaman, Penn., Pittsburgh; A. H. Utter, C., B. & Q., W., Lincoln; Harold Knight Erb, Youngstown; C. J. Long, N. Y. C. W., Cleveland; C. C. Berritt, Southern, Washington, D. C.; Ed Winship, Mo. Pac., St. Louis; J. E. Dobb, M. C., Detroit; J. T. W. Jennings, E. J. & E., Joliet; H. I. Benjamin, S. Pac., San Francisco, and E. C. Huffman, C. & N. W., Chicago.

The American Association of Engineers.—An Industrial Department has formally been authorized by the Board of Directors of the association. Steps are under way to organize this department and take up consideration of the problems of mechanical, electrical and chemical engineers in industrial work. A. M. Cornell, chief engineer of the Pettibone & Mulliken Co., of Chicago, will supervise the activities of the department until such time as the duties warrant the employment of a full-time paid secretary.

The Committee on the Reclassification and Compensation of Engineers has submitted a report to Engineering Council on a standard classification of grading for engineering service, with a tentative schedule of standard rates of compensation in each of the proposed grades. The adopted classification and the corresponding schedule of compensation tentatively suggested are as follows: Junior Aid, $1,080 to $1,560; Aid, $1,680 to $2,400; Senior Aid, $2,500 to $3,240; Junior Assistant Engineer, $1,620 to $2,580; Assistant Engineer, $2,700 to $4,140; Senior Assistant Engineer, $4,320 to $5,760; Engineer, $5,940 and upward; Chief Engineer, $8,100 and upward.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention in the Hotel Pennsylvania, New York City, Sept. 20 to 24. The following tentative program of papers will be presented during the convention: "A Condensed History of Ore and Coal Loading and Unloading Machinery," W. K. Monroe; "The Reversing Electric Mill Considered from the Standpoint of Tonnage," K. A. Pauly; "Power Transmission for Industrial Plants," D. M. Petty; "Centralized Turbine Generating Stations for Steel Mills," T. E. Keating; "Some Considerations in the Determination of Auxiliary Drives," Gordon Fox; "Report of Electrical Development Committee for 1920," E. S. Jefferies, chairman; "Relation of Standardization in Electrical Equipment to Safety," Walter Greenwood; "Report of Electric Furnace Committee for 1920," E. T. Moore, chairman; "Standardization Committee Report," W. T. Snyder, chairman; Practical Education of Steel Mill Electricians," Educational Committee; 'Underground Transmission," A. L. Freret; "Current Limit Reactance," R. H. Keil.

Miscellaneous News

The National Exposition of Chemical Industries, which will be held at the Grand Central Palace, New York, Sept. 20-25, will have for the first time a Fuel Economy Section.

It Is Planned to Begin Work at an early date on a power development on the Colorado River, north of Flagstaff, which will supply, among other services, four hotels to be built and 300,000 acres of irrigation effected by the power development.

The Federal Power Commission at a recent meeting planned to form a National Organization composed of the following subdivisions: Engineering, accounting, statistical, regulating, licensing, legal and operation. The country has been divided into five districts as follows: No. 1, Washington; No. 2, St. Paul; No. 3, St. Louis; No. 4, Denver; No. 5, San Francisco. Branch offices will be maintained in each city.

Business Items

The Chicago Pneumatic Tool Co., of New York and Chicago, announces that its publicity department has moved to the Chicago Pneumatic Building, 6 East 44th St., New York City.

The Mohawk-Edison Co. and the **Adirondack Electric Power Corp.** have been consolidated into the Adirondack Power and Light Corp., in conformity with orders of the Public Service Commission of New York

New Construction

PROPOSED WORK

Mass., Worcester—H. W. Trulson, 35 Berksmans St., will soon award the contract for a 2 story, 90 x 115 ft. garage including a steam heating system on Pleasant St. About $150,000. E. T. Chapin, 340 Main St., Archt.

N. Y., Buffalo—The Bureau of Water Supply is in the market for thirteen, 3 phase, 2,300 volt switchboard panels.

N. Y., Buffalo—The Bureau of Water Supply is in the market for 1 multistage centrifugal type pump to have a 250 gal. per min. capacity with a 10 ft. suction head capable of discharging against head of 700 feet.

N. Y., Marcy—The State Hospital Comn., Capitol, Albany, will receive bids until August 25 for a pumping station, filtration plant, etc., for the Utica State Hospital here. E. S. Elwood, Secy. Noted July 13.

N. Y., New York—The United Zinc Smelting Corp., 233 Bway., is in the market for 2 boilers, 250 kw. direct connected unit for generating two 100 hp. motors for fans, two 20 hp. kiln motors, three 20 hp. elevator motors, two 5 hp. gas producer motors, etc. J. W. Murry, Engr.

N. Y., Syracuse—The Common Council plans to build a pumping station and storm sewer. About $100,000. H. C. Allen, City Hall, Engr.

N. J., Camden—The Victor Talking Machine Co., Front and Cooper Sts., will soon award contract for a 1 story, 60 x 69 ft. boiler house. Ballinger & Perrot, 17th and Arch Sts., Philadelphia, Pa., Engrs.

N. J., West Orange—The Thomas A. Edison Co., Lakeside Ave., will receive bids about August 25 for an addition to its plant and about September 1 for equipment for same. About $80,000. Lockwood Green & Co., 101 Park Ave., New York City, Engrs.

Pa., Bakerstown—The Pittsburgh Cut Flower Co. had plans prepared for a 1 story, 57 x 72 ft. boiler house. About $75,000. Charles Bickel, May Bldg.,, Pittsburgh, Archt.

Pa.,, McKeesport—The McKeesport Hospital plans to build a 3 story power building, dormitory, nurses home, etc. About $250,000. S. F. Heckert, Bessemer Bldg., Pittsburgh, Archt.

Pa., Philadelphia—Berger Mfg. Co., 16th and Washington Sts., is in the market for a power saw table.

Pa., Philadelphia—The Germantown Y. M. C. A., 5849 Germantown St., will have plans prepared for a Y. M. C. A. building including a steam heating system on Haines and Germantown Sts. About $400,000. Martin & Kirkpatrick, 130 South 15th St., Archts.

N. C., Asheville—The Asheville Power & Light Co. plans to remodel and enlarge its power plant. About $100,000. John D. Caldwell, Supt.

Ga., Savannah—The Bd. Educ. plans to build a 2 story, 152 x 158 ft. school, $500,000 and a 3 story, 148 x 224 ft. school, $1,000,000, here. A low pressure steam heating system with electrically operated ventilating system will be installed in each. William B. Ittner, Bd., Educ. Bldg., St. Louis, Mo., Archt.

La., Lauderdale—S. J. Matz, Asst. Mgr. of the Salsburg Refining Co., Ltd., plans to install 4 boilers.

O., Cleveland—The Amer. Turpentine Co., 136 Engineers Bldg., plans to build a 1 story, 24 x 40 ft. boiler house and a 3 story, 100 x 180 ft. factory along the Beltline Ry., here. Two 300 hp. boilers will be installed in same. About $200,000. H. D. Tremmel, Secy.

O., Cleveland—The Gongwer Syndicate, c/o W. S. Longee, Archt., 500 Marshall Bldg., plans to build a 10 story, 50 x 100 ft. office building including a steam heating system on East 3rd St. and Lakeside Ave. About $500,000.

O., Cleveland—Nathan Kritzer, 10514 Massie Avenue, is in the market for one 2 hp., a.c., 60 cycle, 220 volt electric motor.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ.,, Lee Rd., is having plans prepared for a 3 story school, including a steam heating system on Taylor Rd. About $500,000. E. K. Bryan, Clk. F. C. Warner, Hippodrome Annex Bldg., Archt.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ., Lee Rd., plans to build a 50 x 67 ft. heating plant for Public School on Lee Rd. Three 200 hp. boilers, overhead conveyer system, stokers, 3 turntables, ashpit and blower system will be installed in same. About $100,000. E. K. Bryan, Clk. L. A. Quayle, 1455 West 98th St., Cleveland, Engr.

O., Linden (Columbus P. O.)—The Bd. Educ. will receive bids until August 20 for the construction of a grade school including a steam heating system. E. B. McFaddin, Clk. D. Ruhil & Son, New Trust Natl. Bank Bldg., Archt.

O., Oxford—The city is in the market for new electrically driven centrifugal pumps in connection with the proposed hydraulic development here. About $100,000. L. A. Boulay Co., 1250 Nicholas Bldg., Toledo, Engr.

O., Springfield—Clark County nad plans prepared for a 3 story, court house including a steam heating system. About $245,000. W. K. Shilling, Fox Hollow Farm, Archt. and Engr.

Ind., Evansville—J. E. Pridmore, Archt., 38 South Dearborn St., Chicago, will soon award the contract for a 6 story, 144 x 148 ft. hotel and theatre building including a steam heating system for the Standard Evansville Realty Co.

Mich., Detroit—The General Forgings Corp., c/o J. D. Edwards, 54 Lafayette Blvd., plans to build a 3-story, 65 x 210 ft. drop forging shop. Plans include a steam heating plant.

Mich., Detroit—Smith, Hinchman & Grylls, Archts. and Engrs., 710 Washington Arcade, will soon award the contract for a 2 story, 60 x 117 ft. factory including a steam heating system and motors for power on Hart Ave., for the Zenith Carburettor Co. About $70,000.

Ill., Chicago—The West Disinfectant Co., 2637 Cottage Grove Ave., is in the market for miscellaneous equipment including an electric winch with a 12 hp. motor.

Ill., Granite City—The Bd. Educ. is having plans prepared for a 3 story school including a low pressure steam heating system. About $280,000. William B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archt.

Wis., Campbellsport—The White House Milk Products Co,, West Bend, is having plans prepared for a 1 story, 50 x 100 ft. condensed milk plant. Two 150 hp. tubular boilers will be installed in same. M. Tullgren & Sons, 425 East Water St., Milwaukee, Archts.

Wis., Cedarburg—Fred Schuette, City Clk., will receive bids until August 24 for one air compressor, one 300 g.p.m. motor driven centrifugal pump, and one 60 hp., 2 phase, 60 cycle, 440 volt motor, a 20 x 26 ft. pumping station, etc. About $200,000. W. G. Kirchoffer, 3 Vroman Block, Madison, Engr.

Wis., Cudahy—The Worthington Pump & Machinery Co. will soon award the contract for a 3 story, 60 x 170 ft. pattern shop. Electric motors will be installed in same.

Wis., Milwaukee—The Park Bd., City Hall, received bids for the furnishing of new heating boilers for the Mitchell Park Conservatory, from the General Heating & Ventilating Co., 198 Milwaukee St., one at $5,700, $5,100 and $6,860.

Wis., Racine—The Bd. Educ., City Hall, is having preliminary plans prepared for a 3 story junior high school including a steam heating system. About $400,000. E. B. Funston Co., Robinson Block, Archt.

Ia., Des Moines—The State Bd. of Comrs., Capitol Bldg., plans to build a 3 and 4 story, 190 x 200 ft. power plant. About $200,000. Canfield Eng. Co., Flynn Bldg., Engr.

Kan., Arcadia—The city is in the market for pumps and equipment including an air lift, centrifugal pumps, etc. in connection with the proposed waterworks system. W. B. Rollins Eng. Co., Ry. Exch. Bldg, Kansas City, Mo. Engr.

Kan., Minneola—The City Clk. will soon award the contract for all labor and material necessary for the construction of a water works system including two 100 g.p.m. deep well pumps and motors, pump houses, etc. W. B. Rollins Eng. Co., Ry. Exch. Bldg., Kansas City, Mo., Consult. Engr.

N. D., Hankinson—G. W. Rennex, City Aud., will soon award the contract for two 500 gal. fire pumps, 2 deep well pumps, etc. About $50,000. Dakota Eng. & Constr. Co., Valley City, Engr.

S. D., Mitchell—Rapp & Rapp, Archts., 190 North State St., Chicago, will receive bids until August 15 for a 3 story, 150 x 180 ft. auditorium including a steam heating system, for the city. About $500,000.

Mo., Poplar Bluff—The city is in the market for 1 auxiliary pump and boiler accessories. W. T. Morris, c/o Bd. of Pub. Wks.

Mo., St. Louis—The city plans to build a power house addition to the Koch Hospital. An additional boiler and generator will be installed in same. About $23,000. L. R. Bowen, City Hall, Engr.

Ark., ,Cotter—The Dixie Power Co., Little Rock, plans to build a dam across the White River to generate electrical power. Henry A. Allen, Chicago, Ill., Engr.

Ark., Fort Smith—The St. Edwards Hospital Bd., North 15th and A Sts., is having plans prepared for a 4 story, 70 x 128 ft. hospital including a hot water heating system. About $250,000. Hedrick & Huff, Interstate Bldg., Kansas City, Mo., Engrs., A. Klingensmith, Rowland, Okla., Archt.

Col., Denver—The School Bd. will receive bids until Sept. 15 for a 2 story, 125 x 350 ft. junior high school. Electric motors will be installed in same. About $420,000. W. N. Bowman, Central Savings Bank Bldg., Archt.

Ariz., ,Bouse—R. M. Stene & Associates plan to build a dam across the William River for power and irrigation purposes.

Ariz., Phoenix—Carrick & Mangham have made an agreement with the Salt River Valley Water Users' Association to install pumps, build drainage irrigation ditches and steam plant to generate 5,000 kw. electrical energy. G. W. Sturtevant, Engr.

Ariz., Phoenix—The Landowners are having plans prepared for the installation of 350 second ft., electrically operated pumping plant, individual pumping units, etc., cost $800,000, ultimate cost, $4,000,000. Reed & Baker, 519 Fleming Block, Engrs.

Ariz., Phoenix—The Paradise Verde Irrigation Dist. plans to build a power plant along the Verde River here in order to utilize the waters of the River for power and irrigation purposes. Cost, from $16,000,000 to $20,000,000.

B. C., Trail—The Consolidated Mining & Smelting Co. of Canada plans to install three 200 hp., 550 volt motors direct connected to three 3 stage centrifugal pumps with a capacity of 550 gal. per min. and designed to pump against a head of 337 ft. rating 1,500 r.p.m. in the main pumping station on the banks of the Columbia River here; a relay station having 2 pumps similar to those in the main pumphouse; a 1,200 k.v.a. synchronous motor generator set, 2,200 volt motor and a 200 volt generator in the additions to its copper plant.

Ont., Acton—H. A. Cox, Chn. of the Water Bd., will soon award the contract for furnishing and installing two 250 Imp. gal per min. pumps direct connected to 220 volt, 25 cycle, 3 phase, a.c., electric motors and motor driven centrifugal pumps, for the town. About $16,000. E. A. James Co., 36 Toronto St., Toronto, Engr

Ont., East View—The Town Council voted $15,000 bonds to install new water mains, pumping machinery, etc. Patterson & Bayne, 33 Sparks St., Ottawa, Engrs.

Ont., Exeter—The Exeter Creamery Co. plans to build an addition to its plant and is in the market for machinery and equipment for same.

Ont., Fordwich—The ratepayers plan an election August 13 to vote on $10,000 bonds to provide for the installation of a hydro-electric lighting and power distribution system.

Ont., Hamilton—The Bd. Educ. plans to build a 2 story school including a vacuum steam heating system. About $125,000. Grayson Brow, Clyde Bldg., Archt.

Ont., Hamilton—The Steel Works of Canada, Harvey Lane, will soon receive bids for a 1 and 2 story steel plant and foundry including a steam heating system. About $300,000.

Ont., Toronto—The city plans an election in January to vote on $8,000,000 bonds to build a waterworks system in the eastern section of the city to include intakes, pumphouse, filters, high and low pressure pumps, reservoirs capable of handling 100,000,000 gal. R. C. Harris, City Engr.

CONTRACTS AWARDED

Me., Brunswick—Bowdoin College has awarded the contract for remodeling the heating and lighting plant, to Blackstone & Smith, 185 Middle St., Portland, at $25,000.

Mass., Holyoke—The Holyoke Water Power Co. has awarded the contract for the installation of turbine wheels in the proposed plant $50,000 and in the proposed addition to plant, $70,000, to James Leffel & Co., Springfield, O.

Mass., Holyoke—The Holyoke Water Power Co. has awarded the contract for the installation of generators which will be used to supply additional electric current, to the General Electric Co., 387 Main St.

Mass., Springfield—The Wallace Realty Trust Co., 392 Main St., has awarded the contract for altering boiler house and garage, to E. J. Pinney, Inc., 374 Main St., at $26,500.

Conn., Bridgeport—H. N. McCathron, 72 Knowlton St., will build a 1 story, 60 x 220 ft. forge building including boilers, etc., on Cross St. About $20,000. Work will be done by day labor.

Pa., Essington—The Westinghouse Electric & Mfg. Co., has awarded the contract for a 1 story, 120 x 200 ft. foundry building including a steam heating system, to the Austin Co., Bulletin Bldg., Philadelphia.

O., Cleveland—The Anshi Beth Tephito Congregation, 10615 Grantwood Ave., has awarded the contract for a 2 story, 150 x 240 ft. synagogue including a steam heating system on East 105th St. and Hayden Ave. to the Edwards Eng. Co., Hippodrome Annex Bldg., at $500,000. Noted Jan. 20.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., has awarded the contract for the installation of a steam heating system in school building, including two boilers, etc., to John W. Danforth, 70 Ellicott St., Buffalo, N. Y.

O., Columbus—The Bd. Educ. has awarded the contract for installing a heating and ventilating system in the proposed 2 story, 100 x 190 ft. school on Sullivant Ave., $35,383 and 2 story, 150 x 200 ft. school on Taylor Ave., $35,382, to Huffman & Wolfe, 669 North High St.

Mich., Caro—Cooper & Stiller has awarded the contract for a 1 story, 75 x 140 ft. garage and salesroom including a steam heating system, etc., to the O. W. Jenkins & Co., 388 Dearborn St., Chicago, at $35,000.

Mich., Detroit—The Bd. of Water Comrs., 232 Jefferson Ave., has awarded contract for a 1 story, 90 x 120 ft. machine shop to Martin & Krausman Co., 747 Garland Ave., at $21,180. Motors will be installed in same.

Mich., Detroit—The Wood Hydraulic Hoist & Body Co., 1789 Hartwick Ave., has awarded the contract for a 2 story, 140 x 400 ft. factory including a steam heating system and electric power, to William Reynolds, 320 Lightner Bldg.

Ill., Chicago—The Chicago Junction Ry. Co., 38 South Deniston St., has awarded the contract for an addition to the boiler room and the installation of two 150 hp. high pressure boilers, compressor room, air compressor, etc., to E. W. Sproul Co., 2001 West 39th St., at $80,000.

Ill., Chicago—David Levi & Co., West 40th St. and Packers Ave., has awarded the contract for a 3 story, 115 x 170 ft. packing plant including a steam heating system on West 39th St. and Emerald Ave., to Jacob Rodatz, Rookery Bldg., at $350,000.

Ill., Kankakee—The W. Terman Produce Co. has awarded the contract for a 2 story, 48 x 15 ft. factory and warehouse including a steam heating system, on 15th St. and the New York Central tracks, to the Dehrens Constr. Co., 1732 North Western Ave., at $60,000.

Wis., Roberts—The Bd. Educ. has awarded the contract for installing a heating and plumbing system in the proposed 2 story, 62 x 69 ft. addition to high school, to the New Richmond Heating & Plumbing Co., New Richmond, at $17,400.

Ia., Davenport—C. A. Koester, c/o Davenport Roofing Co., has awarded the contract for a 3 story, 65 x 150 ft. garage including storage tanks and pumps on Front St., to the H. Horst Co., Brumder Bldg., Milwaukee and Rock Island, at $150,000.

Minn., Minneapolis—The Bemis Bros. Bag Co., 604 South 4th St., has awarded the contract for the installation of a steam heating system in the proposed 7 story, 65 x 150 ft. addition to its factory at 600 4th St., S., to the Hankee Heating Co., 922 2nd Ave., S.

Minn., St. Paul—The Bd. Educ., City Hall, has awarded contract for a heating system in the proposed 3 story, 64 x 96 ft. school addition on LaFond and Avon Sts., to the Hankee Htg. Co., 925 Merchants Natl. Bk. Bldg., at $14,108. Noted July 27.

Kan., Geneseo—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Hutchinson—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water system including pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Kenneth—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Lyons—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Miller—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Neal—The Missouri Pacific Ry Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Osawatomie—The Missouri Pacific Ry Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Ottawa—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Wyo., Salt Creek—The Midwest Refining Co., 1st Natl. Bank., Denver, Col., will build a 2 story, 70 x 114 ft. hotel including a refrigerating plant. About $125,000. Work will be done by day labor.

Mo., St. Louis—The David Rankin Junior School, 4431 Finney St., has awarded the contract for a 1 story power plant, to the J. Stewart & Co., Boatmans Bank Bldg., at $150,000.

Mo., St. Louis—The Landes Machine Co., 407 Gano St., will build a 1 story boiler and machine shop at 4929-31 North 2nd St. About $6,000. Work will be done by day labor.

Mo., St. Louis—The Schulz Belting Co., 4th and Boston Sts., has awarded the contract for a 1 story, 25 x 50 ft. factory and boiler room on South 4th St., to the Dryden Dyer Constr. Co., 816 Olive St. About $6,000.

Mo., St. Louis—J. A. Wetmore, Supervising Archt., Treasury Dept., Washington, D. C., has awarded contract for a boiler plant at the Marine Hospital here, to William Wilby, Selma, Ala., at $4,000. Noted July 27.

Ont., Kitchener—The Dominion Tire & Rubber Co., 140 Strange St., has awarded the contract for a 60 x 100 ft. rubber factory, power house and sub-station on King St., to the Caswell Constr. Co., 53 Wellington St., E., Toronto, at $85,000.

SEE SEARCHLIGHT SECTION

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POWER

Volume 52 New York, August 17, 1920 Number 7

The Federal Water-Power Commission

Sec. of War
NEWTON D. BAKER

Sec. of the Interior
JUDGE JOHN BARTON PAYNE

Sec. of Agriculture
EDWIN T. MEREDITH

Newton D. Baker, John Barton Payne and Edwin T. Meredith, respectively Secretaries of War, Interior and Agriculture, make up the Federal Water-Power Commission as provided in the recently enacted Water Power Bill. The Commission will issue fifty-year licenses for power projects and transmission lines and will pass upon the scheme of development of power sites, plans and specifications of the works, upon certain features of maintenance and operation and will have jurisdiction over the regulation of rates and service whenever the state has no agency to look after such regulation.

The work will include thorough investigation and collection of data pertaining to the utilization of the water resources of any region where plans for development are contemplated. The Commission will also investigate and compile a report on the water-power industry as a whole and its relation to other industries and to inter state and foreign commerce.

The bill provides for an investigation and report on the Great Falls power project on the Potomac above Washington, and reports on all projects on navigable streams in which it appears that construction of suitable structures for unimpeded navigation cannot be undertaken by the applicants for license.

The responsibility for much of the detailed administration of the Water Power Bill will rest with Oscar C. Merrill, formerly chief engineer of the Forest Service, who has been appointed Executive Secretary to the Commission, and the engineering surveys will be placed in the hands of Lieut. Col. William Kelly, who was appointed by President Wilson as engineer officer of the Commission.

It is difficult to estimate the vast benefits of the proper development of our sixty million available horsepower. Only by proper development of these resources can the industrial life of the country reach its maximum. Each year the fuel situation is becoming more acute owing to strikes, transportation difficulties, speculation, etc., but with development of our water-power resources a vast amount of coal will be conserved or rendered available for other work.

The Causes of Trouble in Steam-Turbine Lubrication and the Remedy

By L. E. Strothman
Vice President and General Manager, the Richardson-Phenix Company

Mr. Strothman describes the ordinary circulating system used for the lubrication of a steam turbine. He points out some of the troubles inherent in this simple system and discusses the reasons for these troubles. The various steps in the development of improved systems are traced and their faults and virtues are discussed.

IN THE early days of the steam turbine almost unsurmountable difficulties were experienced with lubrication—largely due to the kind of oil then used, which was not suitable for this severe service. Today the larger sizes of steam turbines are equipped by the manufacturer with an effective circulating oiling system, which can be relied upon to supply an adequate quantity of oil to each bearing.

For the improvement that has been made in lubrication, great credit is due to both the leading manufacturers of steam turbines and the manufacturers of high-grade lubricating oils. The manufacturers of steam-turbine oil have carefully studied the requirements of the service and have consistently followed the subject, through their technical departments, and from data secured in the field on the service obtained from the oil have succeeded in producing the very best oil for the conditions.

Fig. 1 shows graphically the oil-circulating system of a steam turbine. Oil is supplied under pressure to the middle of each bearing, flowing out at the ends and returning by gravity to the oil reservoir *B* in the base of the turbine unit. A rotary pump *A*, driven from the main spindle of the turbine or from an extension of the governor shaft, takes the oil from the reservoir *B* and forces it through oil cooler *C*. A part of the oil is used in the oil-relay system for governing the turbine, and the remainder is reduced in pressure by a reducing valve and is delivered through pipes *D* to the various bearings. A relief valve *L* bypasses any excess oil back into reservoir *B*. The steam-turbine unit, shown, has four main bearings, *E*, *F*, *G* and *H*, and a thrust bearing. The oil, after passing through the bearing, returns by gravity through return pipe *J* and through the screen strainer *K* to the reservoir. The turbine is equipped with an auxiliary oil lamp which is used when starting and stopping the turbine in case of emergency. In pointing out the various causes of trouble in steam-turbine lubrication, it will be taken for granted that a suitable high-grade, pure mineral oil is used. The troubles that would ensue from using a poor grade or an unsuitable oil would be far more serious.

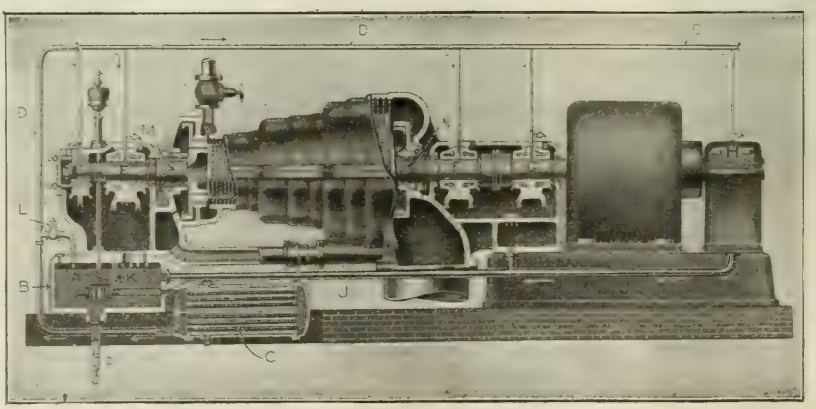


FIG. 1. A TYPICAL SELF-CONTAINED OIL-CIRCULATING SYSTEM ON A STEAM-TURBINE UNIT

In the circulating oiling system of all steam turbines water finds its way into the oil in spite of the precautions taken by manufacturers in the construction of packing glands *M* and *N* (Fig. 1) which are variously fitted with carbon packing rings held against the shaft by springs, labyrinth packing or water seals and water throwers introduced between packing glands *M* and *N* and bearings *E* and *F*. Some water also gets into the oil when the turbine is at rest, owing to condensation of moisture in the air when it comes in contact with the cool metal surfaces of the oiling system. Occasionally, small leaks develop in the oil cooler, permitting water, which is usually supplied under pressure, to get into the oil. As shown in Fig. 1, the bearing shells are sometimes made hollow and cooled by circulating water through them, in which case there is an additional possibility of the bearing shells leaking and allowing water to enter the oiling system.

A drain valve *P* is provided in the bottom of the oil reservoir for drawing off any water in the system, but this drain connection is effective only when the turbine unit has been shut down and sufficient time allowed for the water to separate from the oil and settle to the bottom.

A steam turbine is one of the few power units which is operated continuously, and the oil in the lubricating system, owing to its rapid circulation (from 9 to 40 times per hour, depending upon the size and make of the turbine) and constant contact with hot bearings, air and moisture, receives the most severe service to which lubricating oil is subjected. On account of these severe conditions even the best turbine oils will, in time, emulsify, oxidize and break down with the formation of sludge and a low degree of acidity, unless means are provided to remove moisture, air, sludge and other foreign matter as soon as they appear, thereby constantly maintaining the oil in its original pure state, which results in its giving good service indefinitely.

RAPID CIRCULATION OF OIL

Owing to the limited holding capacity of the turbine oil reservoir and the rapidity with which the oil is circulated, it does not have time to separate from moisture, air or other foreign matter picked up during its circulation, and as the same oil must perform its duty many thousands of times, it is evident that it must receive care in order to prolong its life and enable it to do its work properly. In a closed, continuous, circulating system, it is impossible to know from the outside the condition of the oil and whether water or other impurities are present. Even if samples of oil are taken from the system at frequent intervals and analyzed, the result would show only an approximation of the average condition of all the oil in the system. Any moisture in the oiling system is thoroughly churned up with the oil by the rapid circulation, and an emulsion of water and oil is formed.

OXIDATION OF THE OIL

The oil in circulation always contains more or less air and, furthermore, is exposed to the atmosphere in the bearings. In addition to coming in contact with air the oil at the same time comes in contact with the heated surfaces of the bearings. Bearings become heated from a number of causes, such as the heat generated due to friction, which may become excessive if a heavy oil is used; also the heat transmitted from the steam in the turbine cylinder, etc. This combination of air and heat causes the oil to become oxidized, and a brownish or chocolate colored sediment is produced, most of which remains in suspension in the circulating system. Furthermore, the presence of air where the oil is so rapidly circulated as in a steam-turbine oiling system also results in an emulsion composed of air and oil.

HOW AN EMULSION IS FORMED

An emulsion is a mixture of liquids insoluble in one another where one is suspended in the other in the form of minute globules or a mixture in which solid particles of air are suspended in a liquid. In an oiling system in which the oil is rapidly circulated, an emulsion is easily formed on account of the mixture of the oil with either air or moisture, which reduces the lubricating properties of the oil and results in poor lubrication and the accompanying rise in temperature. One of the most common causes of trouble with steam-turbine lubrication is due to this emulsion of the oil with moisture or air, particularly if impurities (either solids or the products of oxidation) are present. The emulsion takes up dirt, particles of metal, products of oxidation and other foreign substances and holds them in suspension so that they cannot precipitate. Furthermore, a coating is deposited on the surface of the oil cooler medium, the rate of heat transfer from the oil to the cooling water is reduced, and an undue rise in the temperature of the oil results.

The products of oxidation, solids and other foreign substances which would ordinarily settle to the bottom if the oil were not so rapidly circulated, are commonly called "sludge," or "muck," and necessitate the cleaning of the oiling system of the turbine. The presence of this sludge, or muck, in the oil also reduces its lubricating value and is a frequent source of lubrication trouble. Solid impurities consist of such substances as core sand, iron chips and filings, rust, wood splinters, cotton waste, etc., which are generally found in a new turbine. It is evident that these substances must not be allowed to come in contact with the bearing surfaces because immediate abrasion would result. Furthermore, the full supply of oil to the bearings would be interfered with if these solids became lodged in the passages conducting oil to and from the bearings.

BREAKDOWN OF OIL MAY BE CAUSED BY ELECTROCHEMICAL ACTION

The materials of which the various parts of a steam-turbine circulating system are composed, such as steel, iron, zinc, copper, etc., are of decidedly different potentiality and electrochemical action may take place, causing the oil to break down. It has been found that these chemical and physical changes produce an acid condition in the oil which will in time corrode the metallic parts of the turbine and eventually impair the smooth, clean bearing surfaces.

The moving parts of the governor in most steam turbines are lubricated with the same oil as used on the bearings, and in cases where the oil is in bad condition, the regulation of the turbine is affected owing to the governor not being able to move freely. In order to overcome this difficulty, force-feed lubricators have been installed on many steam turbines to effectively lubricate the governor.

METHODS THAT HAVE BEEN TRIED TO OVERCOME THE DIFFICULTY

The combination of an effective circulating oiling system with the very best oil for the service is responsible for the greatest improvement in the lubrication of the steam turbine. However, owing to the fact that moisture and other foreign substances enter the oiling system and become mixed with the oil, it was found that some means would have to be provided to remove the foreign substances in order to keep the oil in proper condition. A number of methods for overcoming the difficulty were tried, and the following shows how, step by step, the successful solution of the problem was finally arrived at.

The first method tried was to add make-up oil. To make up for the amount lost by evaporation and leakage, oil was added occasionally, but it was found that even when the amount of new oil added was very small, a dark-colored deposit was thrown down, due to the action of the old oil on the new, and that all the oil in the system would in a short time become very dark in color, with a considerable increase in acidity.

The viscosity of the oil in the system was also increased as the new oil was of the same average viscosity as the oil originally put into the system, while the oil which was lost, owing to evaporation, consisted of the lighter parts of relatively low viscosity. This method does not overcome the results of rapid circulation nor provide for the removal of moisture, the products of oxidation or the accumulation of impurities, and eventually the turbine has to be shut down and the entire quantity of oil replaced by new.

To avoid the troubles due to simply adding make-up oil, "sweetening" was resorted to. This consisted in withdrawing from the turbine-oil reservoir a certain amount of oil periodically, depending upon the severity of the service, and adding enough new oil to replace the amount withdrawn and that lost by evaporation and leakage. This method was found but little more effective than the first method, as it was only a question of time before the whole charge of oil was unfit for use.

These two methods contain no provision for filtering the oil in order to keep it in good condition. "Batch filtration" was tried and found to be a pronounced improvement as the whole charge of oil in the system is withdrawn and filtered before being used again, the turbine in the meantime having been filled with a charge of clean oil. There are several serious objections to "batch filtration," however; namely, it requires the unit to be shut down while withdrawing the dirty oil and refilling with clean oil; also, as the oil is not withdrawn until it becomes unfit for use, the turbine is compelled to run for a large part of the time on oil that is not in proper condition, and furthermore, it is dependent upon the judgment of the operator who decides when the oil should be withdrawn and filtered.

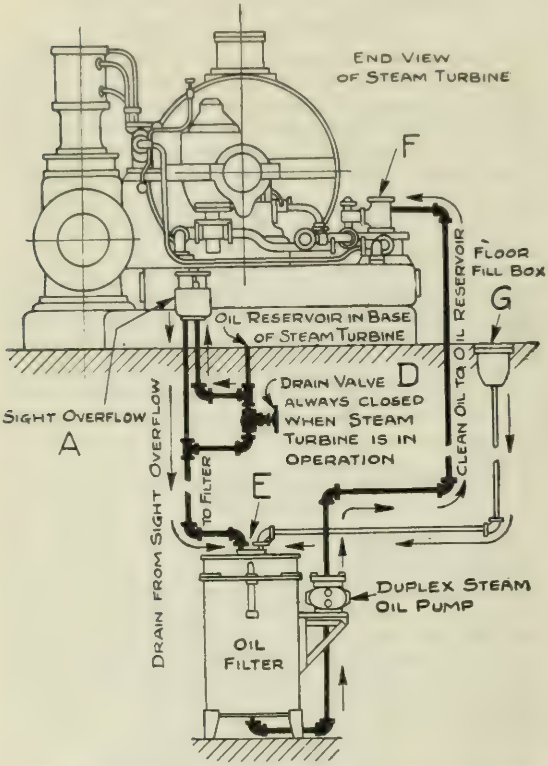

End View of Steam Turbine
F
Floor Fill Box
G
Oil Reservoir in Base of Steam Turbine
Clean Oil to Oil Reservoir
Drain Valve D always closed when Steam Turbine is in Operation
Sight Overflow A
Drain from Sight Overflow
To Filter
E
Duplex Steam Oil Pump
Oil Filter

FIG. 2. CONTINUOUS BYPASS TURBINE-OIL FILTERING SYSTEM

Continuous filtration was next tried. In this method the entire volume of oil is filtered each time it is pumped by the oil pump of the circulating system. This method is very effective and, for very small turbines where only a small quantity of oil is circulated, is the best method. For larger turbines, however, the expense of the necessary filter, filter oil pump and piping makes this method undesirable. Another objection is the great amount of space occupied by the filter and its accessories.

THE REMEDY FOR TROUBLE IN STEAM TURBINE LUBRICATION

The experience gained with the methods described resulted in the development of the "continuous bypass" oil-filtering system, which maintains the lubricating oil in its original pure state by continuously bypassing a part (from 10 to 20 per cent) of the oil contained in the turbine oil reservoir; removing any moisture, air, solid impurities, emulsion, products of oxidation and any other impurities that impair the lubricating value of the oil, and returning the purified oil to the self-contained oiling system of the turbine. To filter the entire volume of oil each time it is pumped by the oil pump of the turbine circulating system would necessitate using very much larger sizes of filter, filter oil pump, and piping, which would materially increase the cost of the equipment. This additional expense is not warranted, as equally good results are obtained with the continuous bypass system. Steam turbines equipped with these systems have been in operation for a number of years, and the operating records show that the original oil was still being used, only enough having been added to replace the amount lost by evaporation and leakage, also that regulation was all that could be desired, indicating that the governor was being properly lubricated.

The continuous bypass oil-filtering system shown diagrammatically in Fig. 2, is extremely simple. It consists of a sight overflow through which the oil in the turbine reservoir flows by gravity to an oil filter which removes moisture and other foreign matter, and a filter oil pump which returns the clean oil to the turbine reservoir. The sight overflow is vented to prevent siphoning, and when being connected to the turbine, the level of its overflow pipe is set to correspond with the desired level of oil in the turbine reservoir, which level is thereafter automatically maintained at all times. This arrangement assures that the turbine-oil reservoir will always be full to the proper level as the quantity of dirty oil overflowing to the filter is balanced by the amount of clean oil delivered to the turbine reservoir by the filter oil pump. An accidental stoppage of the filter oil pump cannot in any way jeopardize the continuous operation of the turbine, as accidental draining of the turbine-oil reservoir is not possible with the vented sight overflow.

This system is the best insurance against lubrication troubles. In addition to its keeping the oil in proper condition, less work is required of each gallon of oil because the volume in use is increased by the additional quantity in the filter. Furthermore, this system makes it possible to use the oil over and over again indefinitely, thus the cost becomes an investment rather than an expense.

If a bearing on a new machine persists in heating and the operator is satisfied that the oil used is not too light or too heavy, then the bearing may be out of line, or designed with insufficient clearance. Overheating may also result when the clearance is too great and trouble may follow because the bearing has high and low spots upon its surface.

Utah Coals and the Fuel Supply of Salt Lake City

By OSBORN MONNETT

This article is taken from the smoke-abatement report of the Bureau of Mines, made as a result of its work in co-operation with Salt Lake City and the University of Utah. Published with permisssion of the Director, Bureau of Mines.

IN CONNECTION with a smoke-abatement investigation, a fuel survey of Salt Lake City was made to determine the amount of coal burned in the city, the amount burned by different classes of fuel users, the source of the coal and its characteristics.

The total amount burned in the city was arrived at in a preliminary manner by finding from the railroads entering the city the tonnage of commercial coal hauled into the city, and adding to this total railroad coal burned within the city. This amount gives the grand total of all coal consumed in the city and a figure to check against when determining the amount burned by the various classes of fuel consumers. The amount of coal used by the different classes of fuel consumers except for residence and domestic use was obtained by means of questionnaires sent to all coal consumers. The information obtained was tabulated under the following heads: Apartment houses, business houses, churches, cleaning and dyeing establishments, dairies, creameries, hotels, hospitals, industrial boiler plants, laundries, office buildings, central heating plants, public buildings, schools, residences and locomotives.

The coal consumed by residences was determined by a house to house canvass made by the Boy Scouts. This canvass also included a tabulation of domestic heating and cooking equipment. The coal consumed was distributed over the entire year by months. All of the information concerning coal consumption excepting in residences was supplied by months. In order to distribute the residence consumption by months, it was necessary to make some calculations. The coal used by plants which have a heating load only was distributed by percentage for each month and it was assumed that the residences which use coal principally for heating would use fuel in the same ratio, so the residence coal was distributed throughout the year in the same ratio as that used by strictly heating plants. The fuel oil consumed in Salt Lake City is a very minor quantity and amounted during the year of our survey to only 1,927,560 gallons.

The coke consumed in the city was also determined. This was a very small amount—3,470 tons for residence purposes and about 8,000 tons burned at the plant of the Utah Gas and Coke Co., the remainder of the coke produced being shipped out of the city. The source of the coal supplying the city coal market was obtained by questionnaires sent to all the coal operators who supply coal to that market. The coals were classified as to the particular locality from which they came. The coals in the same locality have about the same characteristics. Those classed as the Carbon and Emery County coals are from the group of mines in southwestern Carbon and northwestern Emery County. The Spring Canyon coals include all those mined in Spring Canyon. The Carbon County coals include all coals mined in Carbon County with the exception of those separately classed. The Grand County coals are those mined in Grand County. The Wyoming coals were all grouped into one class.

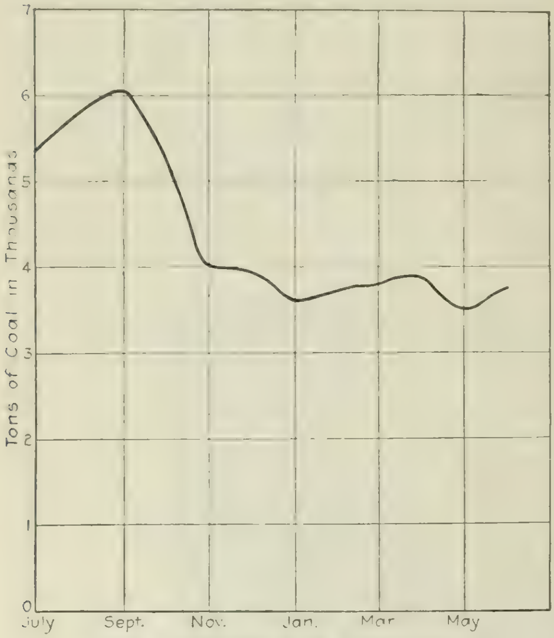
The characteristics of Utah coals was determined from a series of samples taken from railway cars and storage piles in yards of retail dealers. This gave the characteristic of the coal as delivered and used in Salt Lake City. The samples taken were sent to the Pittsburgh laboratory of the Bureau for analysis. Utah coals show a marked contrast to the general run of Western coals. The results of our analyses show them to be low in moisture, low in ash, with a high B.t.u. value. Their most pronounced characteristics

SALT LAKE CITY ON A SMOKY DAY
The need for smoke-abatement study is obvious.

re a high percentage of volatile matter and an extremely low sulphur content. These characteristics make a coal that is easily burned in all types of furnaces. The high volatile content produces a coal that is easily ignited, one that burns freely with a minimum production of clinker.

From the smoke standpoint the most pronounced characteristic of Utah coal is the volatile content. In general the higher the volatile matter in the coal the more smoky its performance. This is because of the difficulty of supplying sufficient air or oxygen to burn the volatile matter before it distills away from the fire and passes off through the boiler in the form of unconsumed carbon. Our experiments show that the standard methods of handling high-volatile coal as developed in cities of the Middle West are sufficient to burn the Utah coal smokelessly; that is, the headroom flame travel and other requirements for a successful furnace will satisfactorily handle coals on Salt Lake market.

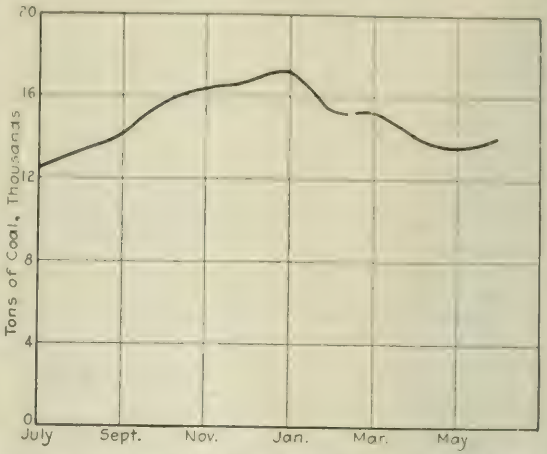
Possible sources of anthracite available in Salt Lake City are: Pennsylvania anthracite, which, of course, is prohibitive in price; Colorado anthracite from Crested Butte, which is eliminated because of producing less than 20,000 tons per year and having abundant market in Denver; Routt County anthracite; the proposed anthracite from Marble, Col., and a limited anthracite deposited at New Harmony, near Cedar City, Utah, in the southern part of the state. The latter three constitute the only source from which there is even a faint possibility of getting a supply of anthracite.



COAL CONSUMPTION OF RAILROADS

Engineers have spent considerable time examining the Routt County region for available anthracite and have reported adversely on this region because of the unreliability of the deposits in regard to continuity. Anthracite from this region, even if found in good quantity and of good quality, would have a prohibitive haul through Denver until such time as additional railroad facilities are provided through northern Utah.

Glenwood Springs (Marble Region, Col.) coal is situated about four miles from the Marble Glenwood Springs R.R., and samples analyze as of a fair grade of anthracite. Mining interests have regarded this deposit as inaccessible by ordinary means of transportation, which, coupled with the fear that the deposit would prove unreliable in extent, has retarded development.



COAL CONSUMPTION OF INDUSTRIAL POWER AND LARGE HEATING PLANTS

From information available there seems to be a fairly large acreage available with seam pitch of about 60 deg., and there would be about 600 or 800 ft. of ground available above the level at which the coal would be intersected by a feasible tunnel. In the proposed development of this property it is planned to bring the coal to the mouth of the tunnel by ordinary mining methods and thence over a very high, rough country by three to four miles of aërial tramway.

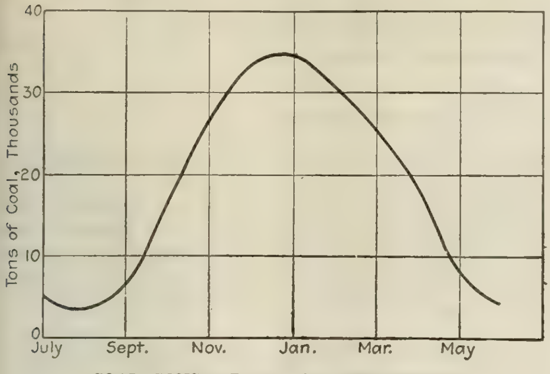
Assuming that the coal is dependable anthracite of good quality and abundant tonnage, the proposition would not offer an immediate solution of Salt Lake's fuel problem; with a pitch of 60 deg. it would take extensive development before sufficient ground could be opened to give a thousand tons per day, while this amount of tonnage transported over an aërial tramway would offer problems, especially in the winter season, which, to say the least, would be difficult in the extreme.

BRIQUETS AND COKE

(a) Briquets—Prepared fuel in the shape of briquets would offer a solution of the domestic problem if manufactured under proper conditions. Some Western coals, including lignites, have been prepared in briquet form by driving off the moisture and part of the volatile matter and producing a fuel that is smokeless for domestic purposes.

Briquetting has not as yet come into extensive use in the United States. The possibility of smokeless briquets for the Salt Lake market is one that should be considered only as a future possibility. Any process of briquet making with native coals that would include a partial carbonization, might more advantageously use coking methods, which would recover a larger percentage of byproducts.

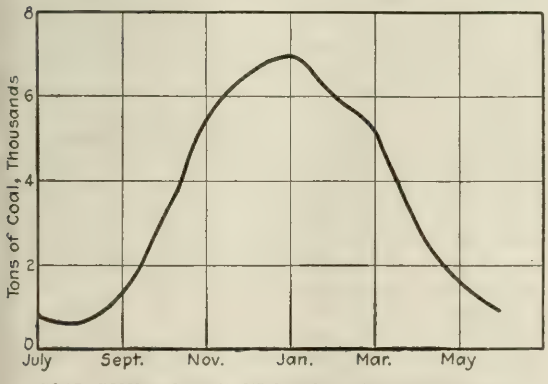
(b) High-temperature Coke—An attractive solution of the domestic smoke problem is to be found in the burning of coke. The manufacture of coke for residence purposes would not only be a means of eliminating the domestic smoke nuisance, but would also be a step in the conservation of natural resources. The time is not yet ripe for the use of coke in industrial plants, although it seems likely that in the course of a few decades no coal will be burned before carbonization and recovering of the valuable byproducts.



COAL CONSUMPTION OF RESIDENCES

Coking processes fall into two general classes—high-temperature processes and low-temperature processes. In the first class, coal is carbonized at a temperature of from 900 to 1,200 deg. C., producing a coke with very low-volatile content which is correspondingly difficult to ignite. The low-temperature process now being given considerable attention by engineers proposes to carbonize coal at temperatures of 450 to 600 deg. C. and produce a coke with higher volatile content and one that can be more readily ignited.

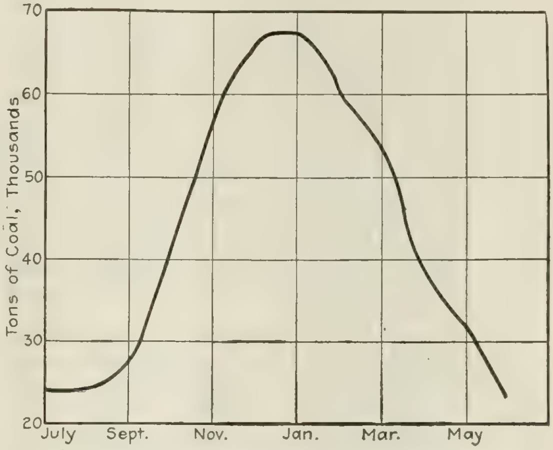
To supply the present needs of Salt Lake City 210,000 tons of coke would have to be produced annually. This would necessitate the carbonization of about 350,000 tons of coal and would produce nearly 4,000,000,000 cu.ft. gas, 3,500,000 gal. tar and 4,000 tons ammonium sulphate. There are about 15,000 tons of gas coke available yearly in Salt Lake City, most of which is shipped out of the state. A small number of residents have burned this coke for years with satisfactory results. Steps should be taken to bring about the consumption of all this coke in Salt Lake City.



COAL CONSUMPTION OF SMALL HEATING PLANTS

(c) Low-Temperature Coke—During the last ten years increasing attention has been given to the possibilities of low-temperature carbonization. A low-temperature coke is one containing sufficient volatile matter to make a fuel that ignites and burns readily. When coal is carbonized at temperatures of 450 to 600 deg. C., coke and byproducts differing in nature and amount from those produced by the high-temperature process are obtained. The coke still contains from 8 to 16 per cent of volatile matter and is more suitable for domestic use. It ignites readily, somewhat similar to semi-bituminous coal, burning without smoke. The smoke-producing constituents have been decomposed and driven off during the carbonization process.

The tar produced in such a process is a thin fluid better called an oil. It is produced in twice the quantity given in high-temperature carbonization. It contains considerable quantities of motor fuel, burning and lubricating oils, a small amount of pitch and 20 to 40 per cent cresols and other phenols. The gas is produced in smaller amount, but is of high calorific value. One ton of coal carbonized at a temperature of about 450 to 600 deg. C. will give 1,300 to 1,500 lb. of coke, 2,000 to 7,000 cu.ft. of gas, 20 to 30 gal. of tar and 2 to 8 lb. of ammonium sulphate.



TOTAL COAL CONSUMPTION OF CITY

(d) Disposal of Byproducts—Disposal of the gas produced offers the most difficult problem in the operation of a high-temperature carbonizing plant at Salt Lake City. Tar and ammonia can be sold at points some distance away. Gas must be consumed as soon as produced and sold in or near the city.

As before shown, a plant of sufficient size to supply a high-temperature coke to domestic consumers in the city would produce nearly 4,000,000,000 cu.ft. of gas. Salt Lake City uses at present about 420,000,000 cu.ft. of gas, or about one-tenth of the amount produced by a plant of the size mentioned. Part of this gas might be used in carbonizing the coal, but disposal of the remainder would be a difficult matter, necessitating the selling of the gas at a low rate for industrial and domestic purposes and holding down the production of coke for many years while the demand for gas was being built up.

Low-temperature carbonization produces about one-third as much gas, practically all of which can be used in the carbonization process itself. In this respect low-temperature carbonization seems the more feasible.

Electric Welding Machines—Direct-Current Constant-Current Types

Wiring Diagrams Are Given of Various Types of So-Called Constant-Current Welding Machines, and the Operation of the Machines is Explained Comparisons are Made of the Different Methods of Control

By L. W. Webb
Master Electrician, United States Navy Yard, Norfolk, Virginia

IN ORDER to do away with the resistance losses necessary with the constant-potential type of welding machines and provide single-operator sets as efficient and as light as possible consistent with reliable operation, etc., there have been developed various equipments of the so-called "constant-current types." A diagram of a United States Light and Heat Co.'s arc-welding converter is shown in Fig. 1. This type of machine combines in a single structure the functions of a motor and generator. Conversion of direct current from 120-volt supply to a lower voltage suitable for the arc is accompanied by small losses and therefore has a high efficiency from the standpoint of power input to energy delivered at the arc. This efficiency, of course, is obtained when machines are used upon existing 120-volt direct-current installations. When it is necessary to supply a separate motor-generator set to obtain 120-volt current for the operation of one or more machines, then the combined efficiency of the whole is not as good as that of the motor-generator type, which can have its motor designed to operate from any existing circuit.

The reactance coil is constructed to have two independent windings so they can be connected in series to give high reactance on low welding currents and in parallel to give low reactance on high welding currents. This equipment has the disadvantage of requiring special 120-volt direct current and also, unless the circuit is insulated from the ground, there is always the danger of a ground coming on one side of the line or other separate circuits or devices, causing a short-circuit of a part of the armature. Or possibly one side of the line had a ground on it before the machine was connected, and upon attempting to connect for operation caused a short-circuit when grounding to the work. However, where the work can be insulated from the ground this disadvantage does not exist.

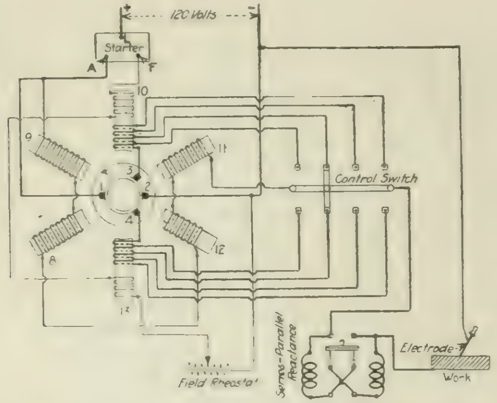


FIG. 1. DIAGRAM OF ARC-WELDING CONVERTER

As seen from Fig. 1, six poles are provided, but four of them are so wound as to produce a magnetic flux in the horizontal axis, constituting, therefore, a bipolar field. The main poles are provided with two windings, one a shunt winding connected across the source of supply, and a series winding in two parts connected between brushes 3 and 4 and a common terminal. The series winding is so arranged that more or less turns of these coils may be introduced or withdrawn from the circuit by a control switch. The current supplied to the welding circuit is furnished in equal portions by brushes 3 and 4. This current passes through the series winding and unites at a common point on the control switch, thence through the reactance, the welding arc, and back to the negative line connected to brush 2. The voltage existing across brushes 3 and 4 and brush 2 depends upon the direction and degree of excitation of the two main poles. On open-circuit this voltage is approximately 60, which is automatically reduced to an arc voltage of 20 by the action of the current flowing through the differentially wound series windings. The coils constituting the armature winding of this converter are placed in slots approximately 120 deg. apart and are effective in either the two-pole or the four pole field. The current supplied through the complete armature winding from brushes 1 and 2 and operating in the bipolar field on the horizontal axis forms the motor function. The current supplied to the welding circuit from portions of the armature winding through brushes 3 and 4 and brush 2 results from the generator action and depends for its final value upon the direction and magnitude of the right-angle components of the flux produced in poles 10 and 13 on the vertical axis of the armature. Control of this machine is simple, and adjustments

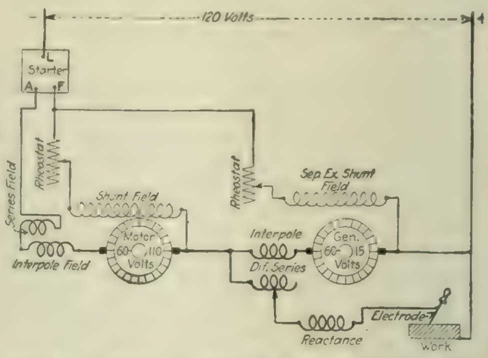


FIG. 2. ROTARY-BALANCER SET CONNECTIONS

of the various current values are easy to obtain. It is very compact, and for this reason can be taken in places where an ordinary motor-generator type of machine could not be placed.

Fig. 2 is a wiring diagram of the General Electric Co.'s rotary balancer set. This set operates with an external reactance having a fixed value for all currents. As can be seen from the diagram, this is a motor-generator type of machine, but owing to the way in which it is operated it offers certain advantages in being light, compact and easily portable. This equipment is also capable of wide variations in the welding-current control, and these adjustments are easily made by the shunt-field rheostats, and a dial switch, the latter varying the number of series-field turns on the generator. The set is self-regulating to an extent that the short-circuited current at the moment of striking the arc does not exceed 25 to 40 per cent above normal. Its disadvantages, however, are that its use is limited to one certain voltage, 120, also that it is necessary to ground the positive side of the line to the work. As regards insulating the work and the efficiency of the set, the same may be said as for the aforementioned type.

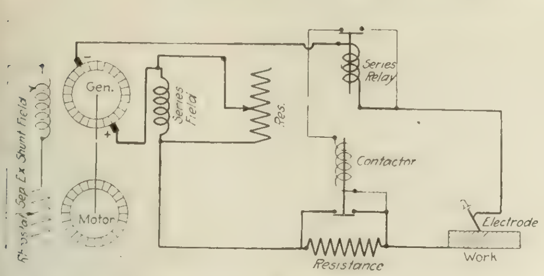


FIG. 3. ARC-WELDING MOTOR-GENERATOR SET CONNECTIONS, HAVING CONTACTOR TO SHORT-CIRCUIT RESISTANCE

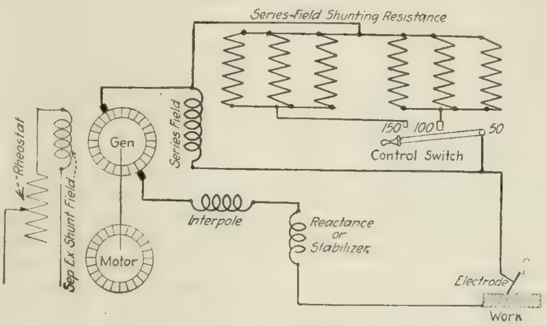


FIG. 4. WELDING EQUIPMENT HAVING DIFFERENTIALLY CONNECTED SERIES-FIELD WINDINGS

A wiring diagram for a C & C Electric and Manufacturing Co.'s motor-generator is given in Fig. 3. This type of machine consists essentially of a generator with a differentially wound series field and separately excited shunt field. The machine is designed so that the welding current flowing through this differentially wound series field opposes the ampere turns of the separately excited shunt field, which reduces the no-load voltage from approximately 60 to a value sufficient to maintain the arc at approximately 20 volts. Current ranges varying from 80 to 200 amperes can be obtained, and proper voltage automatically maintained at the arc for welding within the foregoing limits. Welding-current adjustments are made by regulating the separately excited field and also by shunting a part of the current around the differentially wound series field. There is supplied a resistance in series with the welding circuit which is automatically cut in at the moment the arc is struck and short-circuited when the electrode is raised. No external reactance is supplied since the necessary reactance is provided in the design of the series-field winding and the magnetic circuit of the armature. The design of the machine is such that while the arc is flexible it cannot be drawn out too far, or to such a point where dependable welding cannot be done. The over-all efficiency of this machine is approximately 65 per cent at normal output. Also the motor may be designed for use on any circuit available and the welding operation is entirely separate and distinct, electrically, from the power supply. When these machines are driven by alternating-current motors it is necessary to provide a separate exciter to take care of the shunt-field winding, but when they are driven by direct-current motors this is unnecessary.

The wiring diagram, Fig. 4, is for another type of equipment having a separately excited shunt-field winding and a differentially wound series field; the latter causes the open-circuit voltage to be reduced from approximately 65 to 20 volts at the arc under normal welding conditions. This equipment is built by the Lincoln Electric Co. Adjustments are made by rheostatic control of the shunt field and also by shunting part of the current around the series field. An external reactance or stabilizer is furnished which enables the operator to maintain a stable arc easily. Currents varying from 80 to 200 amperes can be obtained by adjustments of the separately excited field and shunting of the series field to maintain the current as set practically constant during the welding operation. The over-all efficiency of these machines is approximately 48 per cent, and as the motor can be designed for operation from any circuit the set is more efficient than the constant-potential machine. At the moment of striking the arc the action of the differentially wound series field is such that the short-circuited current is held down to about 140 per cent of normal, no external resistance being required. The only overload protection necessary is fuses on the motor circuit. When driven by alternating-current motor the machine requires a separate exciter.

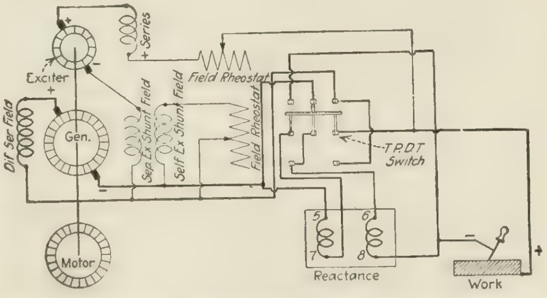


FIG. 5. WELDING EQUIPMENT HAVING TWO DISTINCT SHUNT WINDINGS AND SEPARATE EXCITER

A wiring diagram of the Siemund-Wenzel Electric Welding Co.'s motor-generator is that given in Fig. 5. Two separate and distinct types of shunt-field windings are used, one excited from a separate exciting circuit and the other self-exciting from the generator armature. The separately excited field can be adjusted so that when the machine is short-circuited at the instant of striking the arc it gives certain definite current values which determine the welding current, and as the electrode is lifted the additional excitation produced on the self-excited field provides regulation for the welding current. These machines are provided with external reactance wound in two circuits, and for the lower welding currents of 75 amperes and less the reactances are connected in series, thus giving high reactance values; and on the higher current values these reactances are paralleled, thus materially decreasing the total amount of reactance in the welding circuit.

The over-all efficiency is approximately 60 per cent. A separate exciter is necessary when the machine is driven by alternating-current motors, but is not required when driven by direct-current motors. The control, however, is not very simple, as proper operation depends upon the correct setting of two separate field rheostats, either one of which being incorrectly set would make the welding operation somewhat unstable. This, of course, would not apply if operators had been properly instructed or were experienced.

Fig. 6, which is a diagram of a Burke Electric Co.'s welding motor-generator, is somewhat similar to that in Fig. 5, the main difference being that in the latter there is supplied a differential series winding on a part of each pole, which is used as a compensating winding and which acts to oppose the shunt fields and maintain proper arc voltage. The separately excited field is adjusted so that when the electrode is short-circuited on the work proper welding current will flow, and as the electrode is lifted the adjustment on the self-excited field is so made that the generator armature voltage will maintain proper welding current with 20 volts at the arc. The over-all efficiency of these sets is approximately 63 per cent. The motor can be designed for any voltage or frequency, and if direct current is used an additional exciter is unnecessary. Welding adjustments, however, as in Fig. 5, are somewhat difficult to make, as they depend upon the adjustment of two separate field rheostats, either one of which being improperly adjusted would make the welding somewhat unstable.

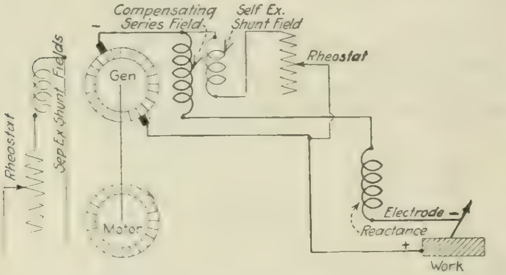


FIG. 6. WELDING GENERATOR HAVING TWO SHUNT WINDINGS AND A DIFFERENTIAL SERIES WINDING

The wiring diagram, Fig. 7, is for a Westinghouse Electric and Manufacturing Co.'s machine and has some unusual connections. It is essentially a four-pole machine with four interpoles. On poles 1 and 3 there are shunt windings connected in series through a fixed resistance *A* and a variable resistance *B* across an external exciter. Poles 2 and 4 have differentially wound series fields, and paralleled shunt windings connected in series with a fixed resistance *X* and across the generator armature. The fixed resistances *X* and *Y* are directly connected across the exciter circuit, and their common connection goes to the positive side of the generator circuit. When the generator is operating under no load—that is, with the welding circuit open—and also during normal welding conditions, the current through the self-excited shunt field is obtained from the generator. During these periods the parallel shunt field is assisting the separately excited shunt field. At the instant the arc is struck the current for the separately excited shunt field comes from the exciter through the fixed resistance *Y* to the work, through the generator's series windings through the shunt windings 2 and 4, in the reverse direction, and back to the negative terminal of the exciter. From this it is seen that when the machine is short-circuited at the instant of striking the arc the excitation of fields 2 and 4 immediately drops to zero and reverses momentarily, so that the current then flowing is that due to the amount of excitation furnished by the separately excited fields minus the bucking effect of the reverse current in the multiple shunt fields and the current flowing through the differentially wound series fields. When the electrode is lifted and welding started, the excitation then furnished to the self-excited fields by the generator provides an amount just sufficient to maintain current under proper welding conditions of 20 volts at the arc.

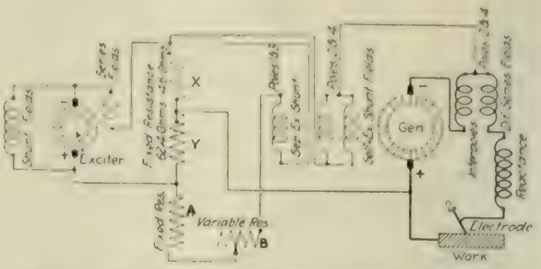


FIG. 7. WELDING GENERATOR HAVING A SPECIAL REGULATING FIELD WINDING

The different welding currents are obtained by a variable rheostat *B* in the separately excited field, and welding-current changes can be obtained variable between 50 and 200 amperes. There is a fixed reactance supplied in the external circuit, which also helps to hold down the short-circuited current at the instant of striking the arc, as well as stabilizing the arc. On machines, whether driven by direct- or alternating-current motors, it is necessary that a separate exciter be furnished to provide the special control shown by the wiring diagram. These exciters normally supply about 125-volt direct current and are compound-wound.

The machine is adapted for portable welding use and has an over-all efficiency of approximately 53 per cent. One point, however, which should be mentioned is the fact that if either one of the resistances *X* or *Y* becomes open, burned out, etc., and is repaired by the ordinary repair man he would very likely change their resistance values without giving it much thought—in order to make rapid repairs, as is ordinarily done, without ordering new resistances from the factory. This means that the entire machine-welding characteristics would be changed, and with the chance of damage to the whole equipment.

Regulation of the United States Light and Heat Corp. motor-generator, schematic wiring diagram, Fig. 8, unlike those described in the foregoing, is obtained without the use of any separate exciter and is termed the "variable-voltage self-regulating welding type," rather than the so-called "constant-current type," although it is capable of supplying current ranges from 80 to 200 amperes under welding conditions similar to the other type described. The windings on this machine consist of a self-exciting shunt winding, which magnetizes the field poles to a low point of saturation.

The action of the light cumulative-compound winding upon the field flux results in maintaining a stable current under welding conditions as set by the adjustments of the shunt-field rheostat and the series shunt around the compound winding. At the instant the electrode is shorted the current flowing is due to the flux produced by the compound winding and the small amount of flux set up by the shunt field, produced by the low voltage across the generator armature. As the electrode is lifted the shunt-field current increases, which provides proper values of flux for the welding current desired. Variations of welding currents are obtained by adjusting the shunt-field rheostat and the shunt across the series-field winding. Separate and external reactances furnished in these circuits enable the operator to maintain a steady arc. Owing to its not being necessary to have any separate exciter with this machine, it is simple and efficient in its operation. The open-circuit voltage is approximately 60 volts, and the over-all efficiency is approximately 60 per cent.

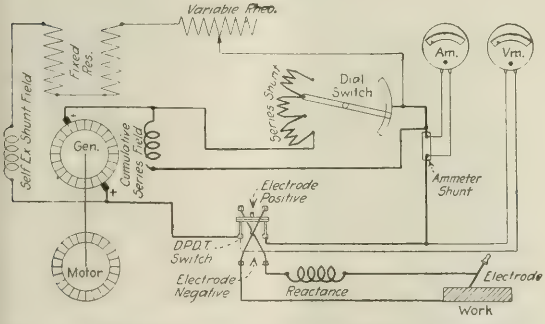


FIG. 8. CONNECTIONS FOR A VARIABLE-VOLTAGE SELF-REGULATING TYPE OF WELDING EQUIPMENT

Regulation of the General Electric Co.'s motor-generator, Fig. 9, is similar to that in Fig. 8 and is also obtained without the use of any separate exciter, whether driven by direct-current or by alternating-current motors. This machine is termed the "constant-energy self-excited type," rather than the "constant-current type," although it is capable of supplying current ranges from 75 to 200 amperes under welding conditions. As can be seen from the wiring diagram, this machine has shunt windings on four poles connected to one side of the line through a variable rheostat and to a special third brush on the commutator, so set as to supply voltage for the shunt-field excitation required for the various welding currents. On two of these poles there are series windings connected in parallel, with taps also connected in parallel. The number of series turns is controlled by a dial switch, thus providing the means for obtaining various welding currents in combination with the rheostat adjustments of the self-excited field. The open-circuit voltage of this machine is approximately 60 volts, which automatically drops to 20 volts while welding is being done. An external reactance of the fixed type is provided which assists to hold down the short-circuit current at the instant of striking the arc and also provides a sufficient amount of reactance for stable conditions during welding. The maximum short-circuited current is approximately 250 amperes. This machine has an over-all efficiency of approximately 53 per cent.

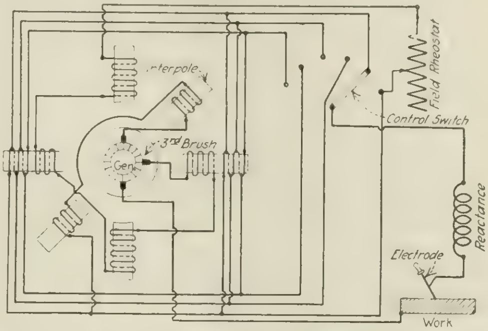


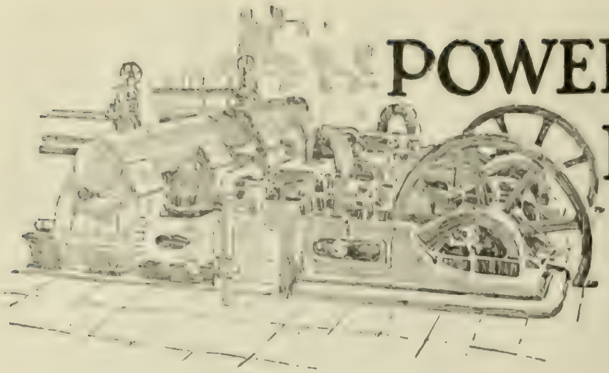
FIG. 9. CONSTANT-ENERGY SELF-EXCITING TYPE OF WELDING-EQUIPMENT CONNECTIONS

(In the previous article constant-voltage welding equipments were treated of. The next article will be a general discussion of welding machines and the reactance values that are required in the circuit in order to do good welding.)

Injury from Engine in Power House

Pumping machinery, inclosed in an iron house at the Little Pirate Oil and Gas Co., Kansas, which was operated and taken care of by an employee, was allowed to run for a short time when he left the plant to attend to another task. The home of his family was within one hundred feet of the power house, and while he was absent, his son, 12 years old, accompanied by another younger son, entered the power house to shut off the engine. The latter went so close to the machinery that he was caught in a belt and suffered injuries which resulted in his death. The children had been repeatedly warned by employees of the danger of close approach to the plant and directed to keep away from it.

Suit for damages was brought against the company by the father of the child, and the decision of the court was to the effect that "if there was any want of care in the premises, it was chargeable to the plaintiffs themselves. They had control and management of the power plant and also the care and control of their children. The defendant could not be expected to supersede the plaintiffs in the direction and guardianship of the children, and neither can it be held responsible to them for their own inattention nor lack of care."



POWER DRIVES FOR ROLLING MILLS

By W. O. Rogers

Large quantities of water are used for boiler feeding, but in many instances it is necessary to treat it chemically. This is especially true of the Mahoning River water, and large treating systems have been installed in several of the rolling mills in the Youngstown district.

WATER FOR feeding boilers is an important factor in steel-mill operation. The two big plants of the Republic Iron and Steel Co., and the Youngstown Sheet and Tube Co. are located on the Mahoning River, into which the sewage from the City of Youngstown and wastes from all manufacturing plants between that city and Warren, Ohio, are discharged. The impurities so introduced, in addition to the normal hardened condition of the water, make it undesirable for boiler feed without treatment. Analyses of the river water before softening and precipitation with analyses of the water after being softened are shown in the accompanying table. The softened water shows the absence of the sulphates, chlorides and nitrates of lime, iron and magnesia, and also that the total of the residual lime as calcium carbonate and the residual magnesia as magnesium hydroxide is less than two grains per gallon. A plant capable of treating 300,000 gal. of water per hour, or 7,200,000 gal. per 24 hours, and laid out so that a 25 per cent extension can be made increasing the treating capacity to 375,000 gal. of water per hour, or 9,000,000 gal. per 24 hours, is in operation at the Republic works, and one with a capacity of 5,000,000 gal. of water per day at the Youngstown plant. Water softening is the chemical removal of soluble impurities that makes water hard, but in order to determine the proper chemicals and the amount, the water must be analyzed to ascertain the impurities. Before soluble impurities can be taken from water, they must be made insoluble so that they can be removed by sedimentation and filtration. To soften water, it is necessary to remove both its temporary and its permanent hardness. The temporary hardness is caused by the carbonates of lime, magnesia and iron, which are held in solution as bicarbonates. The permanent hardness is caused by the sulphates, chlorides and nitrates of lime, magnesia and iron.

Generally, but two reagents are required for water purification. What makes the difficulty is the fact that the impurities in the water are small and are frequently made up of several substances, each of them differing in the time and quantity of reagents required for reaction. Lime and soda ash are the reagents usually employed, but these are frequently supplemented by other reagents in order to obtain the best results. When feed water containing soluble hardening substances is introduced into a steam boiler, the impurities are eventually forced out of solution and are deposited either as a sludge or as a scale, so familiar to steam engineers. It is known that a clean boiler will evaporate more water per pound of coal than one that is coated with scale. The presence of scale also causes overheating, and an overheated boiler plate is more readily attacked by corrosive agents than one that has not been overheated and weakened. Furthermore, in the modern power plant the boilers are operated up to around 250 per cent of rating, and at the higher rate of evaporation the amount of concentration of impurities in the water in the boiler increases. At the Republic

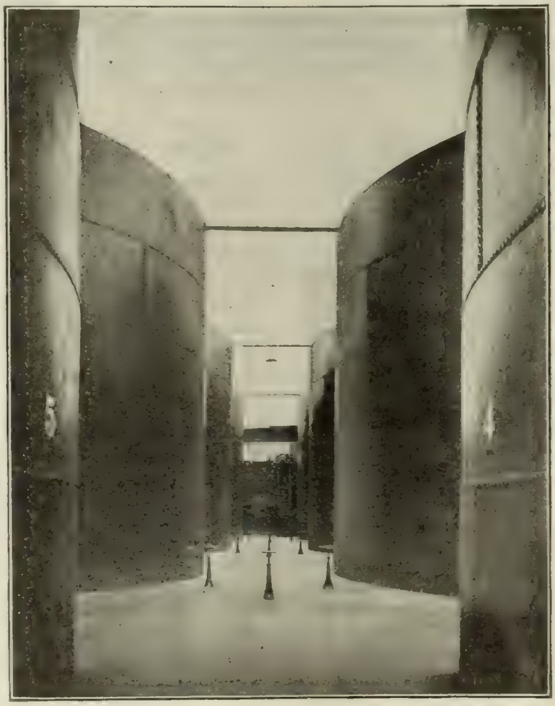


FIG. 1. MIXING AND SETTLING TANKS

Works the intermittent type of purifier was installed, because the water of the Mahoning River could be treated in fixed volumes and a water obtained that is uniformly softened regardless of variation of the condition of the river.

In the intermittent system definite quantities of water are treated all the time, the exact quantities of the reagents required being weighed out so that each tank of water is properly treated.

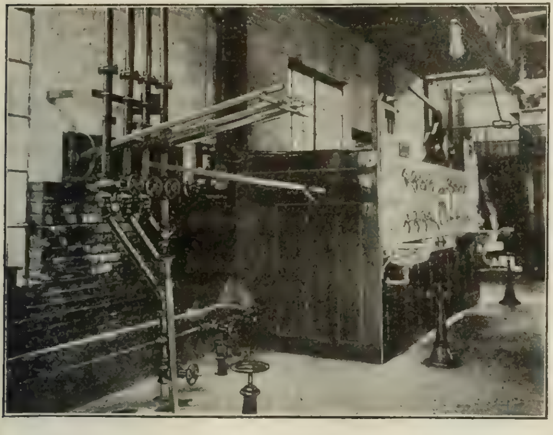


FIG. 2. OPERATING BOARD FOR CONTROLLING MIXING AND SETTLING TANKS

The reaction tanks are filled alternately with water. While the tank is filling, the reagents are introduced and mixed with the water by means of a stirring apparatus. After the tank is filled, the stirring is stopped and the water becomes static. This allows the precipitate to settle. The softened water is taken out near the surface, where it is cleanest and carries the least floating sludge, by means of a float arrangement and is then discharged to the filter bed.

MAHONING RIVER WATER—RAW AND TREATED

Grains per U. S. Gallon

	Raw	Treated	Raw	Treated	Raw	Treated
Volatile and org. matter...	1.15	0.65	0.95	0.75	1.05	0.65
Silica....................	0.45	0.45	0.75	0.75	0.75	0.45
Oxides of iron and alum...	trace	trace	trace	trace	trace	trace
Calcium carbonate........	2.43	0.88	2.80	0.60	3.20	0.80
Calcium sulphate	11.32	....	5.03	....	3.94	....
Magnesium sulphate	4.86	....	3.84	....	2.88	....
Magnesium hydroxide....	....	0.48	....	0.17	....	0.23
Sodium carbonate..........	....	2.78	....	2.12	....	2.00
Sodium sulphate..........	0.53	18.46	4.40	15.05	0.85	8.95
Sodium chloride..........	9.40	10.22	2.45	2.57	2.22	2.34
Sodium nitrate...........	....	....	trace	trace	0.17	0.17
Sodium hydroxide.........	....	0.94	....	1.36	....	0.64
Manganese carbonate.....	0.08	....	....	....	....	....
Total solids.............	30.22	34.86	20.22	23.37	15.11	16.23
Suspended matter.........	0.65	trace	0.45	filtered out	1.45	trace
Free carbonic acid........	0.25	none	none	none	0.25	none
Incrusting solids..........	19.14	1.81	12.42	1.52	10.82	1.48
Non-crusting solids.......	9.93	32.40	6.85	21.10	3.24	14.10

There are eight steel reaction and settling tanks at each of the two plants mentioned, those at the Republic plant being 37 ft. in diameter and 35 ft. high, arranged in two parallel rows with four tanks per row. Fig. 1 shows the mixing and settling tanks that are used for filtering the boiler-feed water at the main plant of the Youngstown Company. Fig. 2 shows the operating board for operating the mixing and settling tank, on which is mounted the control handle. At the ends of the control board there are open mercury gages for indicating the height of water in the tank. These are shown in Fig. 3. A recording thermometer placed in the center of the board records the temperature of the water.

A view of the soda ash and lime-mixing tanks is shown in Fig. 4. The stirring apparatus is driven by means of belts that run through the floor to a shafting that is motor-driven, a friction clutch on each tank permitting of starting and stopping each one independently of the other. The charges of reagents are weighed out and dumped in the reagent mixing tank, whence the charge is pumped into either one of the reaction tanks by means of motor-driven centrifugal pumps in a pit below the floor of the mixing tank.

The lime is slacked ready to be introduced into the reaction and settling tanks when the filling of the tank begins. As soon as the filling begins, the charge of lime is pumped into the tank and the stirring apparatus is started and is kept in operation during the period of filtering. When the tank is full, a charge of ferrous sulphate is introduced, and after a lapse of about ten minutes a sample of water is taken for testing the correctness of the lime treatment and the ferrous sulphate.

After the introduction and mixing of the ferrous sulphate, a charge of soda ash is put in and stirring is continued for about fifteen minutes. Then the water is allowed to stand for reaction and settling. One-half hour after stirring is stopped, a sample of the fully treated water is drawn for testing. At the end of the settling period the water is delivered to the filters as required. The filters are equipped with individual air-washed systems, consisting of brass laterals drilled for the uniform distribution of air. This piping is placed above the strainer piping in the filter bed. The filter removes the crystalline precipitate that is too fine to settle and guards against the possibilities of dirty water from the settling tanks getting into the boiler-feed system.

When I left the rolling mills, I was more impressed with their bigness than I had ever been before. The sizes of some of the units, both engines and motors, were impressive, as was also the area covered by the mills as a whole. It was not possible to obtain permission to go through many of the steel mills such as those in the Pittsburgh and Cleveland districts, but enough large mills were accessible to enable me to obtain

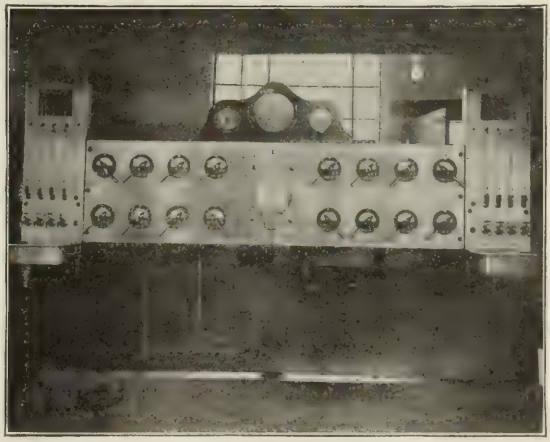


FIG. 3. FRONT VIEW OF THE OPERATING BOARD SHOWING MERCURY GAGES AT EACH END

FIG. 4. SODA-ASH AND LIME-MIXING TANKS

sufficient data and illustrations to convey to the reader an idea of the general process of making steel and also of the types of machines and equipment used in its manufacture.

Checking Single-Phase Wattmeters

By H. C. Yeaton

Like all switchboard instruments, a single-phase indicating wattmeter should be checked frequently to ascertain that it is indicating correctly. The wattmeter can be checked with a portable single-phase instrument, and the accompanying diagrams of connections and instructions explain, in general the procedure:

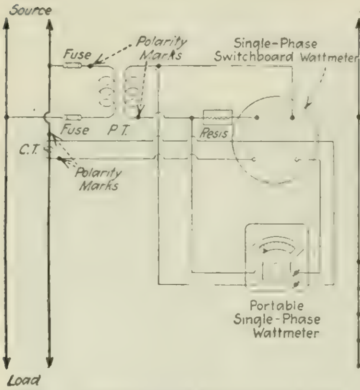

Source
Polarity Marks
Fuse
Single-Phase Switchboard Wattmeter
Fuse
P.T.
Resis
C.T.
Polarity Marks
Portable Single-Phase Wattmeter
Load

FIG. 1. CONNECTION FOR CHECKING WATTMETER IN POWER CIRCUIT

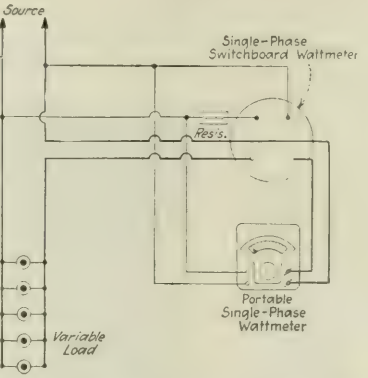

Source
Single-Phase Switchboard Wattmeter
Res's.
Portable Single-Phase Wattmeter
Variable Load

FIG. 2. CONNECTIONS FOR CHECKING WATTMETER ON VARIABLE LOAD

Connect the single-phase portable wattmeter in the circuit as shown in Fig. 1, the current terminals of the portable wattmeter being connected in series with the current terminals of the switchboard instrument, and the potential terminals of the portable instrument being connected across the potential circuit. The scale of switchboard indicating wattmeter is usually marked in primary watts—that is, the actual watts or kilowatts of the circuit—and is equal to the primary amperes multiplied by primary volts. This scale is marked so that it can be easily read, and it generally ends in an even number. The calibrating watts of a single-phase wattmeter is the watts required to make the needle deflect from zero to full scale, and equals the scale range divided by potential-transformer ratio multiplied by current-transformer ratio, when transformers are used. By checking the calibrating watts of the switchboard wattmeter with the portable wattmeter, the accuracy of the former may be determined.

Suppose that the single-phase system shown in Fig. 1 is a circuit of 100 amperes and 2,200 volts. The potential transformer has a ratio of 20 : 1 (2,200 to 110 volts) and the current transformer ratio is 20 : 1 (100 to 5 amperes). The watts of the circuit would be 2,200 multiplied by 100, or 220 kilowatts, but as a 220-kilowatt scale would have rather an uneven ending, a 200-kilowatt scale would probably be marked on the instrument. Therefore, full-scale calibrating watts would be

$$\frac{200{,}000}{20 \times 20} = 500 \textit{ watts}$$

If the pointer of the switchboard instrument read 150 kilowatts, then the calibrating watts for this point would be

$$\frac{150{,}000}{20 \times 20} = 375 \textit{ watts}$$

Therefore, if the pointer of the switchboard wattmeter indicated 150 kilowatts, it would mean that only 375 watts were actually impressed on the instrument itself, and the portable wattmeter, also being connected on the secondary of the transformers, would indicate 375 watts if the switchboard wattmeter was indicating correctly.

The foregoing method of checking a single-phase wattmeter compares only one point on the scale, as it would not be convenient to vary the primary load, which would probably be a feeder circuit. For general checking, this method would be sufficient to obtain the approximate accuracy of a wattmeter.

If it is desired to check more than one point on the wattmeter scale, short-circuit the current transformer and disconnect the instrument from the circuit. Then connect the instrument on a single-phase circuit, using a variable load, so that different readings on the scale may be obtained, as in Fig. 2. For the switchboard meter the calibrating watts of any reading is determined as in the foregoing method, and by varying the load, any point on the instrument's scale can be checked with the portable meter.

Suppose that it is required to check the previous instrument at the points 50, 100, 150 and 200 kilowatts. Connect the instrument on a 5-ampere 110-volt circuit, as shown in Fig. 2. *The calibrating watts of any particular reading = Scale readings ÷ Potential-transformer ratio* (20) × *Current-transformer ratio* (20). Substituting the readings 50,000, 100,000, 150,000 and 200,000 watts and dividing by the product of transformer ratios we obtain:

Switchboard Wattmeter Scale Reading, Kilowatts	Calibrating Watts of Switchboard Wattmeter	Portable Test Wattmeter Readings, Watts
50	125	125
100	250	250
150	375	375
200	500	500

Other readings of the switchboard wattmeter can be checked in like manner.

Excessive Diesel Piston Clearance

It is generally assumed that the piston and cylinder wall clearance of Diesel engines should range from 0.006 to 0.010 in. Before the wear exceeds 0.015 in., or approximately $\frac{1}{64}$ in., it is time to rebore the cylinder and install a new piston or insert a new liner. If the engine is to carry full load with fair economy, 0.010-in. clearance is too great, although it is possible for a Diesel to have a far greater clearance and still carry a fair percentage of its rated load. The fuel consumption, in such event, will show a decided increase.

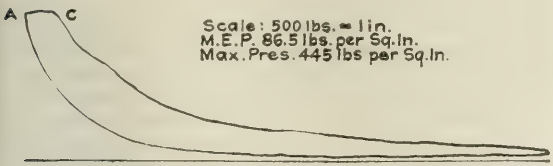


FIG. 1. FULL LOAD WHEN NEW

Fig. 1 is an indicator card from a three-cylinder Diesel taken in 1912 while the engine was carrying full load. The speed was 164 r.p.m. and the injection air pressure averaged 70 atmospheres, or 1,050 lb. gage. The fuel consumption per brake horsepower was computed to be 0.425 lb.

In Fig. 2 is shown a diagram from the engine after five years of operation followed by a two-year period of idleness. At the time this diagram was taken the engine had been re-erected in another locality. It was carrying 120 kw. with the injection pressure at 80 atmospheres and the speed at 145 r.p.m. The drop from the no-load speed of 164 r.p.m. was due to the load being more than the engine could carry while maintaining its speed. In other words, 120 kw. was more than the engine's capacity in its worn condition. On calipering the piston and cylinder, the clearance was found to range from $\frac{1}{8}$ in. to $\frac{3}{16}$ in.

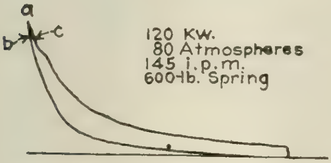


FIG. 2. FULLY LOADED WHEN WORN

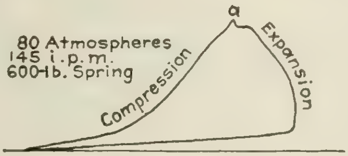


FIG. 3. DISTORTED CARD

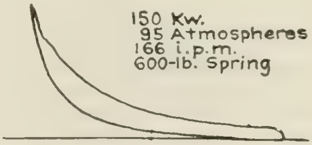


FIG. 4. INCREASED AIR PRESSURE

Comparing Figs. 1 and 2, the combustion lines *a-c* are found to be entirely different. In Fig. 1 the fuel was burned at constant pressure, while in Fig. 2 the pressure during combustion, *a* to *c*, apparently follows an isothermal line. The explanation is found in the excessive piston clearance, which allowed the gas to escape almost as rapidly as the combustion took place.

It was at first assumed that the inertia of the indicator piston was responsible for the sharp peak at *a*. However, this point was due to the high injection air employed. The atomizer was of a design that allowed a considerable air charge to blow into the cylinder before the oil charge was picked up by the air current. The pressure in the cylinder at the end of the compression stroke then received quite an increase when the needle valve opened. Fig. 3, which is a distorted card taken from No. 3 cylinder while the indicator rigging was connected to No. 2 piston, shows the decided rise in pressure at the point of fuel-valve opening *a*.

An interestng feature was the ability of the engine to carry a greater load with an increase in the injection air pressure. With 95 atmospheres, or 1,410 lb. gage, the engine was able to carry 150 kw. at 166 r.p.m. Since with 120 kw. and 80 atmospheres, the governor was at its lowest point, the ability to carry 150 kw. with 95 atmospheres was not due to an increase in the fuel charges. In fact, the governor rose to its normal position when the higher injection pressure was used. Fig. 4 is a diagram taken when the engine was operating under these conditions. Employing lower pressures it was found that the engine's capacity followed the pressure changes.

Relief by Raising Injection Pressure

In the operation of this unit the piston clearance was so great that a major part of the cylinder charge of air escaped along the piston as the latter moved outward on the compression stroke. The amount of air contained in the combustion space was insufficient to thoroughly consume the fuel charge without the assistance of the injection air. Since the weight of the injection air entering the cylinder during a given interval of time varies with the air pressure, it is apparent that a higher pressure enables the fuel to be more thoroughly consumed. This is, to all intents, a case of surcharging.

Such procedure is not to be recommended for ordinary operation, but in plants where the equipment is old and the peak load is somewhat greater than the engines can carry, raising the injection pressure to around 80 atmospheres will afford a temporary relief. Care must be exercised to prevent an increase that will cause the fuel valve to wedge open. Adjustment of the needle-valve spring will usually eliminate this danger. It should be understood that very high air pressures will seriously affect the exhaust valves and will impair the cylinder lubrication. This is due to the fact that considerable after-burning, or combustion during expansion, occurs at such times, resulting in high exhaust temperatures.

When the supply of oil to a bearing is interrupted, overheating will prove serious and rapid. The supply of oil may be cut off because a feed pipe has become plugged or through the oil reservoir running dry, broken ring oilers, glazed felt pads or pads which have fallen away from the journal. Dirt entering the bearing with the oil or from outside sources usually results in overheating. The more abrasive materials cause heating because they roughen the journal and bearing, but the softer materials are usually found to have plugged the oil grooves and cut off the oil flow.

Steam-Engine Operation and Maintenance—Lubrication and Oil Pumps

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

WITH wet steam no engine can run satisfactorily for any length of time, as the water will be separated from the steam in the cylinder and carry off the lubricant. A good deal of trouble in this respect is caused through insufficient covering of the steam pipe. It is unreasonable to let steam condense in the pipe and the condensate destroy the lubrication in the cylinder. The fuel required to make the steam condensed in the pipe is a total waste. To cover a steam pipe efficiently is an expense incurred but once, but the loss through condensation in the pipe is continuous and may sum up to a good-sized figure in the course of time. Since about 2½ hp.-hr. are lost per 100 sq.ft. of bare pipe through radiation, which is equivalent to 57 ft. in length of 6-in. pipe, the loss per year would amount to between 15 and 20 tons of coal, the price of which would more than pay for the covering.

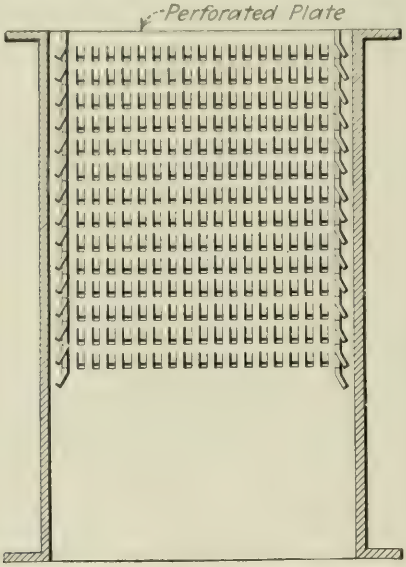


FIG. 1. PERFORATED PLATE IN PROFESSOR SWEET'S SEPARATOR

Some condensation in the steam pipe is unavoidable, even with the best kind of covering. To keep it from entering the cylinder, it must be separated from the steam. A change in direction combined with a reduction in velocity will effectually separate water from the steam in which it is entrained. A simple contrivance, or steam separator, made of some pipe and fittings, will in many cases answer the purpose. There are, of course, many varieties of steam separators manufactured, for which some wonderful claims are made, but a home-made one like that mentioned above may be just as effective provided the body has ample capacity. One of the most effective separators was originated by Professor Sweet, who as the designer of high-speed engines learned by experience that the best place to separate water from the steam is in the steam pipe near the engine, but not in the cylinder. His separator is practically the same as the one shown in the sketch, except that it has a perforated plate inserted with lips projecting on one side pointing downward, as shown in Fig. 1. The object of the lips is to catch the drops of water and let them drip to the bottom. The so-called receiver separators, which have a large space for the separation and accumulation of water, are far more effective than the smaller kind, which depend on the impinging of the steam on corrugated surfaces. No large accumulation of water in the separator must be permitted, for which purpose the latter should be connected to a trap.

From the primitive tallow cup and the periodical fifteen or thirty minutes' oiling, which were in use and practiced some thirty years ago, engines have graduated into a new class, with oil pumps, self-oilers and highly satisfactory oiling and filtering systems. The joy of the cub engineer to chase round with a long-spouted can and squirt oil into this oil hole or that, leaving a trail of oil on the floor or having the spout of his can nipped off in the endeavor to lubricate the link block on a reversing engine, has departed. We see fancy oilstands with beautifully polished copper oil cans exhibited in an engine room, as an ornament, but the cans are hardly ever used.

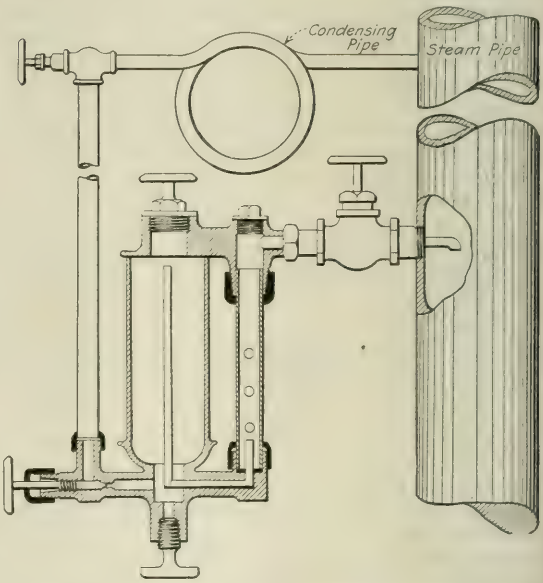


FIG. 2. SECTION OF DISPLACEMENT LUBRICATOR

The first advance in lubrication was the introduction of sight-feed cylinder lubricators, which rest on the principle of displacing small quantities of oil by condensed steam in an oil reservoir from which it is fed dropwise and visibly into the steam pipe. The operation is made clear in Fig. 2, which shows a general arrangement and sectional view of a sight-feed lubricator. The action of the lubricator is as follows: Steam enters through a small pipe screwed into the steam pipe a few feet above the engine; the steam entering this pipe is condensed and the water led to the bottom of the reservoir underneath the oil, which is raised and discharged through the small vertical pipe and sight feed into the steam pipe right over the throttle. The admission of steam and water and the discharge of oil are controlled by valves; the lubricator can be filled and drained through suitable openings. The sight feed shows the drops of oil on their way to the steam pipe.

All kinds of combinations and variations of designs have been incorporated in these sight-feed lubricators, but the principle is the same in all of them. The oil can be injected at any place in the steam pipe, steam chest or cylinder where it is most desirable, but to become effective for lubrication it must be taken up and thoroughly diffused by the steam. In many cases the oil pipe is simply screwed in and the oil runs down the pipe or wall of the steam chest without lubricating effect. This of course is a waste of the lubricant and will lead to trouble; the oil pipe must enter at least two inches, and its end should point downward to mix the oil freely with the steam.

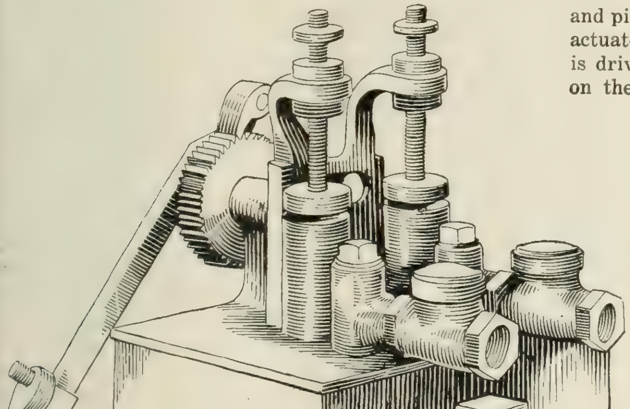


FIG. 3. SIGHT-FEED OIL PUMP DRIVEN BY RATCHET WHEEL

Displacement lubricators are not positive. There is a possibility of impurities such as scale and sediment being carried along with the steam, clogging the pipes and putting the lubricator out of order. To avoid trouble of this kind, mechanically operated devices in the form of force-feed oil pumps have come into use. They consist of an oil tank in which are immersed one or more plunger pumps driven by eccentrics or racks and pinions, as shown below in Fig. 3. In the eccentric-actuated pumps the plunger moves slowly, the eccentric is driven by means of a ratchet wheel and lever placed on the outside of the tank, the lift of each pump is regulated by stops. A ratchet wheel is likely to become noisy at high speeds.

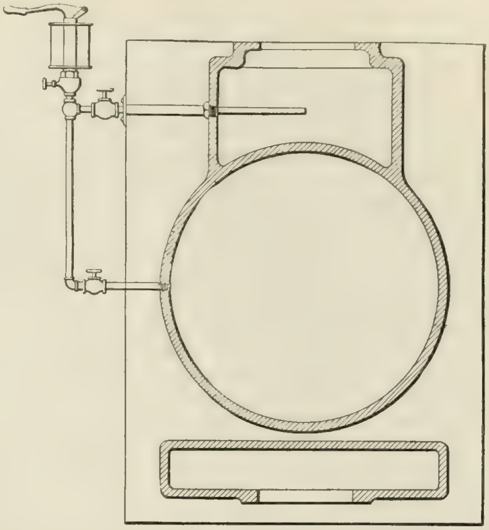


FIG. 5. HAND OIL PUMP ON STEAM-ENGINE CYLINDER

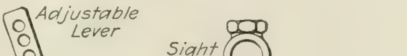


FIG. 4. SECTION OF A SIGHT-FEED OIL PUMP

The other kind of oil pumps, in which the upper part of the plunger is provided with a number of teeth which are engaged by a small pinion, is well adapted for high speeds. There is no lost motion to be taken up, and the plunger makes a double stroke for every revolution of the engine. All the working parts are running in oil; the wear on them is therefore negligible. On this pump the strokes of all the plungers are simultaneously changed by shortening or lengthening the adjustable lever, while the quantity of the oil delivered is regulated by a bypass. The latter is a great convenience for the engineer since it enables him, if necessary, to change the feed to the cylinder and other lubricated parts from a drop to a flood of oil. This feature is lacking in the displacement lubricator, which is therefore as a rule supplemented by a hand oil pump by means of which a considerable quantity of oil can be discharged into the steam chest or cylinder in case of emergency, as shown in Fig. 5. Lubricators or oil pumps for engines up to 100 hp. are generally provided with but one feed, but those for larger engines should have a number of feeds according to the size of the cylinders. On compound engines each cylinder should have a suitable lubricator or sight-feed oil pump.

Rarely is any attempt made to reclaim the cylinder oil carried off by the exhaust; it may be considered as a total loss. To reduce this expense, engineers and managers are tempted to use inferior grades of cylinder oil or reduce the amount used to the lowest possible limit. It is questionable if efforts in this direction can be recommended, since they may result in permanent and costly injury to the engine. There is no sure indication that a cylinder is sufficiently lubricated, except the smoothness with which the piston is working and the appearance of the cylinder bore when the back head is removed; neither can a deficiency in the supply of the lubricant be detected until piston and valves begin to groan and work hard, when on inspection they may be found to be dry and perhaps scored. The idea of cutting down the oil supply by reducing the number of drops per minute until the engine shows distress is certainly wrong, as is also the substitution of a high-priced lubricant by a cheaper article, unless the lubricating qualities of the latter have been demonstrated or its composition found to be of equal merit.

Dragline Cableway Excavator Rehandling Coal

At the plant of the Indianapolis Light and Heat Co. a dragline cableway excavator, designed originally for the handling of sand and gravel, was brought into emergency use to supplement the coal-handling facilities, the recent shortage making it necessary to draw upon storage more heavily than usual. The coal is stored in a concrete pit having a capacity of approximately 30,000 tons. The pit is 100 ft. wide, 300 ft. long and 25 ft. deep. A railroad track running through the center on a level with the top of the pit is supported by a concrete trestle, and the coal is dumped into the pit directly from the hopper-bottomed cars.

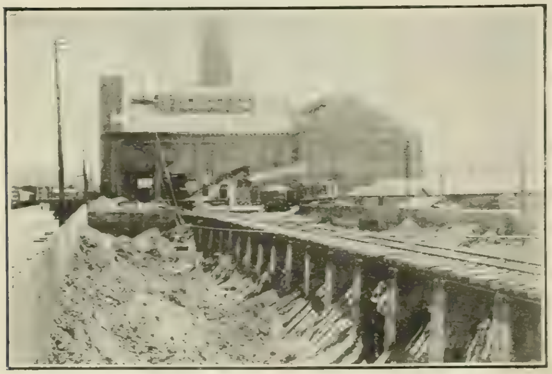


FIG. 1. CABLEWAY AND COAL-STORAGE PIT

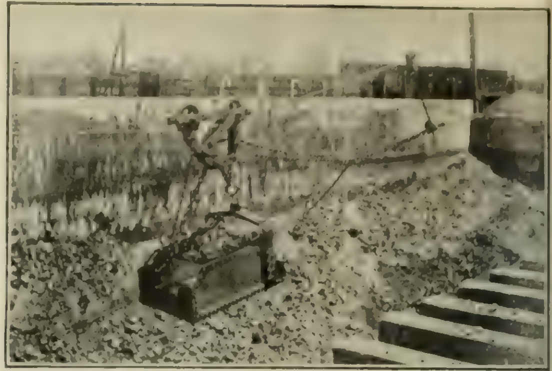


FIG. 2. SHOWING AVERAGE LOAD FOR BUCKET

Ordinarily, the coal in the pit is held as a reserve supply, and under normal conditions the coal for the stokers is unloaded directly from hopper cars to a conveyor system supplying the bunkers. Gondola cars are unloaded by a locomotive crane. When necessary to draw on the reserve supply in the pit, the coal is loaded into railroad cars by the locomotive crane, and again by the same means the coal is unloaded from the cars to the conveyor system supplying the stokers, thereby requiring a double handling of the coal.

During the recent coal shortage the company found it necessary to draw heavily on the reserve, and the locomotive crane was unable to load and unload the coal fast enough to supply the demand. In view of this the company decided to increase the handling capacity by using a ¾-cu.yd. Sauerman dragline cableway excavator which has been employed for cleaning out the intake channel in the creek. The cableway was installed over one side of the coal pit to handle the coal direct from the pit to a hopper on the roof of the power house immediately over the coal bunkers.

An ordinary 8¼ x 10-in. double-drum steam engine is used to operate the cableway. The engine shed is shown behind the locomotive crane in Fig. 1, and the bucket is traveling along on its aërial cable over the pit. A street runs along the outer end of the pit and here the main cable is anchored to upright posts set in the ground along the wall of the pit. By means of a bridle hitch the digging angle is easily changed. The total span of the cableway is 550 ft., and the top of the hopper shown on the roof of the building is 150 ft. above the ground level. In digging from the center of the pit, the operator states he is able to make four trips in nine minutes, handling three-quarters of a ton on each trip.

From the hopper on the roof the coal passes by gravity directly to a crusher and is then delivered to the bunkers supplying the stokers. The floor of the pit is level, and the bucket fills easily and almost within its own length. Fig. 2 shows the bucket loaded.

By means of the augmented supply furnished by the cableway the company has been able to give continuous service.

The Indicator Was Faulty

By G. H. Crawford

After a run of several years, a two-stage air compressor was not giving satisfactory results, so it was decided to take indicator diagrams to locate the trouble. Fig. 1 was obtained from the crank-end low-pressure cylinder. Diagnosis was made that a discharge valve was leaking badly. On examination this was found to be the case. One blade from one of the feather valves was missing. The valve was repaired and replaced and the supply of air materially increased.

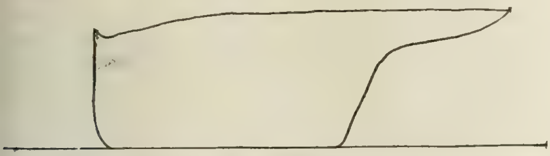


FIG. 1. CRANK END—LOW PRESSURE 80-LB. SPRING

The investigators then proceeded to take another set of diagrams and were astonished to obtain Fig. 2. The same type was also obtained from the head end of low-pressure cylinder. Much thinking failed to result in a satisfactory analysis of this diagram. If the curve *AB* had continued its sharp rise to a pressure corresponding to *CD*, it would have been supposed that the discharge valves were leaking badly, which also might have accounted for the queer re-expansion curve *DEF*; but why the abrupt change at *B*?

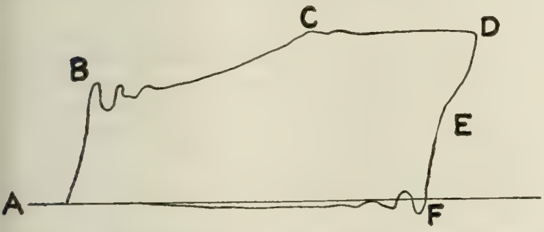


FIG. 2. CRANK END—LOW PRESSURE 80-LB. SPRING

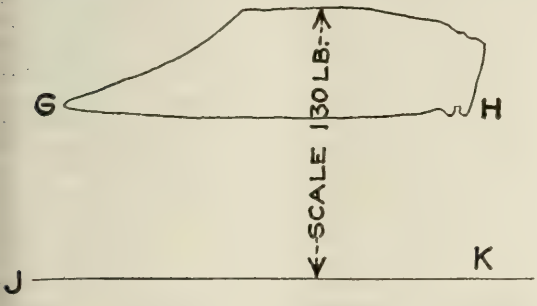


FIG. 3. CRANK END—HIGH PRESSURE 80-LB. SPRING

It was decided to take a high-pressure diagram, Fig. 3. From inspection this seemed normal.

A leaky piston would have given lean compression curves on both head-end and crank-end cards. Leaky suction valves would also have given lean compression curves and tended to give a square heel to the cards.

Finally, the back head of the low-pressure cylinder was removed and a thorough inspection made. Nothing was found out of order. All the valves were taken apart and cleaned. None of them was found broken. The machine was then re-assembled, and still the same low-pressure diagrams (as Fig. 2) were obtained. The investigators were rather at their wits' end.

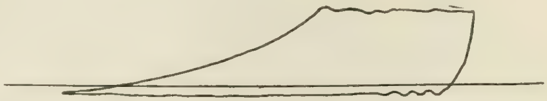


FIG. 4. CRANK END—LOW PRESSURE 60-LB. SPRING

On checking over the indicator it was found that the setscrew that tightens the top ball of the exposed spring was not screwed down tight on the ball, owing to a crossed thread. Consequently, there was lost motion in the indicator piston rod.

On Fig. 2 a line through *BE* would represent the atmospheric line, *AF* being fictitious, due to the lost motion in the indicator piston rod. Similarly, line *JK* on Fig. 3 was fictitious, and this should have given the hint as to the trouble. If the high-pressure diagram discharge line had been scaled, it would have shown 130 lb. discharge pressure, whereas the high-pressure gage read about 75 lb.

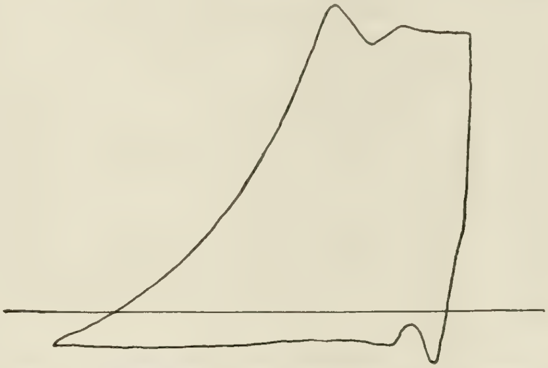


FIG. 5. CRANK END—LOW PRESSURE 16-LB. SPRING WITH UNLOADER

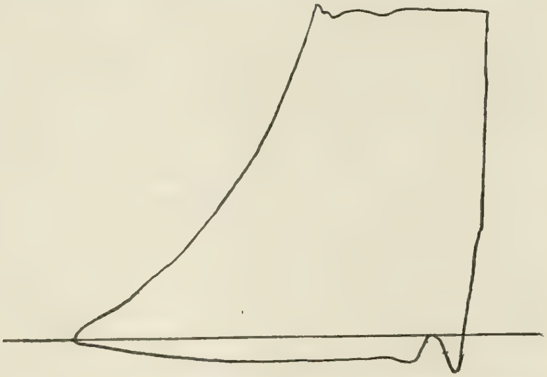


FIG. 6. CRANK END—LOW PRESSURE 16-LB. SPRING WITHOUT UNLOADER

Another indicator was then used and Fig. 4 obtained, which from inspection is good. The reduction of the suction line below atmospheric pressure is due to an unloader with too small lift. Figs. 5 and 6 were taken with a 16-lb. spring with and without the unloader.

Salt-Water Leakage in Condenser

By C. E. Overend

Recently, a very interesting problem was put up to us by a customer. In a system involving a condenser and auxiliaries, including our hotwell pump, the customer claimed, after the unit had run for some time, that we had furnished a pump of inferior metal—in fact, as he expressed it, one made of sand, putty and glue. He supplied a sample of the metal from the water passages of the pump and the sample surely fitted his description, as the pieces submitted looking like burnt molding sand, baked together in cakes about $\frac{3}{16}$ in thick. The specimens were very brittle, almost crumbling to dust upon handling.

An indirect investigation was started, and upon finding out that the pump was all right when it left the factory, as regards test, inspection and material, an analysis of the specimens submitted was ordered. The chemist reported that the pieces submitted had evidently been treated with some acid or similar liquid and the analysis was as follows: Iron oxide, 65; graphite, 26; silicon, 9.

From the chemist's explanation that the pieces had evidently been eaten with an acid, we realized what had taken place. We asked the customer if he had had any trouble with his unit and he said, "No, none outside of a few leaks in the condenser." Upon being told that the salt water leaked past the tubes into the condensate and thence into the pump and caused the corrosion of the cast iron, he wanted to know why, if this was the case, the cast iron in all the accessories, including the boiler sheet, was not eaten also?

High Velocity Favors Corrosion

He was informed that salt water will attack cast iron at ordinary temperatures and if the water is in violent action, or moving with a high velocity, the part eaten into will be washed away, thus exposing a new surface of metal for the salt water to attack, the action continuing indefinitely. In the condenser itself the water is not traveling at a very high velocity. As a consequence, the salt water at first eats into the iron, forming a thin layer of a mixture which acts as an insulator to the further action of the water. When condenser shells are opened up it is frequently found, especially around the nozzles, that the metal, where exposed to the action of the water, has become quite soft and can be scraped off with a knife. This action, owing to the low velocity of the water, is not carried on to any destructive extent, it seemingly eating in to a certain depth and then it is not carried any further.

In the boilers we have a different condition. Here the high temperatures cause the salt in the water to be thrown down as a scale and precipitate, which is later removed upon blowing out the boiler. Thus the iron in the boilers is not affected by salt in the feed water.

In the case of the hotwell pump we have a fine combination for the destructive action to be carried on. The higher temperature of the condensate, together with the high vacuum and the high velocity of the same through the water passages, helps to make a continuous eating away of the metal possible. The warm solution and the high vacuum cause the fluid to act at an increased rate and the high velocity causes the residue to be carried away thus continuously exposing a new surface of iron for the solution to attack.

It seems to be the consensus of opinion that a very small quantity of salt in water will start a destroying action. One case was cited where the supply water was taken from a well and was supposed to be fresh and free from salt, there not being enough salt in the water to be detected by tasting. The cast iron, however, was attacked, and upon analysis the water was found to contain a small quantity of salt.

Most concerns employing condenser units in their establishments have, at one time or another, experienced this difficulty, and they have found it advantageous to keep a sharp lookout for salt in the condensate. At the slightest detection of salt they immediately open up the condenser, and if only a few tubes are leaking they plug up the ends so that the circulating water cannot enter the leaking tubes and put the condenser back in operation. At some future date, when there are enough condemned tubes to warrant the expense, the condenser is cut out and the leaky tubes replaced with new ones. They find that attending immediately to this trouble saves them enormous repair and replacement bills.

If True, We Are Glad To Know It

(From *Petroleum Magazine*)

Why this twaddle as to the imperialistic designs of Britain on the oil fields of the world? We're all after them. If Downing Street is more active, more keen than Pennsylvania Avenue, it's not the fault of this industry. Conquest by capital is no less complete than that by armed conflict, and if Washington is content to sit idly while London grabs available oil supplies, it's our duty not to yell at the lion but to tweak the eagle.

But in all truth there is no such thing now as British control of the oil business. It is unlikely she ever will dominate it. The petroleum industry is peculiarly that of the people of the United States. This country's production is 82 per cent of that of the world.

We have acquired control of as many acres, if not more, the world over, as has Great Britain. Those who see otherwise are myopic or fanatic. American capital has bought most of the potential fields of South America, than which there is none more pregnant of possibilities. We control three-fourths of the oil output of Mexico, which land yields 16 per cent of the world's production. The fields of Wyoming are likely to fill the gap between supply and demand in this land. The monetary interests of this country also are active in Rumania.

English capital, it is true, eagerly scans the oil lands of Baku and Batum, of Persia and Mesopotamia, but Britain as trustee, under the league of nations, has forbidden development of the latter countries until they shall have re-established themselves. Russ Reds hold the others.

Production of the United States, Mexico and British countries are shown by the following table:

	1918	%	1917	%
World production	514,729,354	....	506,702,902	....
United States	355,927,716	69.15	335,315,601	66.17
Mexico	63,828,327	12.40	55,292,770	10.91
British countries:				
India	8,000,000	1.55	8,078,843	1.59
Trinidad	2,082,068	.40	1,599,455	.32
Egypt	2,079,750	.40	1,008,750	.20
Canada	304,741	.06	205,332	.04
Total	12.466.559	2.41	10,982,380	2.15
Persia	7,200,000	1.40	6.856,063	1.35

Pish, tush—forget the lion's roar and make the eagle scratch a bit.

EDITORIALS

Encouraging Use of Pulverized Rhode Island Coal

AMONG those familiar with its history the mention of Rhode Island coal creates suspicion. Known since 1760, first mined probably in 1768 and many times since mined, it has failed, and failed and failed again. Company after company has tried to exploit it, stock jobbers have come and gone, but the supply of the coal is little more than when British soldiers tried to keep warm with it in Revolutionary days.

Such is the history of Rhode Island coal. Yet, whether or not it is a will-o'-the-wisp, men still chase after it. In fact, one of *Power's* editors was a member of a party that has the last few days been chasing it. But more about that later.

Rhode Island coal is classed as an anthracite. In color it is more of a dark gray than the lustrous black of Pennsylvania anthracite. Its fixed carbon content is very high, samples frequently showing more than ninety per cent and seldom less than fifty-five per cent. The coal is so graphitic that it is mined for this product and the mines are called graphite mines. The ash averages twenty-three per cent and the moisture sixteen per cent. When reading these figures, it must be borne in mind that the character and quality of the coal vary widely. The coal is very heavy; Pennsylvania anthracite has from thirty to forty cubic feet per short ton, whereas much of the Rhode Island coal has a volume of but twenty-five to thirty cubic feet per ton.

So much for the character of the coal.

Other than the vicissitudes of mining, the chief obstacle to the use of the fuel is the difficulty of getting it to burn. Unless a recently tried method of burning it develops into success, it may be said that there has been little success in burning it for commercial steam-making purposes, at least, notwithstanding that the Taunton Copper Company is said to have used it for twenty years. But when pulverized and fed to a furnace in that form, it seems to warrant expectations of a favorable kind.

A party of engineers were invited by the Fuller Engineering Company to witness the combustion of Rhode Island coal under a water-tube boiler equipped with a dutch oven, in the plant of the Allentown Portland Cement Company, Evansville, Pennsylvania. The coal was pulverized, eighty-five per cent passing through a two hundred mesh screen. Though a boiler test was not made, an excellent fire was produced, the color in the furnace being dazzling white, the coal was practically fully ignited within twenty inches from the tip of the vertical burner. Though the temperature of the furnace was high, approximately 2,600 degrees, it was evident that the fuel was capable of producing a temperature much higher than given. As the period over which the fuel was burned was too short, and because no test of long duration made data available, it is not possible to form a worthy conclusion as to the commercial success of burning the coal in this form. But the character of the fire and the ease of controlling it make even the most critical feel optimistic.

Frankly, we are from Missouri. We are indeed optimistic about the commercial success of burning it by the pulverized method, but granting that the method of burning it has been found, can the coal compete with Pennsylvania anthracite and various bituminous coals? The seams in most places lie at steep angles and, we understand, pinch out suddenly from the full thickness of the seam to little or nothing, the seam picking up again and continuing on until pinched out again. The seams, many of them, though many feet in thickness, lie deep in the earth. Can it be successfully mined in sufficient quantities to satisfy prospective users of great quantities of it, and made to pay favorable dividends? Some of those now mining it say it can. The owners and engineers in one of the greatest industrial and coal-consuming areas on earth, under whose very cellars this coal lies, are anxious for the mining companies to prove it.

The Providence Engineering Society is considerably interested and was instrumental in bringing together the parties who recently burned the coal in pulverized form at Evansville, Pennsylvania.

The Integral Economizer

INTEREST in various forms of economizers has been heightened by recent increases in coal prices and by the probability that they will never return to pre-war levels. It used to be said that economizers showed an ultimate saving when coal cost more than five dollars a ton. Even with increased cost of economizers this statement is quite generally true today in large plants.

There are many forms of economizer available—the standard cast-iron economizer, the steel tube economizer and the integral economizer. The last-named form has been tried out in many plants and has certain distinct advantages over other forms. The integral economizer consists of a section built in the boiler setting itself and usually as part of the boiler. It receives the cold boiler feed and heats this water as it passes up the tubes by gases that have already passed over the active boiler surfaces and are on their way to the chimney. Usually, this is arranged for counter-current operation. Such surface is truly economizer surface as distinguished from surface obtained by increasing the tube height of a water-tube boiler, for there is a greater temperature difference between gas and water in the first case. These integral economizers consist generally of an additional boiler element comprising one or more drums and sets of tubes exactly as in the other parts of the boiler itself.

The integral economizer has the advantage of low unit cost compared with standard cast-iron economizers. It takes up small floor space and requires no greater headroom than the boiler itself. Its heating surface is usually made about one-quarter of the boiler heating surface, and as the temperature differences are large over the whole of this surface, it corresponds relatively to the most effective portion of a standard economizer. Its draft less is also low as compared with a standard cast-iron economizer.

The principal disadvantage of this economizer is the unknown factor of internal corrosion. When condensate from surface condensers and distilled water are used for boiler feed, there have been cases of severe internal corrosion. In new installations provision is being made to remove the oxygen from the entering feed water and thus prevent this corrosion from taking place. There should be no trouble from external corrosion for the temperature of the leaving gases is sufficiently high to prevent it. This high temperature of leaving gases indicates that the integral economizer, on account of its limited size, does not recover all the heat that a standard economizer might. In many cases, however, the lower investment and relatively greater savings per square foot of surface may warrant the installation of an integral economizer where the full standard economizer is out of the question.

Power Factor Versus Reactive Watts

IN A direct-current circuit a wattmeter not only measures the component of the power that actually does the work but also that which is used to magnetize the circuit. As a result the total volts times amperes supplied to the load is accounted for on the wattmeter. However, in an alternating-current circuit the component of power only that does actual work is registered by the wattmeter. The magnetizing power is first supplied by the generator to the load and then by the load back to the generator; consequently is not recorded on the wattmeter but only circulates around in the system, loading up the equipment without being accounted for in any way. It may be considered as being one instant added to the wattmeter reading and the next instant subtracted from this reading. For a given connected load on the system the magnetizing component is practically constant, where the power component varies as the work done. It is when the magnetizing component becomes equal to or greater than about sixty per cent of the power component that the power factor of the circuit approaches values that are objectionably low.

A polyphase wattmeter may be so connected into a two- or three-phase circuit as to measure this magnetizing component and, when measured, is known as the reactive component or reactive watts. Since the magnetizing watts is the objectionable part of any alternating-current load, and also since this quantity is something that is concrete and can be measured easily, whereas the power factor of an unbalanced polyphase circuit cannot, why not measure the reactive watts and not the power factor?

Knowing the true watts of the circuit and also the reactive watts the power factor or volt-amperes, if either are required, can be determined. Where a cutsomer is to be penalized for low power factor, if this is applied in the form of a charge for reactive watts it will be for something that he can read from his own meter and not a value that is figured in about as many ways as there are penalty clauses. What the reactive watts are can be explained much more easily than power factor, and the problem of metering is greatly simplified. The most serious objection that can be raised against measuring the reactive watts with a wattmeter is that when harmonics are present in the circuit there will be an error in the reading, but this is so small in most commercial circuits as to be of little consequence. However, a high degree of accuracy in measuring either power factor or reactive watts is not as essential as in measuring the watts. Past experience has shown that if these values can be determined within a few per cent they will be satisfactory for all practical purposes.

The fact that power factor is a term used since the introduction of alternating current is no reason why it should continue to be used. Like many other things it may have served its usefulness and may have to give way to some other factor that will more adequately meet the present development in the electrical industry. The factor that most readily meets all the needs is reactive watts, and this has the support of many eminent electrical engineers.

There are three kinds of boiler efficiency: First, the standard of performance which good design, conscientious firing and the best of maintenance would make possible; second, that efficiency which the operator thinks he is getting, and third, the actual facts, namely, the true operating performance as judged by the pounds of steam per pound of total coal consumption. All too often the second of these—the operator's belief—is based on the makers' statement of what the plant should do. This is no time for continuing upon either of these bases. What is needed is to get down to facts and see where we stand.

Attorney General Palmer and C. S. Allen, Secretary of the Coal Trade Association, New York, issued a joint statement July 27 in which the view was expressed that appointment by the Attorney General of a committee to decide on a fair margin of profit for producers and dealers in bituminous coal, beyond which prosecutions under the Lever Act will follow, is expected to "have a deterrent effect upon those who are now taking excessive profits." How many of them will be in jail two months from now?

The first convention of the National Board of Boiler and Pressure Vessel Inspectors will be held shortly. No state, city or other political division should fail to send the man who is legally responsible for the enforcement of its boiler laws. He will bring back the experience of others in administering the law and in searching out defects, which may mean the saving of many times his expenses, and he will become part of a national organization to prevent a class of accidents the preventable number of which has been a national disgrace for many years.

There was, it is likely, justification for some of the suspicion with which cold storage was regarded some years ago, and for the legislation restricting that industry. But the world war seems to have wiped the slate clean and to have left the industry unshackeled. Cold storage was of vital importance in winning the war. It is capable of as much in time of peace. The right kind of legislation will do as much good for the industry as for the public.

CORRESPONDENCE

Carelessness in Refrigerating Plants

Coming intimately in contact with a number of refrigerating engineers in various parts of the country, I can truthfully say that most of them are careful men, but I have found some of these same engineers making mistakes, sometimes with disastrous results—not from carelessness, but rather from thoughtlessness.

As an example, assume that Jones has read an article the previous evening on heat transfer or some other interesting engineering subject; he might perform his daily duties in the engine room to perfection, but at the same time might also be going over in his mind the different points he read of the evening before. He goes about his various duties, such as starting up the compressors, pumps, adjusting expansion valves, etc., through force of habit. What to do and what not to do comes to him without serious thought on his part, owing to his having done the same things many times before. Here is where some trouble might creep in when a person is doing one thing and thinking about another.

To illustrate this point, I remember an instance last winter in a plant I was visiting. The engineer had pumped all the ammonia out of a cold storage house to do some repair work and regasketing of the coils, and had stored the ammonia in the condenser and liquid receiver. The temperature outside was about 8 deg. F., and in the engine room it was about 75 deg. The receiver full of liquid became an evaporator and naturally frosted all over and caused considerable dripping of water on the floor. This was objectionable, and to remedy this he shut off the liquid and gas relief valves between receiver and condenser. We all know what the result should be with a liquid receiver, without a safety valve on it, full of 8 deg. below zero ammonia in a 75-deg. engine room, but fortunately this did not happen. The gage glass burst instead. The engineer knew what the trouble was instantly and, realizing what he had done, hastened to open the valves on the receiver. Nothing further happened.

This was a plain case of thoughtlessness. A careless man, as a rule, is a lazy man and would not have taken the trouble to climb a ladder to the top of the receiver to close the valves, as this engineer did. The receiver in question was an old one, made of extra-heavy 16-in. pipe, 18 ft. long. It stood upright in a corner of the engine room and was not equipped with a safety valve. It is easy to imagine what damage to life and property would have been done if this receiver had burst. It probably would have killed or injured the entire refrigerating crew.

Another case of thoughtlessness: The valve stem on the main suction line, an angle stop valve, began to leak, and the engineer climbed up on the steam line to tighten it with a 24-in. wrench. The valve was five feet above the steam line and near the engine-room wall. On this wall was a receptacle and lamp to light the upper part of the engine room. The engineer placed the wrench on the stuffing-box nut of the valve, braced himself as well as he could, leaned out and gave the wrench a hard jerk. The nut was not so tight as he thought it was and the handle of the wrench when it came down broke the electric light globe and the engineer received a shock of 220 volts, tumbled off the steam line, and on his way down grasped the one-inch liquid ammonia line from receiver to expansion valve, and of course it broke, letting the whole charge of ammonia go into the engine room.

The engineer barely escaped with his life, suffering a sprained ankle and several bruised ribs, caused by hitting the engine-room floor.

The following incident should be classed as carelessness:

The oiler in an engine room was scrubbing the engine-room floor with a 1¼-in. hose. As he was in a hurry he had plenty of pressure on the hose so he could quickly wash down. Alongside the flywheel was a piece of 12 x 12-in. pine block, about two feet long, used as a fulcrum when jacking the engine off center. In playing the hose around the pillow block he struck the block square in the center with the high-pressure stream and it tumbled into the moving flywheel. There was a roar and a bang and the engine room was full of steam.

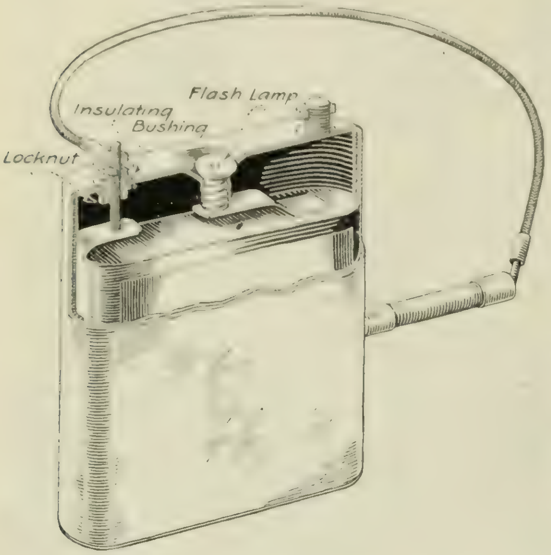
The oiler beat a hasty retreat out into the street. The enginer was up in one of the cold storage rooms, but the fireman had presence of mind enough to shut off the steam line on the boiler header. I happened to come into the engine room about the time the escaping steam had stopped, and we were able to see what was wrong. The block of wood which was washed into the flyheel made a revolution or two with the wheel, then was forced out and up at an angle so that it struck the valve wheel on the main steam line to the engine, which was on a line with the edge of the flywheel, breaking the valve stem and stuffing box off the bonnet of the valve just inside of the bolts holding the bonnet to the body of the valve.

This piece of carelessness caused a shutdown of about six hours until a piece of boiler plate could be drilled and fitted into place of the bonnet, as a temporary repair.

Chicago, Ill. C. E. ANDERSON.

A Testing Device That Can Be Carried in the Vest Pocket

Numerous equipments for fuse testing have appeared from time to time in *Power* and no doubt have proved their value to those who designed them. Most of these devices derive their power direct from the plant current supply through a lamp or bank of lamps and are a fixed or stationary part of the plant equipment, which decreases their value to a considerable extent. I have designed, and used to advantage, a testing device that can be carried in the vest pocket. This outfit may be used to test fuses, open-circuits, short-circuits or grounds—in fact, for locating almost any trouble found in the everyday work of the electrical department of an industrial plant.



BATTERY FLASHLIGHT TESTING DEVICE

As indicated in the figure, the fuse-testing apparatus is made up from an ordinary pocket flashlight. To the top of the flashlight case, after taking out the flash switch, I soldered a terminal, as shown to the right. On the opposite side I drilled a hole and inserted another terminal. The left-hand terminal is insulated from the case and held in place by two nuts. This terminal comes in contact with the flashlight-battery terminal.

In the figure the equipment is shown used to test a cartridge fuse. By bringing a lead out from the right-hand terminal, tests can be made with the battery case in the pocket.

Chadwick, N. Y. JOHN GRANT.

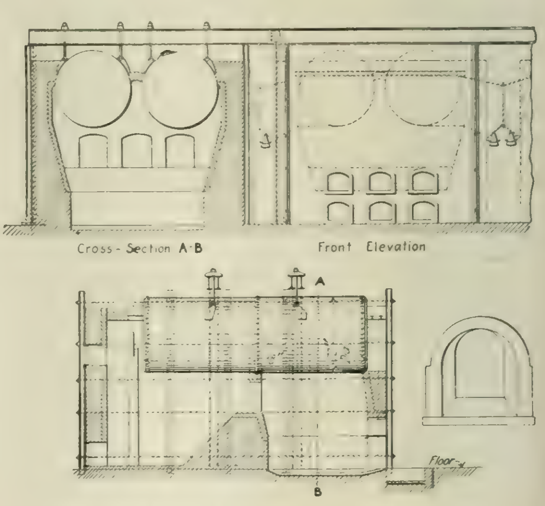
Proposed Setting of Return-Tubular Boilers

In the July 6 issue of *Power*, page 28, is a contribution by M. Riewerts, "Proposed Setting for Return-Tabular Boilers," in which he suggests a change from the present installation of 38 in. from the grates to the boiler shell to 60 in. and gives a sketch of the proposed settings of two units, etc. Neither the natural draft of the plant nor the boiler efficiency nor the evaporation is mentioned, and it is not stated whether forced- or natural-draft furnaces or stokers have been or are to be used after the change in the setting has been made.

If forced draft is used, the higher setting will be necessary to protect the boiler shell, and particularly the belt-line seam, from the blow-pipe effect produced by forced draft. If natural draft is used, there will be no appreciable advantage in the higher installation, because in either case the gases will stratify, the hydrogen rising to the top along the sides of the boilers and passing rearward. The heavier, air-mixed strata will pass rearward under conditions that do not produce the much desired results of approximately perfect combustion of furnace gases, unless a great excess of air above that necessary to produce combustion is admitted to the furnace.

A wall such as shown by the cross section *AB*, provided with ports or openings, was installed under some boilers in Chicago about twenty-five years ago, but they were short-lived and inefficient and were soon discontinued, as was also the inverted arch back of the bridge wall. I have frequently removed the wall *AB* for cause, and also the inverted arch found in many boiler settings during my ten years' experience in Chicago.

Experience has demonstrated that the wall *AB*, if needed at all, is not correctly located, as it does not protect the boiler shell or the belt-line seam. It does not render efficient aid in eliminating smoke or in assisting in the proper combustion of the furnace gases. There is too much talk about burning smoke. If the mixture of air and gas is correctly controlled, in proper proportion, in front of the bridge wall and when passing rearward to the combustion chamber, the combustion of hydrogen will be completed, the use of large volumes of surplus air will be avoided, the smoke problem will be solved and economy of fuel will result. These conditions can be successfully and economically produced when the boiler is located but 36 in. above the grate, and no greater space is required.

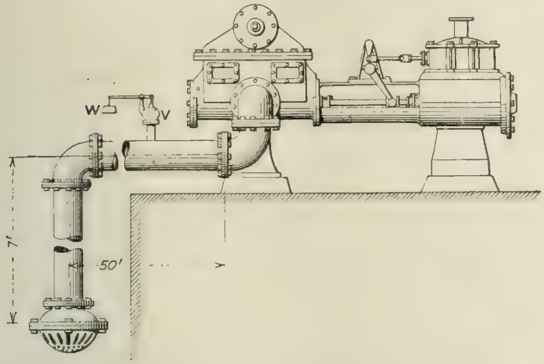

Cross-Section A-B
Front Elevation

MR. RIEWERTS' PROPOSED BOILER SETTING

Buffalo, N. Y. THOMAS E. MARTIN.

Water Hammer in Elevator Pressure Lines

The Royal Poinciana Hotel at Palm Beach, Fla., is the largest wooden structure in the world, and the elevators are located at the heavy traffic points, some of them as much as fifteen hundred feet from the pumps. The report I got when I went there was that the hydraulic lines were always noisy and during the rush before the Washington's Birthday ball an almost continuous water hammer was the rule. The repair man on the elevators said that he used to take the pumps apart a number of times each season, thinking that the pistons were loose.



POSITION OF AIR VALVE ON SUCTION LINE

The pressure is furnished by 20 and 14 x 18-in. duplex pumps with a 12-in. suction and a 10-in. discharge pipe. When I started up last fall, we first put a service elevator to work and it went along fine, but as the help began to come in by the trainload, we had to start up several other service cars, and then the noise began and could be heard all over the lower floors of the building. The pumps acted as if the pistons were loose, and as the main line ran under my office, I gave the matter a lot of thought.

On the suction of one of the pumps was an old arrangement for putting compressed air into the system. It was not in use and was shut off at the discharge line. A leak developed in this old air pipe and that night the pump lost its suction and would not pick up the water again with the discharge pressure on the upper valve deck. The operator shut it down and put on another pump. In the morning I tried the pump against no pressure and found the leak when water squirted out of the rusted pipe. As it was on the suction line, I could not account for the pressure unless the valves on the discharge leaked. It was only 1-in. pipe so I disconnected it at the discharge and plugged it both ways. Upon starting the pump again, water squirted out, keeping in step with the pump reversals. Then it dawned on me what was the matter with the elevator system.

The suction tank was 50 ft. from the pumps, and when a number of cars started at once and lowered the pressure, the pumps would start and pull away from the water, as it takes time to start a body of water flowing; and when it did catch up to the piston, there was a knock, and this jar was passed through the piston to the moving water on the discharge side.

An air chamber on each suction pipe, with the run of water directed into the air chambers and a supply of air kept in the chambers, would be the proper thing in this case. This is how we arranged it. I found an old 1-in. outlet valve that had been removed from an ice-plant skim tank. It had a float that would open the valve when the water reached a certain height. We removed the float and put on a five-pound weight *W*, and then connected the valve in the suction lines as shown. The operation is as follows:

When the pump starts and the piston pulls away from the water, it creates a vacuum stronger than necessary for the low lift; then the atmospheric pressure overcomes the weight and opens the valve *V*, and air rushes into the suction pipe; this air acts as a cushion and stops all noise. The weight *W* will keep the valve closed during the time that the pump is running steadily, as it is proportioned so that the vacuum required to keep the capacity rate flowing through the suction pipe to the pump will not open it.

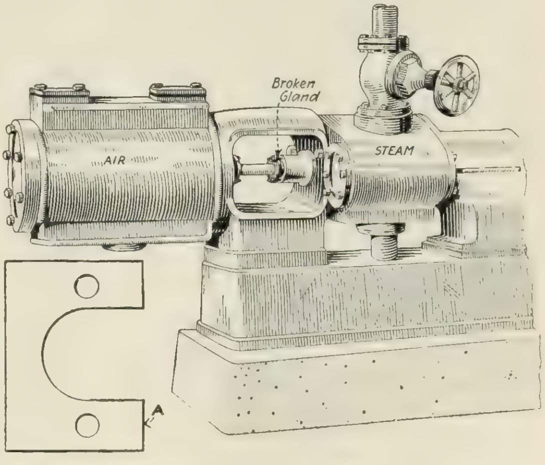
On the other pumps we put even a more simple air-cushion arrangement. We punched six holes in the suction pipes with a prick punch and tapped them $\frac{3}{8}$-in. iron pipe size. Then we took $\frac{3}{8}$-in angle valves and filed off the threads on the stems so that they were free to move up and down. We had to break off the handles leaving the hub on the stem so as to make the stem of the right weight to lift at excessive vacuum and stay closed at ordinary running. The pumps ran quietly throughout the season, starting and stopping with the demand, and the air pulled in kept the proper cushion in the pressure tanks that were situated at the elevator groups.

The same principle was applied to a house pump that was quite noisy during the rush between 9 and 11 a.m.

Palm Beach, Fla. JOHN H. RYAN.

Reinforcing a Broken Stuffing Box Gland

The sketch shows the steam and air cylinders of an air compressor, the stuffing-box gland of which broke about eight months ago, on the steam end, as indicated.



BROKEN GLAND AND REINFORCING PLATE

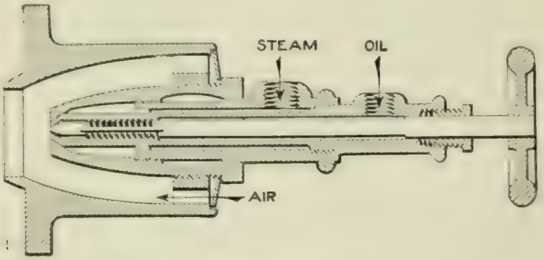
An emergency repair job consisted of placing a piece of iron plate *A* over the broken gland. Of course longer studs had to be made, but the makeshift worked all right in keeping the gland in place. W. F. JOHNSON.

Howes Cave, N. J.

Early Use of Fuel Oil

Over forty years ago, in the City of Detroit, D. H. Burrell & Co., of Little Falls, N. Y., installed a third factory for cutting hoops. It was reported to the home office that the factory was losing one hundred dollars per day. The fuel used under the boilers was elm bark and refuse from the hoop making. I was sent out there, and on the way I decided to use crude oil for fuel. This was done by sprinkling the wet shavings from the elm hoops with crude oil and shoveling the shavings into the furnace as usual. By this method steam was kept up and the mill was kept running to capacity, turning the loss to a profit.

Our success in burning oil brought us trouble, however, in the shape of protests from insurance men on account of its fire risk, so we began making a pipe and tank system, also a good burner. The factory taxed Captain Tard to keep it supplied with logs, and in after years it cut up all the available timber. The heat from the burners quickly made ash of the bark and refuse, which paid the running expenses and kept the yard clean. The ashes from the furnace were sold to soap makers at a clear profit.



SECTIONAL VIEW THROUGH BURRELL LIQUID FUEL BURNER

I reported our success to officials of the Standard Oil Co. at Cleveland, and they offered to assist in procuring the best and cheapest oil. At my request the barrels for the Detroit mill were branded "Fuel Oil," which was proposed as a trade mark. I advertised the oil in trade papers and by means of circulars, and this publicity gave an impetus to liquid fuel because of the success of fuel oil over coal or wood in meeting the conditions at our plant.

The burner that was adopted is shown in the illustration and was known as the Burrell Liquid Fuel Burner with Naylor Improvements. Mr. Burrell, who was interested in various enterprises and did much in the development of this burner, died about a year ago. The main features of the burner were that, owing to its heating and super-heating chambers, it readily decomposed the steam and thoroughly vaporized the oil, and the regulation of the steam and oil vapor was within the nozzle; the admission of air could be regulated to the requirement of the oil and steam, so as to give an intense flame. There is in the Little Falls office of the company one of these old burners, and I believe the original patents are still preserved.

In 1862 I had a model working power plant consisting of a steam boiler piped to a turbine, the steam being generated by a common naphtha burner. Liquid fuel was successfullly used, but that is another story.

Arlington, N. J. JAMES NAYLOR.

Unsteady Engine Speed

I have a friend who had a pain in his left knee cured by having an infected tooth pulled, but I had no idea that such a wide separation between cause and effect could take place in the realm of mechanics, and in my own plant at that. A few days ago I thought I could detect a slight wave effect in the noises and hum of my 15 x 18-in., 200 r.p.m. engine, that is equipped with an inertia governor and is directly connected to a 150-kw. a.c. generator. After a little study I concluded that the governor was hunting slightly. By noon the hunting was a little more pronounced, and I took a look over the governor to see if the gag element was at fault, but it was all right. I then became a little puzzled, for this was a new behavior for a governor that had had a most perfect record for over eight years. During the afternoon run the wave effect increased and I observed that the ammeter hand was swinging slightly and in step with the engine noises. Another search that night revealed everything as being all right, but the next day the hunting increased until it amounted to 30 amperes on the switchboard and could be detected all over the yard in the engine exhaust.

I was greatly puzzled and decided to take down the governor arm that night, having visions of a broken roller or some such thing about the suspension pin. Then I happened to stumble into the trouble. This unit drives 21 induction motors ranging from 5- to 40-hp. capacity. In the afternoon I was called to the mill to change the leads and reverse one of these motors.

TRACED TO LOOSE FAN BELT

Close by the one I was working on was a 40-hp. motor driving a large fan, and as I worked I noticed that the hum of this motor had a decided swinging rise and fall, apparently in step with the hunting of the engine governor. I next noticed that the long belt connecting this motor with the fan was flapping its upper or slack side up and down, instead of running in waves as slack belts often do. This flapping of the belt, rise and fall in the hum of the motor and the hunting of the governor were all evidently in step. I took this to be the effect of the governor's hunting.

Then the thought occurred to me that perhaps the order was the other way about, and that it might be possible that this belt was alternately grabbing and letting go on the pulley as it flopped and that this was communicated back to the engine in the nature of a surge because the motor load would be on and off in impulses, as if a clutch were being thrown in and out.

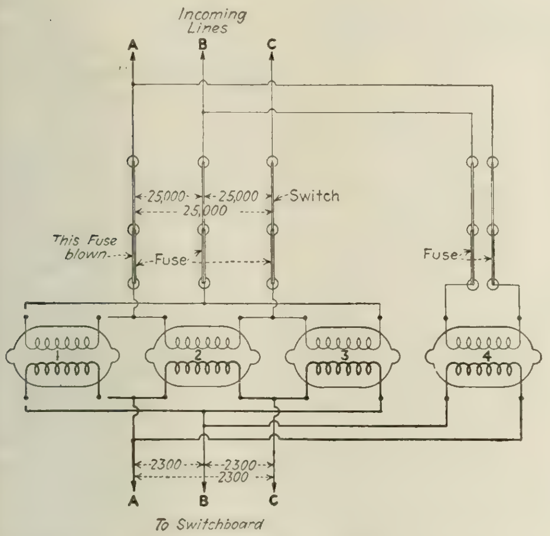
I grabbed a bar of belt dressing and touched it to the belt. Presto! The flopping stopped and the motor hummed in a beautiful even note. I almost ran to the power house and behold, all was serene once more and apparently no hunting.

I moved the motor back on its base sufficiently to tighten the belt, and now my supposed governor trouble has disappeared. The cause of the trouble was due to a new belt that had been put on the fan motor, and its gradual stretching accounted for the slow and steady development of the hunting effect on the governor. Some unusual coincidence between time, weight and force in the belt on the motor and the inertia bar and weights in the governor must have been struck, so that, being in step with each other, the belt was able to keep a sensitive governor swinging. R. MANLY ORR.

Vancouver, B. C., Canada.

Blown Fuse Caused Voltage To Be Unbalanced

In an electrical pumping station the transformers are arranged as shown in the figure. The current used is transmitted at 25,000 volts three-phase and is transformed at the station to 2,300 volts by means of a bank of four single-phase transformers. The scheme of operation calls for three transformers to be in service at one time, being connected in closed delta, with the fourth one as a spare unit. This spare unit is interchanged with the other three at stated intervals. At the time referred to transformers Nos. 2, 3 and 4 were in service, with No. 1 cut out. All units were protected by high-potential fuses as shown.



SCHEMATIC DIAGRAM OF TRANSFORMER CONNECTIONS

A severe electrical storm caused the switch at the main power house to trip, and at the same time the fuse was blown, as shown in the figure. This, however, was not known until later. After service was restored, I tried all three phases for voltage, and as they balanced, I started up the motor-driven pump. Just before reaching full speed, a matter of two or three seconds, the automatic circuit breaker on the motor circuit tripped. Investigation showed the cause of the trouble to be a blown fuse. I tested each phase for voltage again and found that they exactly balanced. However, when the fuse was restored, starting conditions became normal.

Ordinarily, a blow fuse on a three-phase circuit is indicated by an unbalancing of the phases, but, in this particular scheme of connections the blowing of the fuse was not known until I attempted to start up. The unbalanced condition of the phases caused the motor to draw excessive current, which tripped the circuit breaker. The fact that the circuit breaker was controlled by a time-limit relay accounted for the motor nearly reaching full speed before the breaker opened.

Pittsburgh, Pa. **M. A. Anderson.**

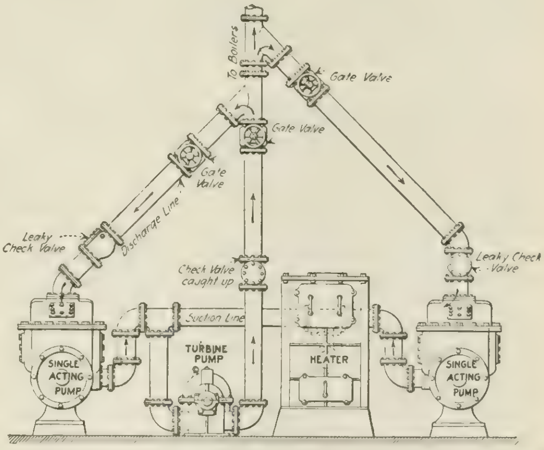
[With the fuse blown as shown in the figure, transformer No. 2 was cut out of circuit, leaving Nos. 3 and 4 connected opened delta, which, either under balanced-load or no-load conditions, should give practically a balanced voltage. However, the two transformers will have only 58 per cent of the normal capacity of three units, consequently when the motor was started a very heavy overload was thrown on the two transformers. This accounts for the circuit breaker opening when the motor was started, rather than an unbalancing of the voltage.—Editor.]

Leaky Valves Cause Shutdown

A large power plant in this vicinity was obliged to shut down for a short time, owing to leaky pump and check valves in the boiler-feed pumps and discharge lines. The plant has nine water-tube boilers of 6,000 boiler-horsepower, supplied with water by three pumps, two of which are single-acting and the third a turbine. The turbine will supply the boilers when they are worked at the highest rating, but it requires the two single-acting pumps to supply them when the turbine is down. The three pumps are connected to one suction line from an open heater; the discharge lines are connected to the feed line by two laterals close together.

At the time of the trouble the turbine pump was feeding the boilers and the load was about normal. When the load was changed, with a consequent demand for more steam, the low-water alarms on three of the boilers began to blow. The water tender opened the bypass valves on these boilers, which reduced the supply from the other boilers, causing the water in them to go low. The engineer ordered the fires drawn and shut the plant down. The two single-acting pumps were then started, steam raised again, and the engines started They had run about fifteen minutes when the low-water alarms began to blow again. Then the plant was shut down a second time for low water.

It was found that the two check valves on the discharge lines of the single-acting pumps were leaking and the turbine was pumping the water back to itself, and that when the single-acting pumps were working, the check valve on the turbine was caught up, letting the water go back to the suction line. After closing the gate valves on the discharge lines from the single-acting pumps, the turbine was started and supplied the boilers without trouble.



PIPING AND LOCATION OF VALVES

C. J. Miller.

North Tonawanda, N. Y.

Power Failure Caused Accident

Some time ago I witnessed a curious incident; although no one was injured, it resulted in a heavy repair bill. A large pumping station was being operated on central-station energy by means of a transmission line several miles long. The pumping station was located at the foot of a steep hill, and the centrifugal pumps discharged into a 36-in. line which went directly over the hill at an altitude of 250 ft. At the time of the accident but one pump was in operation, it being driven by an induction motor having a wound rotor; the normal speed was under 900 r.p.m.

An incident at the power house was the cause of the switch controlling the power to the pumping station being opened, which of course suddenly cut off the power to the pump. The sudden stoppage of the motor and pump caused a high-pressure surge in the pipe line, on the suction side of the pump, of sufficient force to cause a rupture of the pipe line a few hundred yards from the pumping station. Instantly, the centrifugal pump was transformed into a turbine operating with a wide-open valve, neither load nor governor to control the speed, and a head of 250 ft.; a very high speed was the immediate result.

As soon as the pipe line emptied itself (a matter of a few seconds), the pump and motor stopped. An investigation showed that the coil ends of the wound rotor had lifted (owing to centrifugal force developed by the enormous speed) and had cut into all the stator coils, resulting in a new winding being necessary.

When the rotor was rewound, extra-strong bands were placed on the coil ends and a check valve was placed in the pipe line to prevent a repetition of such an occurrence. There was no way of telling how fast the unit rotated, but the engineer on duty estimated the speed at 3,000 r.p.m. Of course the direction of rotation while running as a turbine was the opposite of that while operating as a pump. Pieces of the winding were thrown out with sufficient force to penetrate a $\frac{3}{8}$-in. wire-inserted window glass.

Pittsburgh, Pa. M. A. ANDERSON.

Boiler Inspection Reveals Careless Operation

Some time ago I was called upon to inspect some boilers at a sawmill plant, and on my way from the railroad station to the mill I was informed that one of the boilers had exploded the previous morning. Naturally, I had visions of boilers scattered all over the mill yard, for there were five in all, and they had the reputation of being questionable characters.

Arriving at the plant, I was met by the superintendent and was told that the boilers were ready for inspection and that the manhole frame of No. 4 boiler was broken. I surmised at once that this was the explosion referred to by my informant. Proceeding to inspect the boilers, I began with the one having the broken manhole frame. This reinforcement was made of cast steel and was single-riveted to the shell. I found it split in three places through the rivet holes.

Looking over the top of the boilers and wondering what could have caused the manhole frame to break and why the sheet did not rupture at the same time if the boiler had been operating under normal conditions and pressure, I saw that the safety valve was missing and that a three-inch plug was screwed in its place. From the attendants it was learned that several weeks previously the safety valve had been taken off and sent away for repairs. Having no extra valve, they simply stopped up the opening with the plug, and no thought was given to the possible danger of operating the boiler without a safety valve.

About this time I began using a little plain language to show these men what a chance they were taking through such carelessness. During the conversation I was able to get a few facts about the manipulation of the plant that showed both carelessness and incompetency.

It appeared to be customary, after shutting down at night, to cut out three boilers, and the remaining two were fired, to supply steam for the dry kiln. It was the night attendants' duty to raise the steam pressure on the idle boilers and cut them in ready for service in the morning.

Through neglect, and probably quite often, the night attendants found themselves with hardly enough time left in which to raise the steam pressure on the idle boilers and get them cut in for service ready for the day crew. Then the seemingly impossible was accomplished by opening the main steam valves on the idle boilers, allowing the pressure from the other boilers to rush in and finally become equalized, the attendants thus evading a much-deserved reprimand.

After getting this information, together with the fact that the boiler with the broken reinforcement was one of those cut out each night, it did not take long to surmise that a water-hammer had broken the manhole frame. The attendant being at the main stop valve at the time was able to shut off the higher pressure immediately, thus no more damage was done.

At another time I was summoned to inspect three boilers in a plant that had just changed hands. Two of the boilers were return-tubulars, the third being a dry-back Scotch marine.

Getting into the combustion chamber of the last-named boiler, I noticed that the ashes were quite wet. In looking about to ascertain where this moisture came from, I found that the arch overhead protecting that part of the back head above the water line from the flames had practically all fallen away. Upon closer examination of this part of the head numerous little cracks were found extending out from the rivets attaching the braces to the head, which had been caused by overheating.

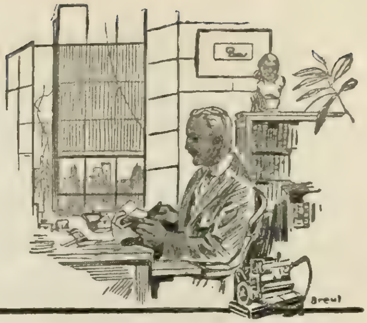
I recommended that the brace rivets be cut out and the head be straightened (for it was slightly bulged in between the brace rivets) and that a reinforcing plate be applied to the affected area on the outside of the head and fastened by patch bolts, the brace rivets to extend through the reinforcing plate, thus making a neat and substantial job.

Now, as all conscientious and careful engineers know, one of the first things to do in taking charge of a strange plant is to find out, as far as possible and as soon as possible, the condition of all apparatus under their care, for a little attention at the proper time may prevent painful accidents and expensive repair bills.

In conclusion I might say that such cases as related are quite numerous, and almost without exception would not have happened if a little more care had been exercised by both the management and the operatives.

Chattanooga, Tenn. P. E. TERROY.

INQUIRIES OF GENERAL INTEREST



Cement for Faced Steam Joints—How is a good cement made for faced steam joints? W. L. D.

Take equal parts of powdered graphite, red lead and white lead and mix them thoroughly with boiled linseed oil to the consistency of a thick paste.

Higher Economy for Greater Speed of Engine—What effect has relative speed in the economy of a reciprocating steam engine? B. M.

For the same initial pressure and point of cutoff, the weight of steam used per indicated horsepower per hour is somewhat reduced as the speed of rotation is increased, probably due to the reduced loss by cylinder condensation at higher speeds.

Advantage of Using Steam With Reduction of Pressure—What is the advantage of generating steam at high pressure for supplying an engine with the steam reduced in pressure by passing it through a pressure reducing valve? F. N. G.

The initial pressure on the engine may be kept more nearly constant and generation of steam at the higher pressure is equivalent to increasing the volume of the steam space of the boiler. Wire drawing of the steam, by reducing the pressure, is a means of converting the steam to a dryer condition at the lower pressure. But unless the steam supplied by the boiler is perfectly dry, or very nearly so, there can be no superheating.

Setting Valve from One Dead Center—How can a plain D slide valve be set without turning over the engine? R. M. G.

First set the valve to give the same maximum port opening on the two ends of the cylinder. For this purpose, loosen the eccentric on the shaft and turn it around until it gives the maximum port opening on first one end of the valve and then on the other. If the maximum port openings are not equal, they are to be made so by changing the length of the valve stem by one-half of the difference in the maximum port openings. The engine is now to be put on a dead center and the eccentric is to be turned on the shaft and set to such a position as to give the valve the proper lead. This adjusts the angle of advance of the eccentric and will give equal leads at the two ends of the cylinder.

Starting and Stopping Boiler Test—For making an evaporative test of a boiler, how are identical conditions of firing and water level obtained for starting and stopping the test? C. T.

For a hand fired test, the fires should be cleaned immediately preceding the test and the final clean out so timed as to be completed just before the end of the run. With mechanical stokers the conditions under which the test is to be run should be established at least 30 minutes before starting the test, and the same conditions should be established at least 30 minutes prior to the close of the test. The water level marked on the gage glass at the beginning should be the same at the end of the test, in each instance with closed fire and ash pit doors, to obviate discrepancies of water surface from circulation of the boiler due to a difference of cooling effect of air admitted.

Dry Saturated and Superheated Steam—What is the difference between dry saturated steam and superheated steam? W. L. G.

Steam is said to be saturated when it is at the evaporation temperature corresponding with its pressure. When steam is formed in a boiler and rises from the surface of the water it is saturated and remains saturated as long as it is in contact with the water. Its condition is said to be "dry saturated" when the steam contains no particles of unevaporated water. Steam is said to be superheated when its temperature is higher than the temperature of evaporation corresponding with the pressure. Superheating must be performed by adding heat to the steam after it has been removed from contact with the water in the boiler and providing for increase of its volume without a corresponding increase of pressure; or saturated steam may be converted to a superheated condition at a lower pressure by wire-drawing, when the heat contained per pound of the steam at the higher pressure is more than the amount of heat required for the condition of dry saturated steam at the lower pressure.

Decreasing Voltage and Frequency on Induction Motors.—The statement has been made that if the voltage and frequency are reduced on an induction motor, as by reducing the speed of the alternator supplying the power, the magnetizing current remains constant. If this was absolutely correct, when the voltage and frequency reached zero the magnetizing current would still be of normal value, which is impossible. Where is the error in the foregoing statement? A. E. M.

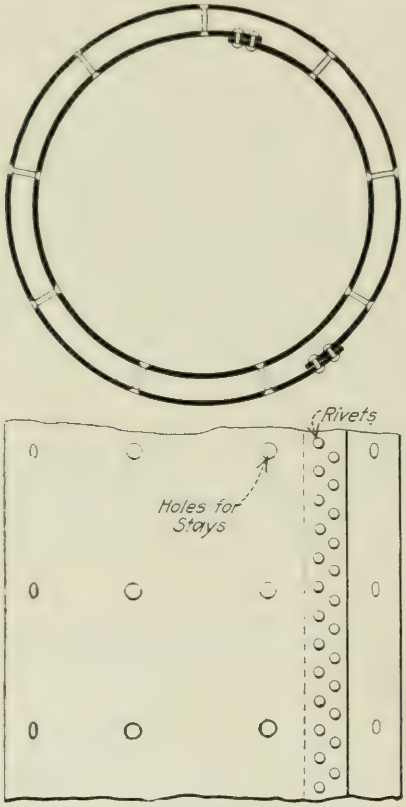
At no-load in an induction motor, operating on normal voltage and frequency, the magnetizing current is practically equal to the voltage divided by the impedance of the motor circuit. This impedance is made up of two right-angle components: one, the ohmic resistance of the stator winding and the other the inductive reactance of the winding. At normal voltage and frequency, the inductive reactance is so high compared to the ohmic resistance that the latter can be for all practical purpose neglected. Therefore if the voltage and frequency are reduced, within reasonable limits, say 10 per cent, the inductive reactance are reduced in a like proportion, and since the ohmic resistance is practically negligible, the magnetizing current will remain nearly constant. However, when the voltage and frequency are reduced by say 90 per cent of normal, then the inductive reactance is also small, approaching the value of or less than the ohmic resistance of the winding, consequently the latter has a very marked effect upon the magnetizing current, causing it to decrease as the voltage and frequency decrease. It is therefore evident that the statement in the question is not absolutely true. When the reduction in voltage and frequency from normal is only a few per cent, the decrease in the magnetizing current is very small and may be neglected but, as the lower limits are approached, the magnetizing current begins to decrease rapidly.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Interpretations of the A. S.M. E. Boiler Code

The following answers to requests for interpretations of the Boiler Code have been prepared by the Boiler Code Committee and approved by the Council of the American Society of Mechanical Engineers. The formal inquiry and reply are given together with explanatory references to the code and illustrations where necessary for a better understanding of the interpretations as issued.

Case No. 299—Inquiry: In using Par. 212 to determine the maximum allowable internal working pressure that may be allowed on a staybolted surface under the Code Rules it is stated that the weakening effect produced by drilling the staybolt holes must be considered. Cylindrical surfaces of the character referred to in this paragraph usually contain a riveted joint that weakens the structure more than does the drilling of staybolt holes. Should not the weakening effect of such joints be considered in the applying of Par. 212?



CASE 299. EXAMPLE OF CYLINDRICAL SURFACE WITH STAYBOLT HOLES

Par. 212 provides that the maximum allowable working pressure shall be computed as in the case of a cylindrical shell, making allowance for the weakening effect of the holes for staybolts. To this may be added the smaller cf the pressures secured by the formula for stayed surfaces (using 70 for the value of C in the formula) or the pressure corresponding to the strength of the stays. In the illustration the code requires the strength of the outer cylindrical shell to be figured only with allowance for the weakening effect of the staybolt holes, making no provision for a case where the riveted joint shown has a lower strength than that of the plate between the staybolt holes.

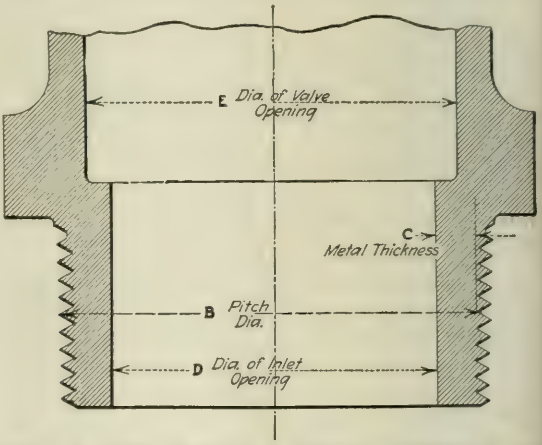
Reply: It is the opinion of the committee that where the curved staybolted surface referred to in Par. 212 contains a riveted longitudinal joint, or other construction except handholes, and the strength of the surface through such joint or other construction is less than through any line of staybolt holes in the same direction, the weakening effect of the joint or other construction, instead of that produced by the drilling of staybolt holes, is to be considered in making the calculations for pressure by this paragraph.

Case No. 301—Inquiry: Is it the intent of the Boiler Code under Par. 182 that the back pitch of tubes and rivets on drums which have a relatively high ratio of shell thickness to diameter of drum shall be measured on the inside surface, the outside surface, or the median line of the shell?

Par. 182 defines the back pitch as the distance between any two adjacent rows of rivets measured at right angles to the direction of the joint. The minimum back pitch if $\frac{P}{D}$ is 4 or less shall be $2D$. If $\frac{P}{D}$ is over 4, the back pitch shall be $2D + 0.1 (P - 4D)$ where P is the pitch in the outer row when a rivet in the inner row comes midway between two rivets in the outer row; and the pitch in the outer row minus that in the inner row where two rivets in the inner row come between two in the outer row, and D is the diameter of the rivet holes.

Reply: It is the opinion of the committee that in measuring the back pitch of tube holes or rivets the measurements should be made on the flat plate before rolling, so that in checking up these measurements after construction the result would correspond to the dimensions on the median line, or the mean of the measurements on the outside and inside surfaces.

Case No. 302—Inquiry: Is it the intent of Par. 278 of the Boiler Code, which requires a full-sized direct connection to the boiler for each safety valve, that the exact meaning of this term shall be applied to small brass pop safety valves with male inlet connections? It is impossible to maintain the nominal threads on the inlet of these valves if the inlet opening is maintained full-sized in a male connection.



CASE 302. SECTION OF MALE THREAD CONNECTION FOR SMALL SAFETY VALVE

Reply: It is the opinion of the committee that the rule given in Par. 278 of the code applies to the connection leading to the safety valve and not to the safety valve itself. There need not be a full-sized opening through the valve itself, as the stamping of the capacity thereon by the manufacturer indicates in any case what is actually guaranteed for the valve by the maker.

Under the requirements of Par. 278 the rating of a safety valve is limited to the size of the opening at D in the illustration. It is desirable that the threads on the small male-threaded connections should conform to the nominal pipe threads for the rated size. If such thread size is used and the opening at D is made the full diameter of the valve, there appears to be a question as to whether there will be enough metal under the threads.

Assuming, for example, a 2-in. valve, the diameter at the bottom of the Briggs standard thread is given as 2.201 in., and if the opening at D is made the full 2 in. diameter the thickness of metal under the thread will be 0.10 in. The area of the metal cross-section, then, would be 0.628 sq.in., and with 250 lb. per sq.in. pressure under the 2-in. valve disc the stress in the connection would be 1,250 lb. per sq.in. This would seem to be a reasonable working stress for good brass castings, and some manufacturers so consider it. The standard internal diameter for extra-strong wrought-iron pipe is 1.93 in. Using this dimension for the diameter at *D* gives a metal cross-section of 0.85 sq.in. and a stress of 924 lb. per sq.in. One manufacturer's standard for such valves calls for a diameter at entrance of 1.77 in., which results in a metal area of 1.35 sq.in. and a stress of only 655 lb. per sq.in.

From the consideration of area at inlet to the valve, the full 2 in. diameter would give 3.14 sq.in., the 1.93 in. diameter, 2.93 sq.in., and the 1.77 in. diameter 2.46 sq.in. The area through the seat for a 2-in. valve with a 45-deg. seat is 0.44 sq.in. for a 0.10-in. lift and 0.89 sq.in. for a lift of one-tenth of the valve diameter. It would thus appear that with as small an entrance diameter as 1.77 in. the valve might safely be rated at 2 in. This would avoid the akwardness of bastard size ratings and at the same time avoid any question as to the strength of the construction.

Case No. 303—Inquiry: Is it the intent of the Boiler Code Committee in its references to commercial lap-welded pipe in Case No. 218 that the weld therein may be considered as conforming to the requirements for welded joints in Par. 186 of the Boiler Code?

Case No. 218 refers to the use of open-hearth, extra-heavy lap-welded steel pipes as headers and manifolds of superheaters. The reply in this case holds that such parts must be made from material which, in its initial form of plate or skelp, conforms to one or the other of the specifications for wrought steel, or they may be made of cast steel of Class B grade.

Par. 186 provides 28,500 lb. per sq.in. as the ultimate strength of a joint welded by forging with steel plates having a range in tensile strength of from 45,000 to 55,000 lb. per sq.in.

Reply: For calculations of the maximum allowable working pressures to be permitted in open-hearth lap-welded pipe used in connection with boilers, it is the opinion of the committee that the weld may be assumed as meeting the requirements of Par. 186.

Case No. 304—Inquiry: What amount of cooling and shrinking under pressure is necessary in the driving of rivets under the requirements of Par. 256 of the Boiler Code? Is it consistent with the intent of this paragraph to release the pressure while the rivet shows any degree of heat redness in color?

Par. 256 requires that rivets shall be machine driven wherever possible, with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure.

Reply: It is the opinion of the committee that the pressure should be maintained upon the rivet after it is driven until no part of the head shows red in daylight.

Case No. 306—Inquiry: Is it the intent of Par. 20 that the minimum thicknesses of tube sheets there specified for horizontal return-tubular boilers is applicable also to vertical fire-tube boilers and to locomotive-type boilers?

Par. 20. The minimum thickness of tube sheets for horizontal return-tubular boilers shall be as follows: When the diameter of the tube sheet is 42 in. or under, $\frac{3}{8}$ in.; over 42 in. to 54 in., $\frac{7}{16}$ in.; over 54 in. to 72 in., $\frac{1}{2}$ in.; and over 72 in. $\frac{9}{16}$ in.

Reply: It is the opinion of the committee that while this paragraph refers specifically to horizontal return-tubular boilers, it is equally applicable to boilers of the vertical fire-tube and of the locomotive types, and its application to these two latter types is recommended by the committee.

Tensile Properties of Boiler Plate at Elevated Temperatures*

At the request of a committee of the Engineering Division, National Research Council, a study of the properties of boiler plate at various temperatures up to about 900 deg. F. has been instigated. This paper is a report of preliminary tests made on $\frac{1}{2}$-in. open-hearth boiler plate of marine and firebox grades.

Special apparatus was designed to carry the extension measuring apparatus so that the indicating devices might be outside a tubular electric heater which surrounded the specimen while under test. The measured length of the specimen was 2 in., and its temperature was measured by a thermocouple inserted in a small hole drilled in the fillet.

The curves in Fig. 1 show the results of tests on firebox-grade steel at temperatures from 70 deg. F. to 870 deg. F., and those in Fig. 2 show the results from marine-grade steel under similar conditions. The curves are the average of three determinations at each of the pick-points. The values for reduction of area were obtained from measurement of the minimum width and thickness of the fractured section and are not identical with values that would be obtained by the use of a planimeter, owing to a decided necking in both width and thickness in rectangular specimens.

The increase in temperature results in distinct changes in the properties, namely: (a) The tensile strength first decreases, reaching a minimum at about 200 deg. F., then increases to a maximum at about 550 deg. F., after which a final decrease occurs; (b) the percentage elongation in 2 in. decreases slowly to about 200 deg. F., then rapidly to a minimum at 470 deg. F., after which it increases; (c) the reduction in area closely follows the curve for elongation, but has its minimum at slightly higher temperature; (d) the proportional limit increases slightly to a maximum at about 400 deg. F. for firebox steel and between 200 and 300 deg. F. for marine steel. It is noted that for firebox steel the increase is greater and the decrease takes place more sharply than for marine-grade plate. The higher temperature for the maximum value of the proportional limit with firebox steel is credited to the greater mechanical work received by these samples.

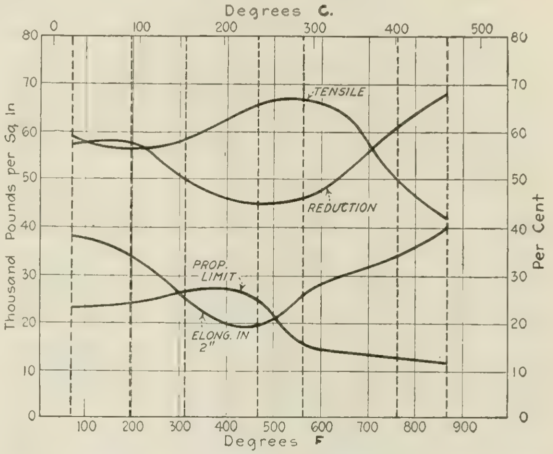


FIG. 1. RESULTS OF TESTS OF FIREBOX-GRADE BOILER PLATE AT VARIOUS TEMPERATURES

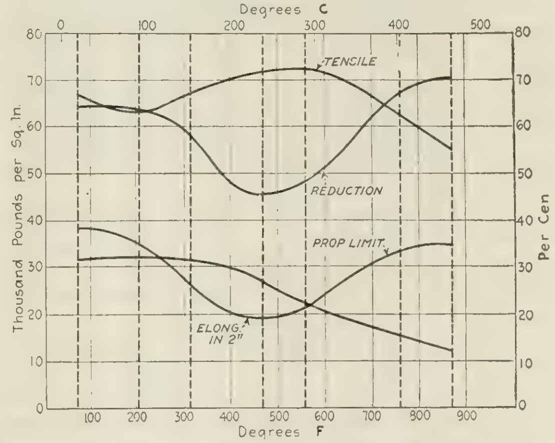


FIG. 2. RESULTS OF TESTS OF MARINE BOILER PLATE AT VARIOUS TEMPERATURES

Fifteen coal operators and brokers were recently arrested at Knoxville, Tenn., on charges of profiteering, and will be prosecuted under the Lever Act. Between fifty and sixty more, it was learned, are to be arrested charged with the same offense.

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*Abstract of a paper by H. J. French, Chief, Heat-Treatment Section, Division Metallurgy, United States Bureau of Standards, presented before the American Institute of Mining and Metallurgical Engineers.

Operation of a Diesel Motor Ship

The following record of the Motor ship "Selene," covering a period of one year, which appeared in *The Engineer*, London, should be of interest.

The "Selene" has the following dimensions: Dead-weight capacity, 5,310 tons; gross tonnage, 3,738 tons; length, 357 ft. 6 in.; breadth, 46 ft. 3 in.; depth, 27 ft. 7 in.; draft (forward), 21 ft. 4 in.; draft (aft), 24 ft. 0 in.; propelling power, 2,200 i.hp.

The "Selene" left Singapore on Oct. 5, 1918, for coasting ports. In these ports no particular work was executed, but, as usual, when a vessel is loading or discharging cargo various work had to be done, such as cleaning filters, cooling pump examined, and air compressor valves to be cleaned, etc.

This ship arrived back in Singapore on Nov. 9, and then made a voyage to Australia, experiencing no trouble and arriving on Dec. 29. Work carried out during the ship's stay in port consisted of examining and grinding in air compressor valves and overhauling cooling water pumps.

During the voyage from Adelaide to Balik Papan the starboard motor was stopped for ¾ hour for renewing a joint on the exhaust-valve box.

The vessel arrived at Balik Papan without any further trouble, and while the ship was in port the exhaust valves of the starboard motor were taken adrift and ground in, and also some small repairs were carried out.

Voyage Balik Papan to Singapore—When at Singapore the following work was executed: Fuel rollers seen and adjusted, some telescopic piping and stop valves seen to, and all bolts on main motors tried.

Voyage Singapore to Bordeaux—Work in latter port consisted of cleaning fuel filters, interchanging air-compressor valves, inspecting lubrication, I.P., H.P., and air-compressor pistons opened up, the rings renewed, and all grooves trued up.

All crosshead, crank bearings, and main shaft bearings fitted, and fuel valve needles repacked.

Voyage Bordeaux to Abadan—The ship left the latter port on April 17, when the port motor was stopped for 1¾ hours for air compressor; and on April 19 the starboard motor was stopped for two hours for interchanging an exhaust valve.

The vessel arrived in Port Said on April 29 and reported "all well," and then proceeded to Abadan, where she arrived May 18 without having experienced any trouble.

On arrival at Abadan the suction and delivery valves, air compressors, main and auxiliary motors were opened up and cleaned.

Fuel and lubricating oil filters were also cleaned and two exhaust valves changed.

The "Selene" then left for Colombo and then round to the coast ports, eventually arriving at Singapore for her periodical docking on June 26. During this overhaul the following incidents were noticed:

All bearings and crankpins opened up for inspection of the crankshafts, and after careful inspection were found to be in good condition.

The starboard shaft was worn down 0.7 mm. over all bearings, and the usual wearing toward the middle bearings was not noticeable in this case.

The port shaft was worn down 1 mm. in the No. 1 bearing, 0.8 mm. to the middle bearing, and 0.6 mm. in the No. 8 bearing. All journals were bearing very nicely, and no sign of salt-water being mixed with the lubricating-oil was noticeable.

All bearings and crankpin brasses were adjusted.

Two pistons were taken out for examination and found in good condition; as the other pistons were not leaking, they were left untouched.

Further to this, the usual repairs were done when vessel was in dry dock. The ship left dock on July 13 for two coast voyages and turned back to Singapore on July 19 without experiencing any trouble.

Work executed during stay in port was: Repacked some fuel-valve needles, renewed two piston bolts, and secured cooling water pump straps, etc.

Vessel left port for Suez on July 23.

On July 25 both motors were stopped for ¾ hour for examination of crankshaft, and on Aug. 1 both motors were stopped successively for ½ hour to examine bottom-ends, and also on Aug. 10 the starboard motor was again stopped for 3 hours for broken slipper guide bolt.

Without any further difficulties vessel arrived at Suez on Aug. 18. During ship's stay in port discharge of cargo the following work was done: L.P. and I.P. air-compressor rings renewed, valves and air-compressors cleaned and ground in, fuel filters and mud boxes cleaned, etc.

Vessel passed through the Suez Canal and left Port Said for Hull on Aug. 27.

The port motor was stopped on Sept. 2 for ½ hour for fastening up piston bolts on No. 5 cylinder, and also on Sept. 12 for 2 hours for renewing two broken-off piston bolts.

The vessel arrived without further accidents at Hull on Sept. 12, when practically no repairs were found necessary.

Having given this information *The Engineer* makes the following comments:

It would be possible to gather quite a disconcerting impression from this report by laying stress upon the fact that in a series of trips covering some 50,700 nautical miles eight stoppages are recorded, and it is necessary to analyze these carefully before coming to any conclusion. The causes of the stoppages are given as follows:

			Engine
(1)	¾ hr	To renew joint on exhaust valve box	Starboard
(2)	1¾ hr	For air compressor	Port
(3)	2 hr	To exchange exhaust valve	Starboard
(4)	¾ hr	To examine crank shaft	Both
(5)	30 min	To examine bottom ends	Starboard
	20 min	To examine bottom ends	Port
(6)	3 hr	For broken slipper guide bolt	Starboard
(7)	½ hr	To tighten piston bolts	Port
(83)	2 hr	To renew two broken piston bolts	Port

We much regret, says *The Engineer*, that we have to admit that we have not been able to obtain such full explanatory notes on all these stoppages as to appraise them justly, and a good deal must be left to surmise. We can say, however, that Nos. 1, 3 and 6 need not have caused stoppage of the engine at all if it had been thought necessary to keep it running, as the particular cylinder affected could have been cut off without interfering with the working of the other five. In No. 6 the slipper-guide bolt was connected with the water service and on that account would have necessitated either the stopping of the engine or the cutting out of the cylinder. Nos. 2, 7, and 8 were perhaps the most disabling casualties and probably called for the immediate stoppage of one engine, whereas it is important to note that only one engine had to be stopped at a time, and all the other stoppages were of such a nature that not only could the trouble be rectified in a short time, but the engineer could to a very large extent choose his own time for the stop to suit the bridge. It is only the stop which puts the ship completely out of control and which occurs without notice to or consultation with the bridge that causes real anxiety.

Cold-Storage Insulation Efficiency

While many factors, such as resistance to moisture, inflammability, strength, durability, etc., must be considered in choosing an insulating material, the material must of necessity be a good insulator and the measurement of its thermal conductivity is, therefore, the matter of most importance. The Bureau of Standards has used for several years a satisfactory apparatus for measuring thermal conductivity. The results obtained have been assembled and a standardized form of apparatus suitable for general use has been designed. The American Society of Refrigerating Engineers has taken an active interest in this work, so that a standard apparatus may be available, the use of which will eliminate disputes due to differences resulting from the employment of unsuitable testing methods.

The results of the bureau's work will be published in a forthcoming number of the *Journal* of the American Society of Refrigerating Engineers, will be issued as a Bureau of Standards scientific paper, and abstracted in *Power*.

"Aquitania" Now an Oil Burner

After having been off the transatlantic route for eight months, the Cunard steamship "Aquitania" sailed from Liverpool, July 17, for New York. The liner has been completely refitted and converted into an oil burner and on her return voyage established a new speed record.

The "Aquitania" had just completed three round voyages between England and America when the war broke out. Rapidly converted into an armed merchant cruiser, carrying six-inch guns, she left the Mersey on Aug. 8, 1914, for patrol duties. Later on in the war she served as a hospital ship, and then again in the spring of 1918 she was employed as a transport, rushing American troops to Europe.

The 168 furnaces of the 21 boilers of the "Aquitania" have been changed from coal burning to oil burning. In a ship like the "Aquitania," assuming that the 28 fires are cleaned every watch, approximately 8,000 hp. is lost every four hours, due to the drop in steam pressure during the cleaning period.

With oil-fired boilers there is no such loss incurred, as the oil can be supplied continuously to the burners, and the furnace temperature maintained so that a constant steam pressure can be kept up, which will improve the speed of the vessel.

As the temperature of the boilers is maintained at a constant figure, the bill for boiler repairs will be considerably reduced. There will be no ashes to remove, and consequently no dust and inconvenience to passengers from that source.

Location of Fuel Tanks

In this ship, with a beam of 97 ft., with three large double-ended boilers arranged abreast, there remains a space of about 18 ft., amidships, gradually reducing to 6 ft. at the forward end of the boiler space, which formed the coal bunker on each side, and in this space, extending the full length of the boiler space, a matter of 369 ft., the oil is carried. These side tanks do not form one continuous group on each side, but are broken into two groups, port and starboard, by Frahm's anti-rolling tanks, which take up 32 ft. of the length. In addition to these side bunkers, large athwartship bunkers, arranged forward of No. 1 boiler room, between Nos. 1 and 2, and between Nos. 2 and 3, have also been made suitable for oil carrying. The large storage capacity in these side tanks and cross-bunker tanks, however, did not prove sufficient to enable the ship to perform the double trip without requiring replenishing, so that six of the double-bottom tanks have been made suitable for oil, to enable the 7,600 tons of oil required to be shipped at New York. Of the total quantity, 5,200 tons will be carried in the fore and aft side bunkers, 1,900 tons in the athwartship gross bunkers, and 700 tons in the double-bottom tanks. All the storage tanks, including the six double-bottom tanks, will be used solely for oil, no water ballast connections being provided.

To make the coal bunkers suitable for carrying oil, a large amount of structural steel work was necessary. For instance, all the bunker bulkheads have been specially stiffened, so that deformation will not occur with the weight of oil pressing against them.

All the plate joints have been specially treated, the general practice adopted being to fit stout double-riveted joggled plate straps over each plate landing, making a thoroughly oil-tight joint. Special attention has been given to plating and riveting of all steam-pipe trunks and passages where these penetrate the cross bunkers.

Transverse wash bulkheads have been fitted in all the side bunkers, and suitable wash bulkheads have also been constructed in the cross-bunker tanks to insure that oil is not in any way affected by the movement of the ship.

For the full length of the side bunkers and also around the cross bunkers, gutterways have been constructed to catch any oil that may find its way outside the tanks through leaky joints. In communication with these gutterways are bilge wells in each boiler room from which the oil bilge-well pumps draw.

In the cross-bunker storage tanks forward of boiler rooms Nos. 1, 2 and 3, four settling tanks have been constructed, each being of 60 tons capacity. In No. 4 boiler room two settling tanks of similar capacity each have been incorporated in the side bunkers, one port and one starboard.

In this ship there are four boiler rooms, the three forward ones each containing six double-ended boilers, and the after one three double-ended boilers. Two settling tanks are provided for each group of three boilers.

In certain parts of the boiler rooms the side bunkers overhang the wing boilers, and to insure that there will be no chance of oil dripping on the hot boiler tops, special screen plates have been fitted in the way of these overhanging parts, so that any oil that may leak through will be directed to the oil gutter below.

Electric Welding Employed

In addition to the special riveting that has been adopted to insure oil-tight joints on all the tanks, electric welding has also been largely employed, with the result that a thoroughly sound and substantial tank construction has been made. The oil fuel is burned under the "White" low-pressure mechanical system, which has proved efficient and reliable on existing oil-burning vessels.

The pumping and heating plant consists of a complete installation in duplicate for each group of three boilers; that is, in the large boiler rooms each containing six boilers there are four sets of pumping and heating plants, while in the small boiler rooms there are two sets. This insures that only under very exceptional circumstances will the supply of fuel to the burners be interfered with through any fault of the pumping plant.

For the full length of the boiler rooms two 8-in. suction and filling mains are provided, one port and one starboard. In each boiler room these mains are cross-connected, and in addition suitable shutoff valves are provided, so that the system in one boiler room can be isolated from any other boiler room.

Special attention has also been given to the bunkering arrangements, so as to insure that the minimum of time will be required to bunker the vessel. Each boiler room is provided with two 8-in. filling pipes from the working deck, one port and one starboard. These pipes communicate with the suction mains.

Special filling compartments have been arranged on "E" deck, where the connections for coupling to the tank steamer or shore hose are fitted. These compartments are separate from adjoining accommodation, so that should any oil escape from the save-all trays which are fitted under the valves and strainers, the oil will not be free to spread over the deck.

On each side of the ship there are four connections for bunkering purposes. Should the connections on one side of the ship be in use at one time, it would be possible to bunker the vessel in about six hours.

No Possibilities of Overfilling

Special precautions have been taken to eliminate all possibility of overfilling the tanks. A special arrangement of air and overflow pipes has been installed, by means of which, should any tank be inadvertently overfilled, the oil will overflow into one of the storage tanks specially arranged for this purpose. An overflow storage tank is provided in each group of tanks in each boiler room, port and starboard.

With the arrangement of overflow pipes and tanks, a sequence of tank-filling must be adhered to. These overflow connections, however, are fitted only as a safeguard should the other means provided for ascertaining the quantity of oil in the tanks fail.

Each storage tank is provided with a Pneumercator gage. By means of these gages the depth of oil and the quantity in the tanks can be noted at any time. It is usual to fill the tanks to 95 per cent of their capacity, and this quantity is indicated on each Pneumercator gage. In addition to these gages, electric float alarms are fitted, so that when the 95 per cent capacity level is reached a bell rings. No sounding pipes are fitted in any of the oil tanks

To insure that the oil will run freely from the tanks in cold weather, or when heavy oil is being used, heating coils are fitted in all the side-bunker tanks and in the double-bottom tanks, but not in the cross-bunker tanks, where it is considered the heating of the adjacent boiler rooms renders heating coils unnecessary.

From the storage tanks the oil is pumped by large vertical direct-acting pumps to the settling tanks. Two of these transfer pumps are fitted in each boiler room, those in No. 4 room being of 70 tons per hour capacity each, and those in the other boiler rooms of 100 tons per hour capacity each. The capacity of each settling tank is such as to insure sixteen hours' supply for three double-ended boilers, so that about fifteen hours will be allowed for the settling of the oil in one tank while the other tank is in use. To facilitate separation of water from the oil, heating coils are fitted in these tanks. Pneumercator gages and electric float alarms are also fitted to the settling tanks. The removal of the settled water from the tanks is done by the transfer pumps, which have special connections for this purpose, so arranged that it will not be possible for the pumps to draw oil from the settling tanks and discharge it overboard.

From the settling tanks the oil-pressure pumps take their supply through suction strainers, discharging through the heaters and discharge filters to the burners in the furnaces. A ring main is fitted in each boiler room to which each pumping unit is connected. An emergency connection is also made to this ring main so that the pressure pumps can draw directly from the oil-storage tanks. Special attention has been given to the fire-extinguishing arrangement in the boiler room.

With a view to speedy detection of oil on the double-bottom tank tops, a special skeleton arrangement of stokehold flooring has been fitted. Broad working gangways have been fitted in front of the furnaces, but these gangways are kept well clear of the bulkheads, leaving an open space to view the tank top and oil gutters. No wood has been used in the construction of the flooring.

Special gas-exhausting nozzles and pipes with connections to the oil-suction mains have been fitted to remove dangerous gases from the storage tanks before these are entered for inspection.

Cleaning and Putting Vehicle-Type Lead-Acid Battery in Service

The following is an abstract from Circular No. 92, "Operation and Care of Vehicle-Type Batteries," issued by the United States Bureau of Standards, Washington, D. C. This circular contains 93 pages and treats of both lead-acid and nickel-iron types of batteries. In addition to the instruction for the care and operation of different batteries a number of forms for use in keeping record of battery performance and maintenance records are given. Copies of this circular can be obtained at 30 cents each by addressing Superintendent of Documents, Government Printing Office, Washington, D. C.

Deposit of Sediment Accumulates

During the normal operation of a cell there is a constant wear of the plates, which causes a deposit or sediment to settle in the bottom of the jar. A space, usually referred to as the "mud space," having considerable capacity, is provided for the sediment.

The rate at which the sediment accumulates depends to a great extent upon the care which the battery receives in charging. If charging is carried on at such a rate as to cause violent gassing, the gas coming through the pores of the positive plate will tend to dislodge the active material, causing it to be deposited in the bottom of the jar. This condition is frequently referred to as "shedding of active material," and very materially shortens the life of the plate. This is one of the reasons why the charging current is reduced, when the battery begins to gas freely to a lower value called the "finishing rate." If a battery is regularly undercharged, the sulphate that remains unreduced on the negative plate will gradually accumulate and finally be washed away and deposited in the bottom of the jar. This is one of the reasons for giving a battery a regular equalizing charge in order to completely reduce the sulphate. If a cell is neglected and cleaning is delayed until the sediment accumulates sufficiently to reach the bottom of the plates, the wear will be increased on account of the local action caused by short-circuits through the sediment, and the cell will be discharged. Indications of this condition are low open-circuit voltage and low specific gravity.

To Determine Necessity for Cleaning

As the nature of the service requirements of a battery varies considerably, it is difficult to state definitely any means by which the necessity for cleaning may be determined. The best method of determining the condition of a battery appears to be a bench discharge test at normal rate, after an equalizing charge, with voltage readings of all cells in the battery. If, on such a test, any cell is found to be much below the others in capacity and the capacity of that cell cannot be restored by an overcharge, it should be removed and inspected for short-circuits or other trouble. This should be done after, say, 150 cycles of normal operation. Some types of cells are provided with extra-high ribs, which allow the accumulation of sediment during the entire life of the plates, thus eliminating the necessity of cleaning on this account.

Sulphation of Lead Batteries

Whenever a battery is discharging, lead sulphate ($PbSO_4$) is formed on both the positive and negative plates. After a normal discharge the sulphate is finely crystalline and of such a nature that it is easily reduced by the current flowing through the battery on charge. If charging is neglected and the battery allowed to stand in a discharged state, the crystalline condition of the sulphate gradually changes, filling the pores of the plates and eventually making the active material dense and hard, which prolongs the time required for a charge. It is this latter condition which is often referred to when a battery is spoken of as "sulphated."

Sulphation in this sense is always the result of some sort of abuse, as (a) standing discharged for some time, (b) neglecting evidence of trouble, (c) replacing loss of water by electrolyte, and (d) regular undercharging. A single cell in a tray may become sulphated by drying out as the result of failure to replace lost electrolyte or failure to replace a broken jar or by an internal short-circuit. During an equalizing charge where the specific gravity has reached a maximum in each cell, it indicates that all of the sulphate in the plates has been reduced. It is the negative plates generally which require a prolonged charge to reduce the sulphate. The active material of this plate is of a light color and hard and dense when in the discharged condition. The life of these plates, however, is shortened by sulphation.

Giving Battery Equalizing Charge

Once a week a lead battery which is used for operating a truck or tractor is to be given an overcharge known as an "equalizing charge." For this the daily charge is to be continued from the normal end at a rate equal to approximately one-half the value of the finishing rate until all cells are gassing freely and uniformly and until three consecutive readings of the specific gravity and voltage taken at half-hour intervals show no increase. If a battery shows a temperature exceeding 43 deg. C. (110 deg. F.), it should be cut off immediately and allowed to cool.

One a month the voltage and gravity readings of each cell should be recorded. These will serve as an indication of trouble within the cells such as sulphation or leakage, if there is a progressive change of the gravity readings.

The gravity of the individual cells should be adjusted to the proper value when the battery is first put in service or when it has been necessary to add electrolyte to any cell to replace that which has been spilled or otherwise lost. This should be done at the end of the equalizing charge. If the gravity of the cell is too high, a portion of the electrolyte may be withdrawn with the hydrometer syringe and replaced by distilled water. Similarly, the gravity may be increased by replacing the portion drawn off by electrolyte. Before considering the adjustment complete, the equalizing charge should be continued to mix the electrolyte of the cell. The final value is shown by several consecutive constant readings at fifteen-minute intervals. The gravity should be adjusted to within five points, corrected for temperature, of the proper value.

EVIDENCE OF PLATE SULPHATION

Some of the evidences of sulphation are (a) continued low specific gravity, (b) continued low open-circuit voltage, (c) loss of capacity, (d) inability to take normal charge on account of increase of internal resistance, and (e) light color of positive and negative plates. The loss of capacity due to sulphation must not be confused with the natural loss of capacity during the life of the battery.

Whenever any of the foregoing evidences seem to be present it is well to give the battery an equalizing charge and then a continuous discharge at the normal rate down to 1.70 volts per cell. If it does not give rated capacity, as in cases of stubborn sulphation, empty out the electrolyte and fill the cells with water (distilled water preferred) and then charge in the usual manner. At the end of this charge read the specific gravity of each cell and the temperature of the pilot cell. Continue the charge at one-half the finishing rate, or as nearly this as possible. Read and record the specific gravity of each cell at regular intervals of, say, four to six hours. The charge at this rate is to be continued until the specific gravity of each cell has been constant for a period of at least twelve hours. The level of the electrolyte is to be maintained constant by the addition of water after the readings. If the water is added before the readings it will not be properly mixed with the electrolyte and false readings will be obtained. Hydrometer readings are to be corrected for temperature. Should the specific gravity of any cell rise above 1,300, draw out electrolyte to the top of the plates and replace by water. If the gravity is deficient, electrolyte should be added. The battery cannot be considered as completely restored until the specific gravity of all cells has remained constant for a period of at least twelve hours of continuous charging at one-half the finishing rate. The temperature must not be allowed to exceed 43 deg. C. (110 deg. F.). If necessary, the currents must be reduced or temporarily cut off. When a single cell of a tray is found to be sulphated it should be removed and treated separately.

If the battery is found to be sulphated, but with the sediment below the bottom of the plates, it should be treated in accordance with the foregoing instructions before cleaning. If the sediment has been allowed to reach the bottom of the plates the battery will be sulphated and should be cleaned before receiving treatment for sulphation.

The wood separators are to be renewed completely, and while many of the rubber separators may be used again it is well to provide about 25 per cent new ones.

INSPECTION OF TRAYS

The trays should be examined to determine their suitability for further use. If found to be in good condition they should be washed out with water, to which soda has been added to counteract the effect of the acid. When thoroughly dry they should be painted with two coats of acid-resisting paint.

If the active material of the negative plates is swollen it must be pressed back into position before it is allowed to dry. A smooth board of suitable thickness is to be placed between each pair of plates and the whole group squeezed between smooth boards in a vise. Any loose particles adhering to the positive plates can be removed by means of a smooth piece of wood, or paddle. Do not wash the plates. All sediment is to be washed out of the jars. The jars are to be filled with electrolyte of specific gravity 1,250 to one-half inch above the top of the plates. If the battery is sulphated, water is to be used instead of electrolyte.

After the cells have been placed in the trays, and the old connectors pressed into position, the battery is to stand for several hours (some manufacturers recommend as long as ten hours), after which it is to be put on charge at the finishing rate. At the end of about fifteen minutes the voltage of each cell is to be read and recorded. This is to insure that the cells are connected right as to polarity. Any cell indicating less than two volts is probably connected backward and should be examined. The cells are now to be reconnected, if the battery is not sulphated, and after an equalizing charge it will be ready for service. A sulphated battery should be restored before reconnecting the cells permanently.

Universal Craftsmen Council of Engineers Meet at Springfield

The eighteenth annual convention of the Universal Craftsmen Council of Engineers was held at Springfield, Mass., during the week beginning Monday, Aug. 6. The Bridgeway Hotel was the headquarters, and in the Municipal Auditorium, a short distance away, the meetings of the delegates and the exhibit of the supplymen were held.

The lower floor of the auditorium was tastefully arranged in booths for the display of power plant equipment and engine-room supplies. The uniformity of decoration and the general color scheme of white and light green was most pleasing to the eye. There were 105 firms represented and the exhibit was liberally patronized during the week.

The several sessions of the engineers were held in the Mahogany Hall of the auditorium. There were present 102 delegates, representing 190 votes. It proved a busy week for the delegates in disposing of the accumulated business of the past year, and many important resolutions were adopted toward the building up of the organization, special interest being manifested in the educational features of the local councils during the coming year.

The Universal Craftsmen Council of Engineers was organized in Cleveland, Ohio, on Sept. 14, 1903, with four councils, located respectively in Chicago, Cleveland, Detroit and Rochester, with a combined membership of 248. At present there are fifty-six councils with an approximate membership of 9,500. In the past four years there has been an increase of 40 per cent in the membership it is claimed.

In the early part of the week all of the past grand worthy chiefs assembled and formed a Past Grand Worthy Chiefs' Association. O. N. Pomeroy, of Chicago, the first worthy chief of the grand body, was made president of the new association.

The ladies present numbered upward of sixty, and on Friday afternoon, permission having been given by the main body, the ladies convened and formed what will be known as the Ladies' Grand Council of the Universal Craftsmen Council of Engineers. Mrs. Joseph Nichols was chosen president; Mrs. David McGregor, vice-president, and Mrs. James Bunce, secretary-treasurer.

On Tuesday morning the opening exercises were held. Walter H. Damon, chairman of the convention committee, was the master of ceremonies, and after a brief address introduced Mayor Arthur A. Adams, who cordially welcomed the visitors to the city. Worthy Chief Frank Conroyd responded and thanked the mayor for his warm welcome. Raymond T. Wilber, Convention Secretary of the Chamber of Commerce, told the audience that the Chamber of commerce was at its disposal, and it was the wish of that body that the stay of the visitors would be so enjoyable that they would all be glad to come again.

On Thursday afternoon there was a steamboat excursion to Forrest Park, where an appetizing clambake was served; fully 400 guests were seated at the tables. During the day outdoor sports of various kinds were enjoyed, with prizes for the winners. The festivities ended with a baseball game between the Engineers and Supplymen.

On Friday evening in the Concert Hall of the auditorium an entertainment was given. There was an organ recital with several enjoyable numbers furnished by Bob Jones, France Packing Co.; Louis Serre, Jenkins Bros.; Jack Armour of *Power*, and others.

During the week there were theater parties, auto rides, shopping trips and visits to places of interest in the city.

The grand officers elected were: Frank Conroyd, past worthy chief, Chicago; Andrew Benner, worthy chief, Columbus; W. G. Warfield, assistant chief, Newark, N. J.;

Thomas H. Jones, secretary, Washington, D. C.; John O'Brien, treasurer, Chicago; Henry W. Burton, warden, Cleveland; P. H. Early, chaplain, Milwaukee; James M Patton, guard, Buffalo. The three trustees comprise G. C. Brown, chairman, Pittsburgh, Pa.; W. W. Law, Princeton, N. J.; J. W May, Brandon, Canada.

Frank Conroyd, retiring chief, was the recipient of a silver service and Walter H. Damon received a traveling bag in token for his excellent work as chairman of the convention committee. Progressive Council, No. 12, of Newark, N. J., presented the grand body a service bag for carrying the paraphernalia of the organization.

Preceding the installation of officers on Friday afternoon memorial services were conducted for the brothers who had passed away during the year. Chaplain P. H. Early officiated.

Toronto, Canada, was selected as the next convention city in August, 1921.

Seattle Considers Means to Relieve Power Shortage

In the discussion of means of relieving Seattle of its power shortage and of insuring continued power supply at lowest practicable cost, J. D. Ross, superintendent of lighting for the city, urges the speedy drilling of a tunnel at Cedar Falls. This tunnel, if drilled, will be 11 ft. diameter by 8,500 ft. long.

This course is urged as an alternative for the use of steam-driven electric generators. The Pacific Coast Coal Co. is said to have presented the City Council with an estimate for powdered coal for the Lake Union steam station to take the place of the Cedar River tunnel. Mr. Ross says that the above coal company gives an estimate of $640,000 to equip only 57 per cent of the steam boilers, which would mean a cost of over $1,000,000 to equip the entire plant. They estimate that on $1,000,000 worth of coal they could save $200,000 a year over the cost of oil which would leave $800,000 to add to the first cost of $640,000, or a total of $1,440,000 during the first year. While the tunnel would cost $1,100,000 and be a perpetual asset, the million dollars worth of coal on the other hand would be a dead loss and would soon have to be repeated. When Skagit power comes in all coal machinery would lie idle and would mean useless overhead charge.

Powdered coal delivers most of its ash to the smokestacks. Last year alone 90,000 tons of coal or 1,800 carloads would have been required at Lake Union, giving 11,250 tons of ash most of which would deluge the residences for a mile around.

For conditions at Seattle Mr. Ross thinks that powdered coal is a doubtful experiment. The Stone & Webster Co. tried to make it a success at its Western Avenue plant, he contends, but has not succeeded so far, and went to stoker feed at its largest plant at Georgetown.

The coal company on the same day they gave this estimate predicted a 20 per cent raise in coal if the new freight rates go into effect.

Governor Hart has just issued a warning that all cars available will be taken to the eastern and middle states.

Mill refuse is not available at any price for more than one-third of Seattle's needs, and even if it were available is dependent on whether a few lumber mills run or close down. There are 63,000 customers and service must be dependable.

Fuel equipment cannot be bought and installed as quickly as the tunnel can be built as machinery is hard to get. On the other hand, the tunnel requires only labor and concrete both easy to get locally.

The builders of the Elizabeth tunnel in California estimate that this tunnel at Cedar Falls could be built in four months actual working time by opening several adits. According to Mr. Ross, several well-known contractors are willing to take the job at $100 per ft. of tunnel. All machinery would be ready for 50,000 hp. without additional work. This summer not more than 2,000-hp. capacity is available at Cedar Falls and present equipment delivers only about 15,000 hp. during the winter months.

Shipping Board Contracts for Fuel Oil

The United States Shipping Board announces that it has entered into a contract with the Standard Oil Co. of New Jersey for supplying fuel oil to Shipping Board ships as follows: New York, 9,300,000 bbl. at $2.30 per bbl. terminal delivery and $2.40 barge delivery; Baltimore, 1,500,000 bbl. at $2.27½ per bbl. terminal delivery and $2.37½ barge delivery; Norfolk, 3,475,000 bbl. at $2.60 per bbl. terminal delivery and $2.70 barge delivery; Charleston, 400,000 bbl. at $2.15 terminal delivery; New Orleans (Baton Rouge), 1,150,000 bbl. at $1.90 per bbl. terminal delivery and $2.05 barge delivery. The following awards on bids for supplying fuel oil have been made: Atlantic Refining Company, Philadelphia, Pa., 3,000,000 bbl. of C grade fuel oil at $2.30 per bbl. terminal delivery and $2.38½ barge delivery, Philadelphia, Pa., deliveries to be made during the calendar year 1921; Gulf Refining Company, Pittsburgh, Pa., 125,000 bbl. of C grade fuel oil at $2.10 per bbl. terminal delivery and $2.20 barge delivery at Port Arthur, Tex., deliveries to be made over a period of six months beginning Oct. 1, 1920; Midco-Mexico Company, Tulsa, Okla., 4,900,000 to 7,000,000 bbl. of C grade fuel oil at $1.10 per bbl. terminal delivery for the first year and $1.25 for the next two succeeding years at New Orleans, deliveries to start on or about Jan. 1, 1921.

Water Power Commission Holds Hearings

Carrying out its policy to hear criticisms of regulations to be used in administering the Water Power Act, the Federal Power Commission on Aug. 12 listened to the views of those interested in the form of permit which will be used in making applications for power sites. The day following, representatives of banks and bond houses were heard on the regulations which have a bearing on the financial aspects of the law.

The Great Falls water power project, on the Potomac, is to be the subject of a hearing before the Power Commission on Aug. 24. All railroads entering Washington have been invited to send representatives to the hearing. All large consumers of power in Washington and throughout the Great Falls area will be represented at the hearing. The Commissioners of the District of Columbia and the public utilities commissioners of Virginia and of Maryland also are expected to be in attendance.

Major L. W. Call, of the Judge Advocate General's office, has been transferred to the Federal Power Commission and will serve as its chief counsel.

Domestic exports of electrical machinery and appliances from the United States by countries during May, 1920, as shown by the monthly report of the Department of Commerce, Bureau of Foreign and Domestic Commerce, are as follows: Batteries valued at $676,624; carbons valued at $129,546; dynamos and generators valued at $549,251; fans valued at $152,100; arc-lamps valued at $38.17; incandescent lamps (carbon filament) valued at $55.66, (metal filament) valued at $343,843; magnetoes and spark plugs, etc., valued at $360,317; meters and measuring instruments valued at $288,021; rheostats and controllers valued at $433.65; switches and accessories valued at $269,794; telegraph apparatus valued at $41,752; telephones valued at $414,838; transformers valued at $319,992, and other electrical apparatus valued at $2,869,808.

The Swiss Standards Association in a communication to various national engineering standardizing bodies proposes the standardization of widths across flats on nuts and bolt heads. The proposal covers the range of ¼ in. (6 mm.), 3 in. (80 mm.) diameter of bolts. Standardizing bodies of America, Belgium, England, France, Germany, Holland and Sweden received copies of the communication. The American Engineering Standards Committee has requested the American Society of Mechanical Engineers and the Society of Automotive Engineers to act as joint sponsors.

Sidelights on the Coal Situation

As a part of their campaign for better car supply to overcome the existing shortage in soft coal, bituminous operators in the National Coal Association have urged the Interstate Commerce Commission to take drastic steps to regulate the distribution of open top car equipment to small country "wagon" mines, hundreds of which have sprung into activity during the coal shortage emergency. It is roughly estimated that there are upwards of 3,000 mines of this character throughout the bituminous coal fields.

These so-called "wagon" mines, which are a considerable factor at this time in the speculative field, are located from one-half mile to 5 miles away from a railway switch, and have to haul their output by wagon or motor truck to the tracks. The mines, having only a small tonnage, draw upon the railroads daily for equipment, tying up cars at the switches because of their necessarily slow method of loading coal. Hundreds of cars which are needed to overcome the shortage in equipment in movements from the soft coal fields where facilities exist for quick loading and expeditious handling of the output, are in this way tied up.

The strike of daymen in the Middle West caused the production of soft coal during the last week of July to drop below the 1919 level for the first time this year. The total output, including lignite and coal coked at the mine, is estimated at 9,357,000 net tons, a decrease when compared with the latest pre-strike week, of 1,523,000 net tons.

Unlike the production of soft coal, that of anthracite increased during the week ended July 31. Shipments originated by the principal carriers (in part estimated) amounted to 36,487 cars, the largest since the middle of June. The total output, including mine fuel and local sales, is estimated at 1,874,000 net tons. This was 104,000 tons greater than that of the preceding week, and 62,000 greater than during the corresponding week of 1919.

Cumulative production since January 1, 1920, now stands at 50,575,000 tons, as against 47,307,000 tons in 1919.

A decrease of 15,000 tons marked the production of beehive coke during the week ended July 31. The total output is estimated on the basis of shipments over the principal carriers at 370,000 net tons, 4 per cent less than that of the preceding week. Production in the Connellsville region, as reported by the Connellsville *Courier*, decreased from 182,145 to 172,870 tons.

The cumulative output since the beginning of the year now amounts to 12,286,000 tons, an increase of 15 per cent over 1919.

Society Affairs

A National Conference of engineering employment sponsored by the American Association of Engineers will be held in Chicago on November 12, 1920. Practically all free employment bureaus will have representatives at this conference. All employment managers of the large industries and employers of technical men will be invited to attend and participate. The object of this conference is to provide a forum for solution of industrial relations problems affecting employers and engineers.

The American Association of Engineers has succeeded in having a board appointed by the Navy Department to consider the salary needs of the navy technical force and other employees. An A. A. E. committee consisting of J. T. Maguire, K. D. Williams and District Secretary R. C. Bailey appeared before the board on August 5 and presented data which indicates the need of about a 40 per cent increase. An increase of somewhat less than this was requested by the committee. The board will report on the 20th of August and the Navy Dept. will take action upon the recommendations on September 1. The members of the board are Captain J. K. Robison, L. McK. Howe and A. J. Berres.

Personals

D. B. Rushmore, chief engineer of the power and mining department of the General Electric Co., has been elected vice-president of the American Welding Society.

C. V. Peeling, formerly manager of the Cornwall (Ont.) Street Railway, Light & Power Company, has become connected with the Palmetto Power & Light Company, Florence, S. C.

A. T. Hardin, vice-president of operation of the New York Central Railroad, has been appointed by W. S. Murray, head of the super-zone engineering staff, to the advisory board, representing the New York railroads.

The American Society for Testing Materials has appointed C. D. Young as its representative on Engineering Council to succeed Albert Ladd Colby. Mr. Young is General Supervisor of Stores, Pennsylvania System, Broad Street Station, Philadelphia, and Vice-President of the American Society for Testing Materials.

H. W. Butler has been designated as industries division engineer of the super-power zone engineering staff. Mr. Butler is a graduate of Cornell University and was connected with the Interborough Rapid Transit Co. until 1907, when he resigned to accept a position with J. G. White & Co., with whom he was engaged until 1913. Later he did consulting work in New York. During the war he was assigned to the aircraft production department of the Army.

New Publications

TIN SHEET-IRON AND COPPER-PLATE WORKER. By Leroy J. Blinn. Published by Henry Carey Baird & Co., Inc., New York City. Cloth, 5 x 7¾ in.; 334 pages.

This volume is a new and enlarged edition, containing many new problems in metal plate work and should prove of practical value to workers in tin, sheet-iron and copper plate. The book is brought up to date with the addition of new problems which deal more particularly with triangulation and modern skylight work. A noteworthy feature is the treatment of metallic alloys and solders; the more important seams or joints used in plate work and the various ways of making them are illustrated and described in a clear and concise manner. There are suggestions for tempering and for other operations useful in the workshop, also numerous useful tables designed to furnish a quick guide and save time. Valuable recipes of all kinds round out this most complete work. Included in its chapters are rules for describing various kinds of patterns, practical geometry, mensuration of surfaces and solids, tables of the weights and strength of metals and other materials, tables of areas and circumferences of circles, composition of metallic alloys and solders. A most complete index enables quick reference to the subject matter.

Trade Catalogs

"Science in Industry" is the title of a 26-page booklet just published by M. H. Avram & Co., Inc., New York City. The booklet contains a discussion of the province of industrial engineering and explains the need of a systematic method of scientific guidance and control whose application would tend to decrease industrial waste and strengthen industrial effectiveness.

The Traylor Engineering & Manufacturing Co., of Allentown, Pa., has ready for distribution a new 50-page catalog entitled "The Traylor Superpump and Hydraulic Machinery." The booklet gives a comprehensive idea of the constructional details of the Traylor Superpump. It should prove of practical value to the operating engineer and will give the purchaser data pertaining to the selection of pumping equipment. A copy will be sent on request.

The Kelly Controller Co. of Chicago has just completed publication of two new catalogs entitled respectively the "Kelly High Pressure Controller" and the "Kelly Low Pressure Controller." The first contains descriptions and illustrations of the high pressure controller manufactured by that company and a table of dimensions of the various parts of the article. The second contains a description of the low pressure controller, with photographs and line drawings.

The Edward R. Ladew Co., Inc., manufacturer of leather belting, 54 Franklin St., New York City, has just finished publication of a new 20-page catalog entitled "A Study of Various Types of Belting." The booklet contains a study of various types of belting and belt-testing equipment. The results of a number of tests are also given, together with curves illustrating the horsepower transmitted at various percentages of slip. A copy of the catalog will be sent on request.

Fan System of Heating, Ventilating and Humidifying is the title of a 115-page catalog ready for distribution by the Buffalo Forge Co., Buffalo, N. Y. In the volume particular stress is laid on the principles underlying all the various steps in the determination of suitable apparatus to meet all conditions of heating, ventilating and humidifying. A brief history of the heating and ventilating art in public buildings is given. This is followed by a comparison between natural and mechanical ventilation and several tests made of each system. A synthetic air chart designed as a convenient method of recording data and arriving at a final percentage of perfect ventilation is given. The chart includes all the known factors that influence the ventilation of a room. Some of the other subjects presented are heating, room temperature, heat losses, humidity, psychrometric charts, carrier air washers, humidity control; ventilation in hospitals, libraries, schools, theaters, churches, department stores. Heating, ventilating and humidifying in industrial plants are treated in a comprehensive manner in part two of the book. Part three describes the Buffalo apparatus, and part four deals with fan engineering problems.

Business Items

The Chicago Fuse Manufacturing Co. has acquired a new factory comprising a frontage of 140 ft. on Laflin St. and 360 ft. on Fifteenth St., Chicago. The building is a two-story factory structure with a four-story office section, and contains a total floor space of 125,000 sq.ft.

Greene, Tweed & Co., New York, announce to operators of steam power plants the completion of arrangements to manufacture the Rochester Automatic Lubricators in their new plant at Newark, N. J. This plant is to be under the supervision of one of their vice-presidents.

M. H. Detrick Company, manufacturers of flat suspended arches and steam jet ash conveyors, announce the opening of an Eastern branch office at 30 Church Street, New York City. This office will be under the management of R. D. Foltz, former Assistant Mechanical Engineer, who has been appointed Eastern Sales Manager. Mr. Foltz will supervise the New York, Boston, Hazelton and Philadelphia offices. Harry S. Sleicher will continue to handle all sales matters in the New York territory.

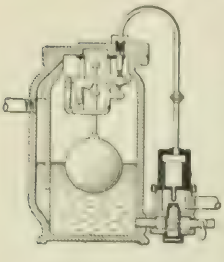
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Trap, Miller Steam

C. J. Miller Co., 1225 Columbia Ave., Philadelphia, Pa.

"Power," June 22, 1920

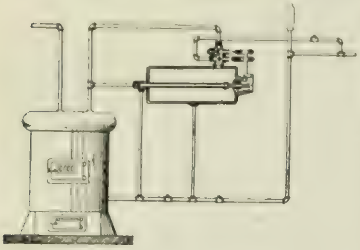


This trap is designed to use with machinery when constant temperature and thorough draining of condensation is desirable. Condensation enters through an inlet pipe and a float holds a lever down, which in turn holds the pilot valve from its seat. Steam and air then flow through the pilot-valve disc and close the discharge valve. As the water rises in the trap, it pushes the float upward until the pilot valve is closed, which action cuts off steam from the cylinder. An air vent releases the pressure in the trap, and the discharge valve is forced wide open to the discharge pipe. Removing the seat holder from the bottom of the valve permits of the seat and valve being easily removed for regrinding or renewal.

Controller, Kelly Thermo Return

Kelly Controller Co., 175 West Jackson Boulevard, Chicago, Ill.

"Power," July 13, 1920

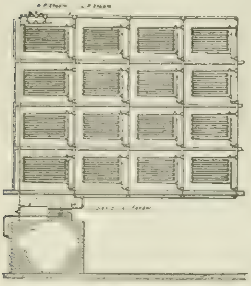


This device is designed to return water to the boiler against any back pressure and keep the return lines dry. It is thermostatically controlled, and the operating mechanism is visible and accessible. A steam line is connected from the boiler to the controller chamber. A check valve prevents a back flow of water from the boiler. When the return water has accumulated in sufficient quantity to cover the thermostat, the thermostat contracts thereby closing one valve and opening another, which action permits steam at boiler pressure to enter the receiver and thus allows the water to return to the boiler by gravity.

Heating System, Farnsworth

Farnsworth Co., Conshohocken, Pa.

"Power," June 29, 1920

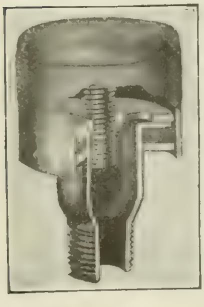


This system consists of a duplex boiler feeder which permits of a continuous flow of condensate into the boiler at a temperature only one or two degrees below that of the steam corresponding to the pressure carried in the system. There are no vent openings to the atmosphere and practically no heat loss. The return line from the risers is carried through the boiler meter, which is located above the water line of the boiler. There is no return line other than to connect the risers through the boiler feeder. The condensate is held under a pressure and is fed directly into the boiler.

Grease Cup, Harrison Center Thread

H. & H. Motor Specialties Co., Inc., 755 Boylston St., Boston, Mass.

"Power," 1920

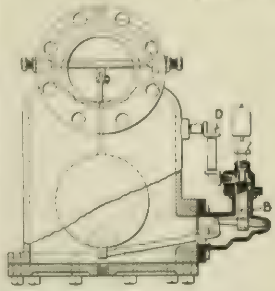


This grease cup is made with a drawn-steel base with a screw plate electrically welded to it. The cap consists of a drawn-steel shell with a screw electrically welded in the center. A heavy leather washer fits over the hexagon base and is reinforced with a steel washer. The screw plate is provided with four holes through which the grease is forced into the base, and which prevents emptying the base when removing the cap.

Controller, Kelly High-Pressure

Kelly Controller Co., 175 West Jackson Boulevard, Chicago, Ill.

"Power," July 13, 1920

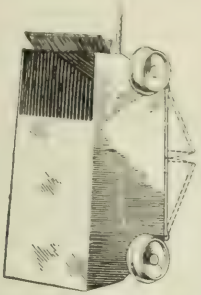


This controller is designed primarily for single boilers and acts as a steam separator when inserted in the steam-supply line from the boiler. The float is connected to a butterfly valve at the upper side and to another valve from the lower side through a series of levers. When the quantity of water separated from the steam becomes greater than can be carried away through the bleeder opening, the float rises and pulls the stem downward, which allows steam to be supplied through a pipe to blow an alarm. If an excessive amount of water accumulates, the float rises and closes a butterfly valve, thus preventing the water from entering the steam main.

Skip Hoist-Transporter, Improved Balanced

Exeter Machine Works, 30 Church St., New York City.

"Power," 1920

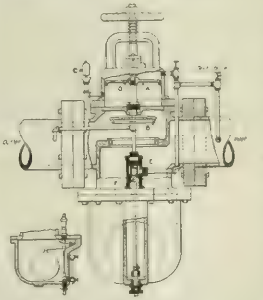


Combines horizontal transportation with hoisting operation in a single machine. Coal is loaded at an opening in the upper front side and discharges through a single- or double-hinged door on the opposite side, when the skip is on a horizontal track. The doors are held closed by a latch, which is operated for discharging by a tripper arranged along the track. This tripper can be shifted to any desired position for dumping. The skip hoist and one-half of its load is balanced by a counterweight which operates only during the vertical motion of the skip. When lowering the empty skip, the motor raises the counterweight. A second counterweight takes up the slack rope paid out during the horizontal travel of the skip. A third weight carries the skip back after discharging.

Valve, Quintuple-Duty Steam

Kelly Controller Co., 175 West Jackson Boulevard, Chicago, Ill.

"Power," July 13, 1920

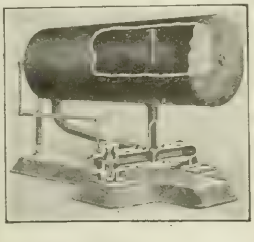


This valve combines five separate functions in that it automatically protects the boiler main and engine by closing when a rupture occurs in either the boiler or mains, or when the boiler primes. It also acts as a non-return or a check valve, as a main protection, as a steam trap, as an engine protection and as an equalizing valve. Should the boiler pressure become lower than the header or steam main pressure, the weight of a plunger and a disk closes the valve slowly against the cushioning action under the plunger. Should the main header burst, the pressure lowers on the top side at the auxiliary valve, and as boiler pressure is under this valve it opens, allowing steam to be applied to the upper side of the plunger, which closes the main valve.

Trap, Ellis Tilting Steam

Ellis Drier Co., Chicago, Ill.

"Power," July 27, 1920



Water of condensation runs into the receiving tank through a trunnion. When sufficient water has entered the tank to counterbalance the weight which is within the tank between a double head, the tank tilts, opening a valve which allows steam to enter the receiver through a vertical pipe and forces the condensation out of the trap. As soon as the water is discharged, the counterweight brings the tank back to horizontal, or filling position. The new position of the counterweight produces a rapid tilting action. When the trap begins to tilt, the center or gravity of the counterweight moves forward as it swings through its arc. Tempered springs act as a shock absorber, and a relief valve attached to and below the steam valve is always open when the trap is filling. The tank has welded seams and is tested to 150 lb. pressure.

Patented Aug. 20, 1918

New Construction

PROPOSED WORK

Me., Saco—The Garland Mfg. Co. is in the market for motors, etc.

N. H., Manchester—The Bd. Educ. will receive bids until August 31 for a 3 story high school including a steam heating system. About $450,000. C. R. Whitcher, 814 Elm St., Archt.

N. H., Manchester—The Bd. Educ. will receive bids until August 31 for a 3 story, 100 x 110 ft. high school including a steam heating system on Notre Dame Ave. About $300.000. W. E. Provost, 581 Union St., Archt.

Vt., Brandon—The Health Comn. plans to build a 1 story central heating plant at the State Hospital here. A. S. Kellogg, 53 State St., Boston, Mass., Engr. Frank L. Austin, College St., Burlington, Archt.

Mass., Athol—The town will receive bids about September 10 for a 2 story, 50 x 125 ft. memorial hall including a steam heating system on Main St. About $250,000. Brainerd, Leeds & Kellogg, 89 Franklin St., Boston, Archts.

Mass., Cambridge—The city received bids for the installation of a heating and plumbing system in the proposed 3 story, 77 x 140 ft. hospital addition on Mt. Auburn St., from Lynch & Woodward, 287 Atlantic St., Boston, $16,675.

Mass., Greenfield—The town is having plans revised for a 3 story high school including a steam heating system on Federal and Saunderson Sts. About $400,000. Harry Richardson, Chn. Patton & Blair, 579 5th Ave., New York City, Archts.

N. Y., Brooklyn—William H. Gompert, Archt. and Engr., 171 Madison Ave., New York City, will receive bids until August 23 for a 2 story, 50 x 120 ft. bank building including a steam heating system for the Homestead Bank, 141 Penn Ave., East New York. About $300,000.

N. Y., New York—The Interborough Rapid Transit Co., 165 B'way, is in the market for conveying and hoisting machinery for the new storage yards at New Lots and Stanley Aves., Brooklyn.

N. Y., New York—The J. P. Morgan Co., 23 Wall St., is having plans prepared for a 20 story office building addition including a steam heating system at 11-21 Broad St. About $4 000,000. Trowbridge & Livingston, 527 5th Ave., Archts. and Engrs.

N. Y., New York (Borough of Richmond)—The Dept. of Pub. Welfare, Municipal Bldg., New York City, will receive bids until August 20 for furnishing, delivering and installing boilers in the proposed addition to the present boiler house at Sea View Hospital, here.

N. J., Point Pleasant—The Lakewood & Coast Electric Co. plans to build a 15 mi., 13,200 volt, 3 phase, transmission line from here to the Borough of Seaside Heights and is in the market for equipment for same. S. W. Borden, Summit, Genl. Mgr.

N. J., Trenton—W. H. McElfatrick, Archt., 701 7th Ave., New York City, will soon award the contract for a 2 story, 100 x 250 ft. theatre including a steam heating system on South Broad St., for the Trent Theatre Bldg. Co. About $800,000.

Pa., Philadelphia—Stewart A. Jellet, Engr., Real Estate Trust Bldg., will soon award the contract for a 1 story, 40 x 76 ft. power house for the Ferguson Carpet Co., Stenton and Rockland Sts.

Pa., Philadelphia—The Lit Bros., Market and 8th Sts., will soon award the contract for a 5 story, 76 x 80 ft. boiler house at 719 Filbert St. Stewart A. Jellet & Co., Real Estate Trust Bldg., Engr.

Md., Dundalk (Baltimore P. O.)—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., Baltimore, plans to build a large steam power plant here.

D. C., Washington—The Office of the Chief Signal Officer, War Dept., will receive bids until August 26 for furnishing five, 1 kw., 115 volt telephone motor generators.

W. Va., Spencer—The Spencer Water & Ice Co. has purchased the plant of the Wieland Electric Co. and plans to install 2 new generators, and a 200 hp. engine in addition to the 20 hp. engine now in use.

Tenn., Memphis—The Mississippi River Comn., 1st and 2d Districts, Custom House, will receive bids until August 26, for furnishing and delivering 5 return-flue boilers for the U. S. S. Chisca.

Tenn., Nashville—The Morgan & Hamilton Co., 1400 8th Ave., N., plans to build a bleachery. Steam and electrical equipment will be installed in same. J. B. Morgan, Pres. and Genl. Mgr.

Ky., Henderson—The Canoe Creek Coal Co. is in the market for electrical equipment, etc. About $1,000. Alex. Blair, Jr., Supt. and Mgr.

O., Cleveland—The city received bids for furnishing one 10,000-kw. steam turbo generator condenser, auxiliaries and switchboard from the Merchants' Light & Heat Co., Indiana, $284,350; Westinghouse Electric & Mfg. Co., East Pittsburgh St., Pittsburgh, $285,567; Allis-Chalmers, Park Bldg., Pittsburgh, $300,000.

O., Cleveland—The Masonic Temple Association, c/o Albert Wright, of the Otis Elevator Co., 1373 East 6th St., plans to build a 21 story, 96 x 150 ft. masonic memorial building including a steam heating system at 3500 Euclid Ave. About $4,000.000. Hubbel & Benes, 4500 Euclid Ave., Archts.

O., Cleveland—The Standard Oil Co., 26 B'way, New York City, is having plans prepared for a pumping plant here. About $1,000,000.

O., East Cleveland (Cleveland P. O.)—The Bd. Educ., Williamson Bldg., Cleveland, received bids for a 1 story, 48 x 66 ft. heating plant in the proposed Prospect school from the Drummond Miller Co., 4500 Euclid Ave., Cleveland, $56,900; C. Peterson Co., 4500 Euclid Ave., Cleveland, $63,500; Tenbusch Parker Constr. Co., 1836 Euclid Ave., Cleveland, $63,696.

O., Lakewood—The Bd. Educ., 1456 Warren Rd., will receive bids until August 25 for a 2 story, 44 x 92 ft. grade school addition to the Lincoln, McKinley and Franklin schools. Plans include the installation of a steam heating system in each. About $250,000. C. W. Hopkinson, Rose Bldg., Cleveland, Archt.

Ind., Ft. Wayne—The Bd. of County Comrs. is having plans prepared for a 2 story county farm building near here. Plans include a power plant. About $600,000. C. R. Weatherhogg, Hamilton Bank Bldg., Archt.

Ind., Indiana Harbor—C. E. Potts, c/o Inland Steel Co., Mill Block Ave., will soon award the contract for a 1 story, 100 x 300 ft. theatre including a steam heating system. About $350,000. Henry L. Newhouse, 4630 Prairie St., Chicago, Ill., Archt.

Ind., Petersburg—The Bd. of Co. Comrs. will receive bids until August 30 for a 3 story, 110 x 110 ft. court house including a steam heating system. About $400,000. Elmer E. Dunlap, 909 State Life Bldg., Indianapolis, Archt.

Mich., Ann Harbor—The University of Michigan is having plans prepared for dormitory buildings including a steam heating system. About $700,000. York & Sawyer, 50 East 41st St., New York City, Archts. and Engrs.

Mich., Dearborn—Malcolmson, Higginbotham & Palmer, Archts., 405 Moffat Bldg., Detroit, will soon award the contract for a 1 story, 46 x 87 ft. power house including equipment for same for the Bd. Educ. About $50,000.

Mich., Detroit—Baxter O'Dell & Halpin, Archts., 1024 Hammond Bldg., will soon award the contract for a 2 story, 45 x 96 ft. factory including a steam heating system and an electric motor for power on Field and Forest Sts., for the Weyhing Bros., 237 Woodward Ave. About $100,000.

Mich., Flint—The Y. M. C. A. is having plans prepared for several dormitory buildings including a steam heating system. About $500,000. Davis, McGrath & Kiesling, 220 5th Ave., New York City, Archts and Engrs.

Mich., Lansing—The Bd. Educ. had plans prepared for a 3 story, 80 x 306 ft. school including steam heating equipment. About $325,000. J. N. Churchill, Archt.

Ill., Savannah—The Construction Division, War Dept., Wash., D. C., plans to build 47 buildings including a small heating plant to have 100 hp. boilers, here. About $3,000,000.

Minn., Fairmont—The Martin Co. Electric Service Co. Inc. is having plans prepared for installing 28 mi. of transmission line from here through Welcome and Ceylon, to Dunnell. About $28,000. W. E. Skinner, 3241 Aldrich Ave., South Minneapolis, Engr.

Wis., Hartford—The Kissel Motor Co. will soon receive bids for furnishing pipe boilers, etc., for the boiler plant. About $25,000. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Marshfield—The city plans to build an addition to the boiler house and will receive bids until August 27 for stokers, feed water heater, superheaters, etc., in same. J. Seubert, Clk. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Milwaukee—The H. N. Davis Co., 129 Michigan St., will soon award the contract for a 2 story, 60 x 110 ft. factory on 32nd St. Several electric motors will be installed in same.

Wis., Plymouth—The Service Motor Co. plans to build a 4 story, 60 x 200 ft. garage including electric power, etc. About $100,000.

Wis., Sheboygan—The Columbia Rubber Wks., 176 16th St., Milwaukee, is having plans prepared for a 2 story, 70 x 200 ft. factory addition including a steam heating system. Plans include a 30 x 40 ft. boiler house. About $75,000. Edward Juul, 805 North 8th St., Engr.

Wis., Sheboygan—The St. Nicholas Hospital Co., c/o P. Reiss, plans to build a 60 x 180 ft. power house on Superior St. About $50,000. Frank Geib, 1439 South 9th St., Engr.

Minn., Duluth—Cathedral Parish, 211 West 4th St., will soon award the contract for a 2 story, 110 x 150 ft. school including a steam heating system on 28th Ave. About $250,000. Maginnis & Walsh. 100 Boylston St., Boston, Mass., Archts.

Minn., Milaca—The city plans to install a new generator and probably an additional unit to the lighting plant. W. E. Skinner. 3241 Aldrich Ave., Minneapolis, Engr.

Minn., Minneapolis—The Bd. Educ. received bids for installing a heating and ventilating system in the proposed 2 story, 60 x 191 ft. grade school on 46th St. between 4th and 5th Aves., S., from H. Kelly & Co., 925 Plymouth Bldg., $21,197; Western Heating Co., 13 East 36th St., $22,980; Belden-Porter-Gray & Co., 914 Mary Place, $23,365.

Minn., Minneapolis—The Hennepin Atomized Fuel Co., B'way and Johnson Sts., N.E., plans to install equipment including pressure machines, driers, pulverizers, etc.

Minn., Stephen—The Minnesota Electric Distributing Co., Crookston, plans to extend its transmission line from here to Crookston, a distance of 50 mi.

Minn., Willmar—Hans Gunderson, City Clk., will receive bids until August 23 for a sewer sludge pump and a 5 hp. electric motor.

S. D., Plankinton—C. H. Nelson, Stickney; Mount Vernon Light & Power Co., Mount Vernon, and W. J. Peters, White Lake, all of S. D., plan to build a central power plant here and extend the transmission lines.

Ark., Ft. Smith—The city is having plans prepared for a waterworks project. Plans include 2 or 4 additional settling basins and equipment, 2 new boilers and 1 pumping engine. F. M. Smith, City Clk. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engrs.

Utah, Ogden—The Construction Division, War Dept., Wash., D. C., has purchased a site here and plans to construct 35 buildings including a small heating plant to have 200 hp. boilers. About $2,000,000.

Cal., Los Angeles—The Bd. Educ. will receive bids until August 25, for furnishing all labor and materials for the installation of a boiler to replace the present boiler at the Virgil Intermediate School, 150 North Vermont Ave.

N. B., St. Stephen—The Maun Axe & Tool Co. plans to rebuild its plant which was recently destroyed by fire and is in the market for one 10 hp., 200 volt, 60 cycle 3 phase, a.c. induction motor, 900 r.p.m.; seven 20 hp., 200 volt, 60 cycle, 3 phase, a.c. induction motor, 1,200 r.p.m.; one 15 [illegible] volt 60 cycle 3 phase a.c. induction motor, 1,200 r.p.m., and one 40 hp. 220 volt 60 cycle 3 phase a.c. induction motor.

CONTRACTS AWARDED

Mass., Arlington—The Bldg. Committee has awarded the contract for the installation of a heating and ventilating system in the proposed Junior High school here, to the [illegible] Chase Co., Summer St., Boston, at $[illegible],958.

Mass., Charlestown—The Palmer & Parker Co., 105 Medford St., has awarded the contract for a 1 story, 16 x 40 ft. boiler plant to W. H. Preble Co., 11 Pemberton Sq., Boston.

N. Y., Brooklyn—The Hebrew Institute of Borough Park, c/o L. A. Abramson, Archt. and Engr., 46 West 16th St., New York City, will build a 3 story school and auditorium including a steam heating system. About $400,000. Work will be done by day labor.

N. Y., New York—Hotel Statler, Pennsylvania Hotel, New York City, has awarded the contract for a 3 story hotel addition including a steam heating system to George A. Fuller, 175 5th Ave., at $250,000.

N. J., Hackensack—The Hackensack General Hospital has awarded the contract for a hospital addition and power house to the W. H. White Constr. Co. at $150,000. Noted May 3.

D. C., Washington—The Bureau of Yards & Docks, Navy Dept., has awarded the contract for a boiler and piping, to the W. G. Cornell Co., 923 12th St., N. W., at $8,586.

Va., Brookneal—The Brookneal High School Bd. has awarded the contract for the installation of a heating system, in the proposed 2 story, 60 x 80 ft. high school to T. R. Marsh, Lynchburg.

Ga., Atlanta—The Red Diamond Motor Corp. has awarded the contract for an assembly building including a steam heating system to H. D. Best, 175 5th Ave., New York City, at $[illegible].

O., Cleveland—The Fuller Dry Cleaning Co., c/o W. A. Theobald, 7606 Carnegie Ave., has awarded the contract for a 1 story, 79 x 40 ft. boiler house on East 76th St. near Carnegie Ave. to Paul Bros., 528 Citizens' Bldg., at $7,000.

O., Cleveland—The Sisters of the Notre Dame, 10610 Euclid Rd., has awarded the contract for a 1 story, 23 x 64 ft. boiler house to Law & Strauss, Builders' Exch. Bldg., at $30,000.

Mich., Detroit—The Bd. Educ. has awarded the contract for installing a heating, ventilating and plumbing system in the proposed 2 story, 105 x 200 ft. Pattengill School on Northfield and Spokane Aves. to Irvin & Meier, 2289 Woodward Ave., at $94,277, in the proposed 2 story, 77 x 139 ft. George School on Russell and Superior Sts. and in the proposed 2 story, White School on Charles Ave. to James W. Partlan, 51 Park Pl., at $56,995; $92,850; and in the proposed Davidson School on Roman and Joseph Campau Aves. to the O'Connor Bros., Vinton Bldg., $85,741. Noted Aug. 3.

Ill., Chicago—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., has awarded the contract for repairing the boiler at the U. S. Marine Hospital here to the Chicago Down Draft Furnace Co., 115 South Clinton St., at $2,569.

Wis., Barron—The city has awarded the contract for the installation of machinery for power plant to Otto Berg., c/o Taylor Flour Mill.

Wis., Colfax—The Colfax Light & Power Co. has awarded the contract for furnishing a switchboard and motors, to the St. Paul Electric Co., 145 East 5th St., St. Paul, Minn., at $11,000.

Wis., Florence—The Peninsular Power Co. will build a hydro-electric plant here. Work will be done by day labor.

Wis., Glenwood City—The Apple River Mining Co. has awarded the contract for a transmission line from here to Emerald, a distance of 10 mi. including transformers, to the St. Paul Electric Co., 145 East 5th St., St. Paul, Minn., at $10,000.

Wis., Milwaukee—The Amer. Shipbuilding Co., foot of 54th St., N.W., Cleveland, O., has awarded the contract for a 1 story, 40 x 100 ft. pump house on Washington St. to the Meredith Bros., 1043 Kinnickinnic Ave., at $60,000.

Wis., Peshtigo—The Peshtigo Pulp & Paper Co. has awarded the contract for a hydro electric power plant and dam 5 mi. from here, to Jorgenson Constr. Co., Denmark, Wis.

Minn., Farmington—The city has awarded the contract for a 500 gal. duplex or triplex pump, motor, etc., to the Power Equipment Co., 212 3rd Ave., N., at $3,194. Noted July 13.

Minn., Minneapolis—The Auto Intelligence Association Schutte Realty Co., 1000 Soo Line Bldg., has awarded the contract for the installation of a heating system in the proposed 2 story, 132 x 165 ft. auto sales building on 4th and 6th Sts., S., to C. E. Hasey, 300 Builders' Exch. Bldg.

N. D., Osnabrock—The city has awarded the contract for the installation of a light and power plant, to the Electric Constr. Co., Grand Rapids.

N. D., Valley City—The city has awarded the contract for a 2 story, 80 x 89 ft. power plant, to McManis & Tarnoski, 484 Endicott Bldg., St. Paul, Minn., at $60,000.

Tex., Waco—Baylor University has awarded the contract for the construction of a heating plant, to J. S. Harrison & Sons and for equipment, to the Hill Bros., 705 Austin St.

EMPLOYERS:

The Nation's foremost industrial plants advertise in the

SEARCHLIGHT SECTION

to locate competent men

(See pages 95 to 112) *Do You?*

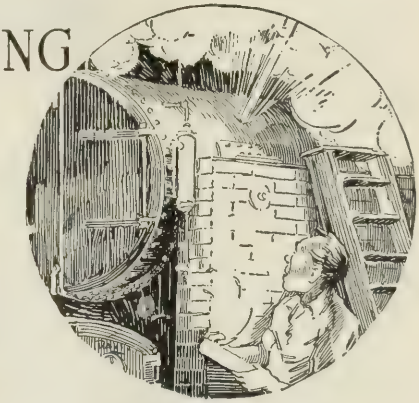
POWER

Volume 52 New York, August 24, 1920 Number 8

PREVARICATING PETE

by

RUFUS T STROHM



ULYSSES, crafty, brave and bold, could draw the longbow, so we're told; but here's our old friend, Peter Stiles, who has him beaten sixty miles. By that we don't intend to call Old Pete a liar—not at all! Let's use diplomacy and say his fancies sort of run away, till finally they get so far that Pete can't tell just where they are.

For instance, Peter swears that he prevented a catastrophe when he was working at the mill of Brown and Son, beyond the hill. It seems the main belt broke one day and let the engine run away; but Peter chanced to stand close by, and quick as you could wink an eye he grabbed a stick of six-by-four that stood outside the open door, applied it to the flywheel rim with resolution stern and grim, and braked the engine with his beam till other hands shut off the steam.

And once a piece of shafting fell endwise and hit the boiler shell and punched a disk out, sharp and clean as anything you've ever seen. The steam, escaping in a blast, reduced the pressure mighty fast, and Peter saw he'd have to stop that roaring leak or close the shop. So, with a judgment truly fine he whittled out a plug of pine and drove it in that hissing gap, and stopped the jet of steam, kerslap! Moreover, as the soft wood swelled, the pressure was more firmly held.

Munchausen, in his early day, produced some whoppers, so they say, but Peter has that Baron chap eliminated from the map. He grabs the outer robe of truth and stretches it until, forsooth, you hear the fibers tear apart and see the seams and stitches start; and while he boldly falsifies, he looks you squarely in the eyes, insulting your intelligence, because he thinks you lack the sense to see his highly colored junk is bosh and blarney, bull and bunk.

One man outbids Pete Stiles for fame, and Ananias is his name.

Ten-Thousand Horsepower Station for Operating Shipyard

BY JULIUS G. BERGER*

Combined 5,000-Kva. Turbo-Alternator and 4,500-Hp. Air-Compressor Plant—New Plant Built Around Old Station While Latter Was Kept in Operation — Steam Header 590 Ft. Long and Main Air Line 2,315 Ft. Long has Butt-Welded Connections — Acceptance Test Data and Performance Are Given.

THE Merchant Shipbuilding Corporation, acting as agent for the United States Shipping Board, Emergency Fleet Corporation, acquired, in the summer of 1917, a tract of land immediately to the northeast of the borough of Bristol, Pa., now known as Harriman, on which has been erected one of three large Government shipyards for building steel merchant ships. The tract contains about 265 acres and includes the property formerly occupied by the Standard Cast-Iron Pipe and Foundry Company. Bristol is twenty-three miles northeast of Philadelphia, on the deep tidewater section of the Delaware River at a point which is the terminus of the Delaware & Lehigh Canal and on the main line of the Pennsylvania Railroad.

At the northeast end of the shipyard property along the river front, which has a southwesterly direction, there are twelve shipways, each having a north-and-south direction and arranged at an angle of about 45 deg. to the river front. To the southwest of the course of shipways and down the stream therefrom there is a 1,135-ft. fitting-out wharf, which will accommodate three ships simultaneously. The steel storage yards, fabricating shops, storehouses, power house and other industrial buildings are grouped in an approximately parallel direction to the river front at the head of the shipways and of the fitting-out wharf.

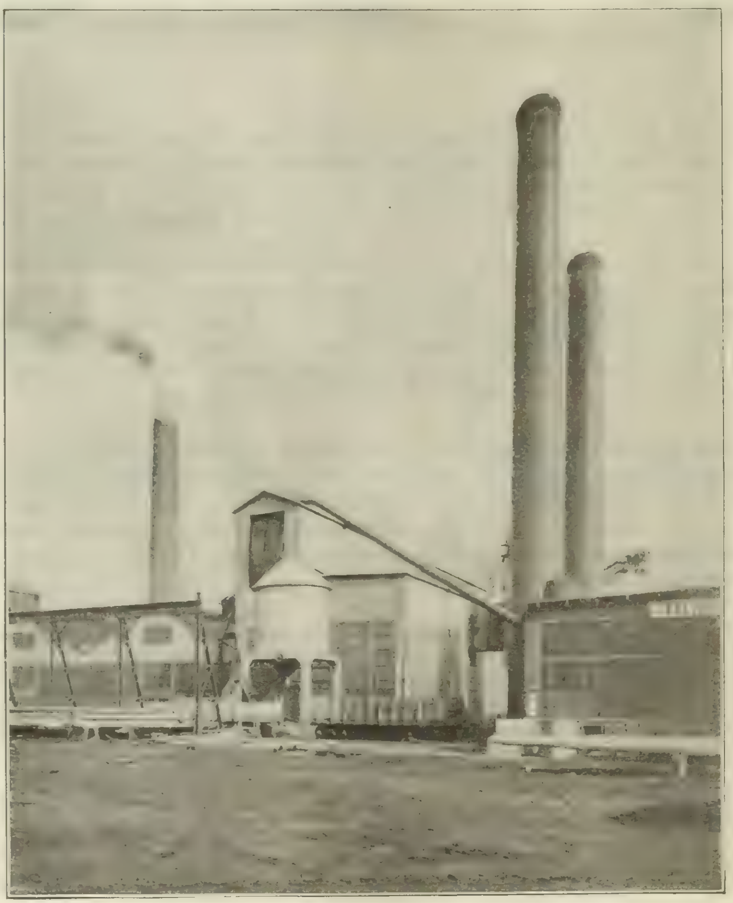


FIG. 1. GENERAL VIEW OF REBUILT POWER PLANT

The shipyard is so designed and proportioned as to be able to construct thirty-six 8,800-ton fabricated steel merchant ships per year. There are used in the building of ships 53 shops and other industrial buildings which vary in size, shape, construction and location, according to the special need; there are 12 buildings used in the fabrication of steel, 9 for fitting out ships, 18 for power generation and distribution and for storing or pumping oil, water and sewage, and 14 for office and administration and general utility purposes. For electric power, pumping, etc., there are 1 power house, 14 distributing and substations and 2 oil and sewage pumphouses.

The power house is in Yard No. 3, near the center of power distribution, close to the river, where there is an abundance of water for condenser purposes, and along the wharf where coal may be unloaded from either boat or railway as de-

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*Manager (Newark, N. J.) office L. K. Comstock Co., New York City; formerly chief engineer Wm. Gordon Corp., New York.

red. The Standard Cast-
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ntal cross-compound
gine; two 150-kw. 250-
lt direct-current generators, each directly connected
a horizontal cross-compound engine, and one 100-kw.
0-volt, direct-current generator, directly connected to
vertical high-speed engine.

The original intention was to remove this power
use, but owing to shortage of material and the fact
at a rotary-converter substation of about 600-kw.
pacity would have had to be erected to supply direct
rrent in that particular vicinity of what was to be the
ipyard, it was decided to retain the old power-house
ilding and construct a new alternating-current plant
jacent to it. When the location of the buildings was
termined upon, lack of space necessitated the building
the new power house around three sides of the plant,
shown on the general plan, Fig. 7.

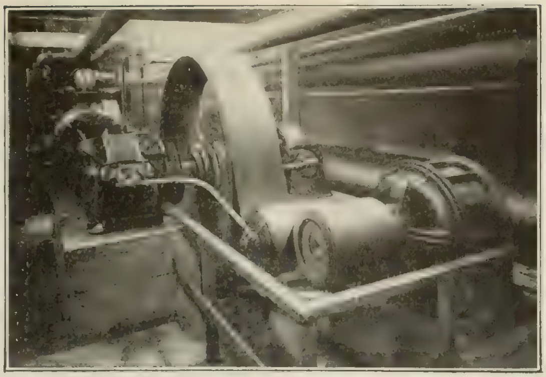


FIG. 2. MOTOR-DRIVEN VACUUM PUMP

Prior to the war it had been customary to determine the equipment required for an industrial development on which the size of the power house was based. However, the stress of war times made it necessary to determine the power house before the other requirements were barely known. This resulted in taking data from existing shipyards and reducing them to a unit basis and multiplying by the sizes of the various shops in this yard. In this manner the power, air and steam requirements were obtained. The air is of particular interest, as it was determined by measuring under actual operating conditions the amount used at the yard of the Chester Shipbuilding Co., Ltd., Chester, Pa., and increased to meet anticipated high production.

Apparatus obtainable, rather than the best combination of sizes for the load conditions, determined the selection; besides, the manufacturers who could make best deliveries received prime considerations. Fortunately, favorable deliveries were obtained on a selection of apparatus from reliable manufacturers in their respective lines. Deliveries, of course, were based on A-1 priority, and in the case of the turbo-alternators a requisitioning order issued by Admiral Capps made it possible to take units destined for other purposes.

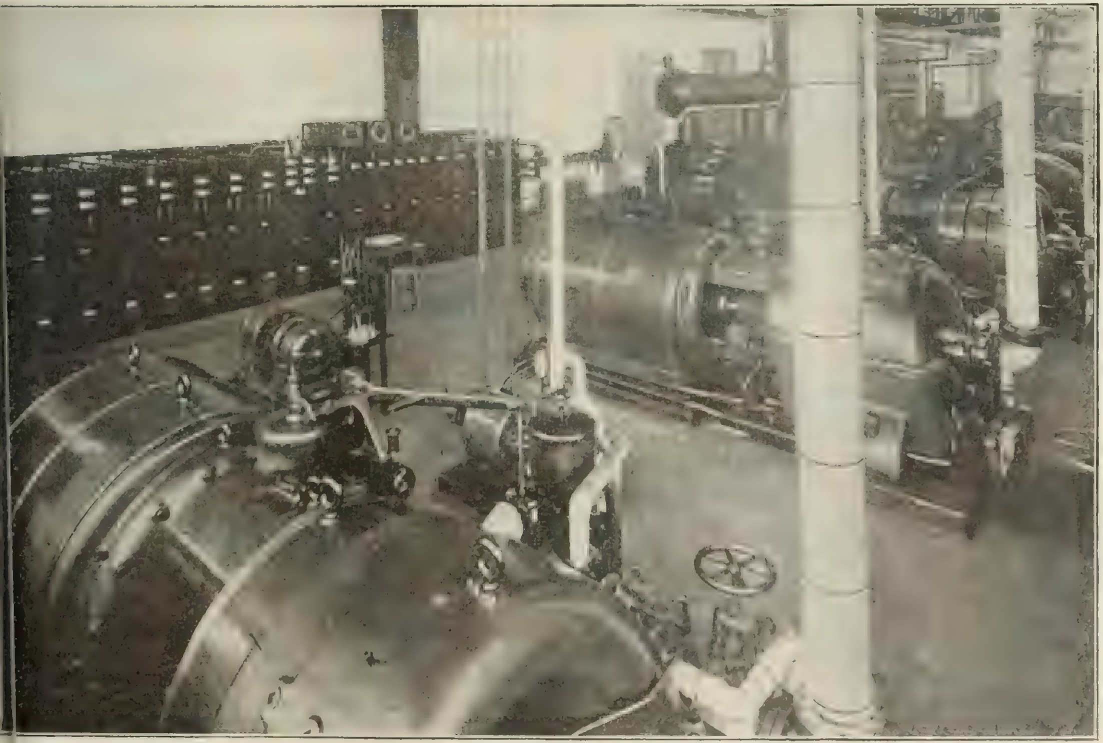


FIG. 3. INTERIOR OF TURBO-GENERATOR AND AIR COMPRESSOR ROOM

The City of Richmond, Va., had ordered one of these turbines for its municipal plant, which unit would soon have been on its way from the factory, but Richmond, to help win the war, sacrificed, as did private manufacturers who were to receive the other two units commandeered.

It will be noted later in this article that steam is applied directly to the compressors to produce high-pressure air instead of going through the intermediate steps of electric-power generation and synchronous motors for the compressors. Such an arrangement would have improved the power factor, but the saving did not warrant the investment, since power-factor correction can be obtained at any time by a synchronous or static condenser installation at less cost. However, if it had not been possible to locate the compressors in the power house and operate them condensing, synchronous motor-driven units would no doubt have been installed. Because of its greater flexibility, ease of transmission, ease of changing voltage and small transmission losses, the use of alternating-current was decided upon. The small amount of direct current required at the far end of the yard away from the old direct-current plant is obtained by means of a rotary-converter substation.

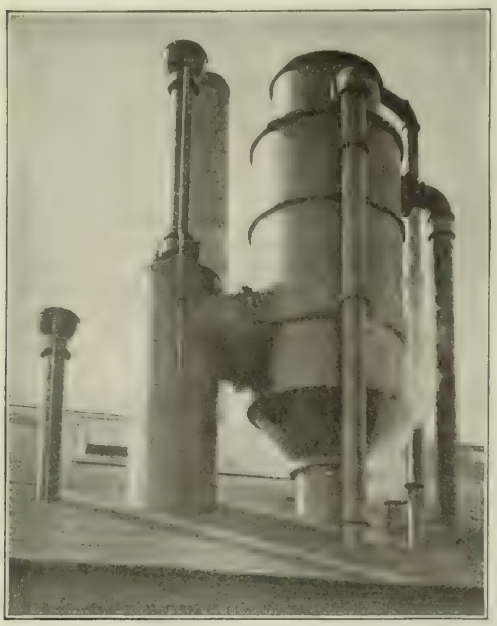


FIG. 4. BAROMETRIC CONDENSER ON TURBINES

The power house is 170 ft. wide by 200 ft. long, of standard steel construction, with concrete foundation, metal sash, ribbed-glass windows, tar-paper and slag roofing. In the power house the electric power is generated for general light and power distribution throughout the yard, shops and other buildings; air is compressed for use in pneumatic tools for riveting, chipping and calking and for miscellaneous uses about yard and in shops; steam is generated for industrial uses in shops and for heating shops and buildings; hot and cold water is pumped to all buildings for sanitary and drinking purposes; river water is pumped to buildings, shops, toilets and about the yard for all other than sanitary purposes and to supplement the supply of river water in case of emergency, pumps are kept in constant readiness. to deliver an extra supply of water to fire pumps and sprinkler systems in all yards and buildings.

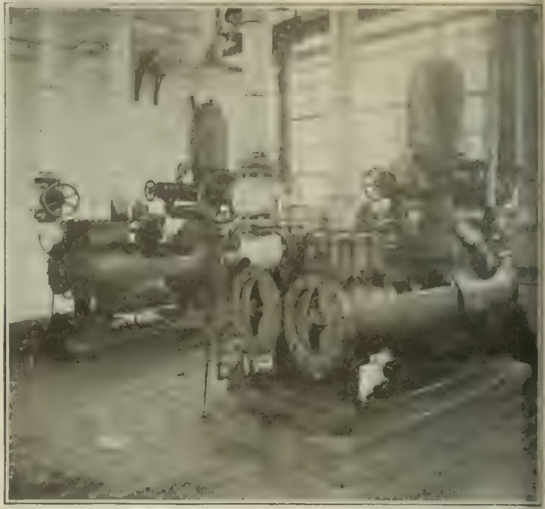


FIG. 5. UNDERWRITERS' FIRE PUMPS

In the new plant there are eight 500-hp. vertical water-tube boilers designed to operate at a normal working pressure of 175 lb. gage. Each boiler is fitted with a superheater to give 150 deg. F. superheat. The boilers are equipped with automatic stokers. Soot blowers are used and arranged so as to clean every square foot of boiler tube surface. Two brick smokestacks have been erected just outside the power house, each 175 ft. high and capable of taking care of five 500-hp. boilers.

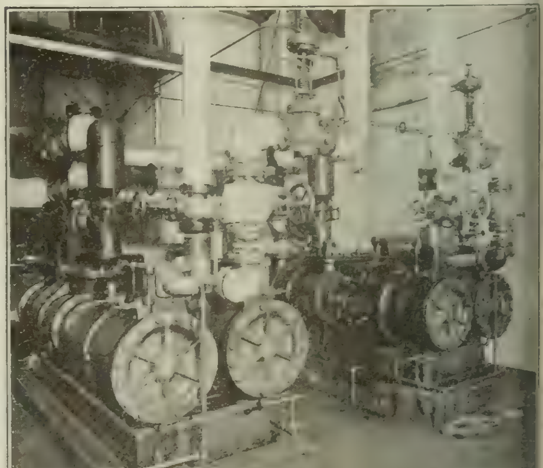


FIG. 6. DUPLEX BOILER FEED PUMPS

Coal is received by either boat or railway and is dumped into a hopper on the wharf; thence is conveyed to a 30-ton per hour coal crusher which is located just outside the power house and is operated by a 30-hp. motor, from where it is lifted by a bucket conveyor and delivered upon a 20-in. belt conveyor which deposits it in the desired section of the coal bunker. From the bunker the coal descends by a gravity chute to the furnace of each boiler. The coal bunker has a storage capacity of 3,000 tons, or about a 30 days' supply for the power house. The steam main is a continuous overhead loop, Fig. 7, running over all the boilers, turbines, air-compressor engines, pumps, heaters, yard connection, etc. Steam-main and larger steam-supply connections to turbines, engines, pumps and yard connections are extra-heavy black wrought-iron pipe butt welded.

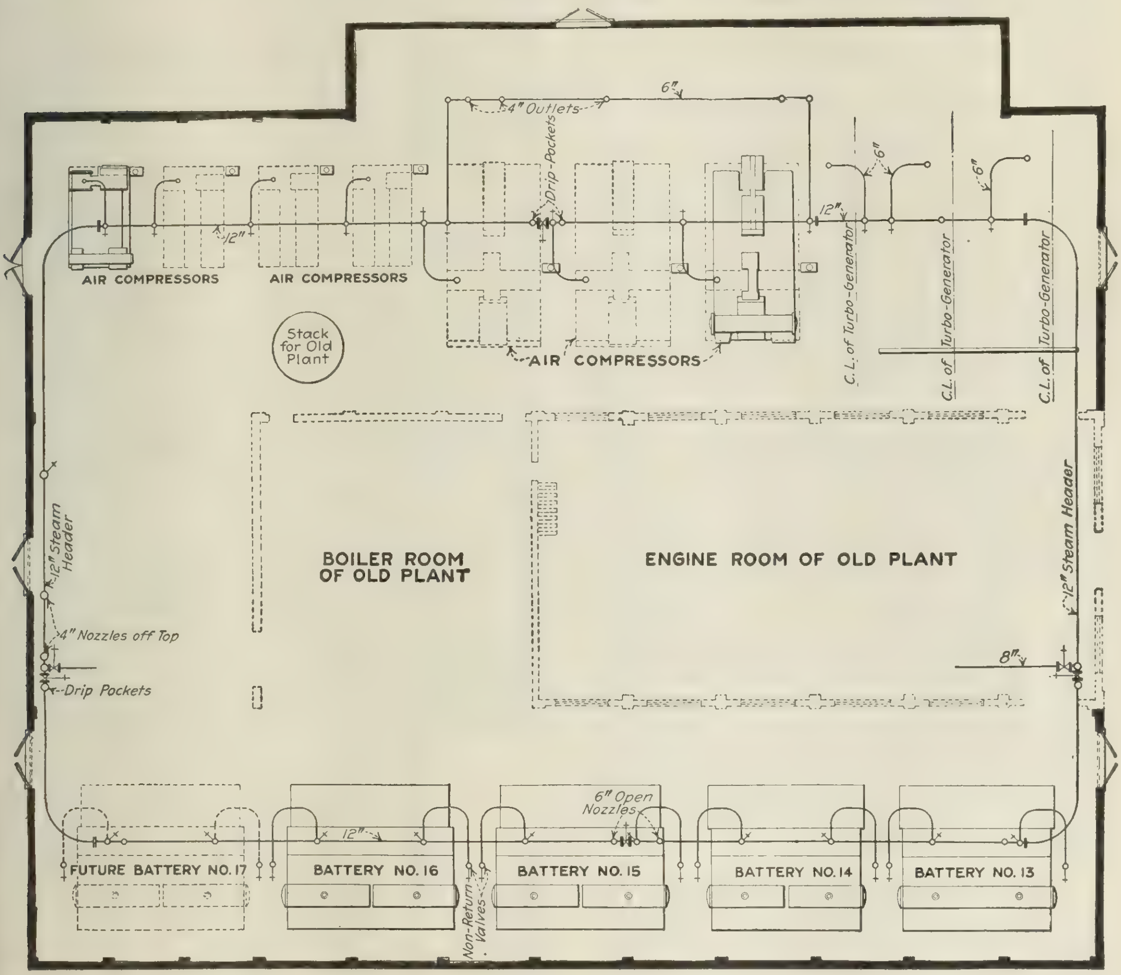


FIG. 7. GENERAL ARRANGEMENT OF HIGH-PRESSURE STEAM HEADER AND PIPING

Spiral-riveted pipe was used on all low-pressure lines and was chosen on account of its lightness, less expense and ease of obtaining at the time. This pipe is serviceable only for low-pressure work, and in order to insure against leaks it was found advisable to give it at least two, preferably three, coats of Bitumastic paint.

There are four 1,955-cu.ft. per min. and three 5,715-cu.ft. per min. cross-compound, steam-driven two-stage, water-jacketed, intercooler compressors, compressing air to 110 pounds. To circulate the cooling water through the water jackets of the air compressors there is one 1,000-g.p.m. turbine-driven single-stage centrifugal pump and one 1,000-g.p.m. single-stage, double-suction, motor-driven centrifugal pump.

There are installed for generating alternating-current, one 1,250-kva. and two 1,875-kva. 60-cycle, 2,300-volt turbo-generators. For the excitation of the generators there are one 15-kw. and one 36-kw. 125-volt turbo-exciter sets and one 25-kw. and one 35-kw. 125-volt, compound-wound, motor-driven exciter sets.

A barometric condenser capable of giving 26 in. of vacuum when condensing 58,000 lb. of steam per hour serves the air compressors; and for the turbo-generators there is a barometric condenser capable of giving a 28-in. vacuum when condensing 75,000 lb. of steam per hour. It will be seen from Fig. 8 that all air compressors are piped into the same condenser, likewise one condenser serves all turbo-generators. Accompanying these condenser equipments there are two steam-driven and one motor-driven dry vaccum pumps, two turbine-driven centrifugal pumps and one motor-driven centrifugal pump.

Two hundred and fifty-volt direct-current power is generated in the old power house and distributed by underground cables to the several shops for operating cranes; 2,300-volt three-phase 60-cycle alternating-current power is generated by the turbo-generators in the new addition to the power house and distributed as such through underground cables to 14 substations suitably located about the yard, where it is transformed to the voltage best suiting the apparatus employed and conditions prevailing; 440-volt three-phase current is used for motors driving shop machines, pier cranes, and miscellaneous apparatus; 220-volt three-phase, for portable pier-pump motors; 110/220-volt single-phase for general lighting, and 250-volt direct-current for gantry and shop cranes and in the machine shops. On the whole system there is a total connected transformer load of 8,773 kva.

ALL DISTRIBUTION FEEDERS UNDERGROUND

There are no overhead wires in the yard to obstruct transportation and industrial operations. All direct-current crane feeders from the power house and rotary substation, and all high-tension alternating-current feeders from the power house to the several substations are lead-sheathed cables run in underground fiber ducts inclosed in concrete, with watertight manholes at intervals of about every 250 ft. and at sharp corners.

In the power house there are seven air compressors which are capable of compressing 25,000 cu.ft. of air per min. to a pressure of 110 lb. per sq.in. The air is transmitted to a manhole outside the power house through a 16-in. main; from there a 15-in. air main runs along the head of the twelve shipways a distance of 2,315 ft. On either side of each shipway there is a 4-in. branch air line with one 3-in. valve and 11 six-hose manifolds, giving each shipway two 3-in. and 132 1-in. hose connections. Along the bulkhead pier or fitting-out wharf there is a 6-in. air line from which are taken nine 3-in. hose connections or three 3-in. connections for each ship being fitted out. Branch connections are also run to each shop and building throughout the yard requiring air. The air mains are of black standard wrought iron or steel pipe, butt-welded and protected with one coat of non-corrosive paint. Anchors and expansion joints are placed at intervals of about 250 ft. to prevent dislodgement and rupture due to expansion, a three-tank air receiver of 1,280 cu.ft. capacity is placed in the power house and a receiver of 67 cu.ft. capacity on each craneway.

AIR AND STEAM MAINS BUTT-WELDED

The 15-in. air main, 2,315 ft. long, is butt-welded throughout with the exception of places where the copper expansion joints are installed, where a flange is welded onto the pipe. This pipe, after welding, when tested out on a pressure of 115 lb., was found to contain only one leak which when repaired put the pipe in good condition, and it has given no trouble since the early part of 1918.

The manner in which this pipe was welded was by machining the ends and chamfering at an angle of approximately 45 deg. until one-half the thickness of the pipe was removed at the butt. The two pipes were then placed together and the weld made with an oxy-acetylene torch. This same type of joint was used on the 12-in. steam header in the power house. Unless a steam main is properly blown out after it has been welded, it was our experience on this job that globules of metal on the inside of the pipe, produced by welding, are likely to come over and be harmful to the machinery supplied from the steam line.

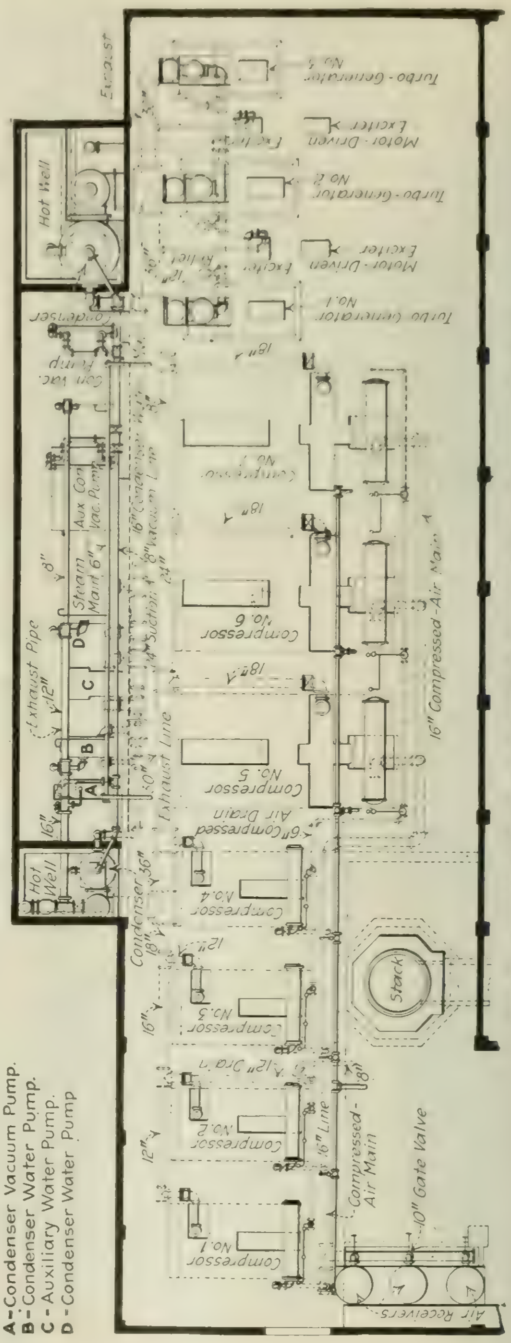


FIG. 8. GENERAL PLAN OF PIPING IN TURBINE AND COMPRESSOR ROOM

To supply the 15,000 gal. of water per minute required for boiler feed, condenser purposes, jacket water for the air compressors, fire protection, sewage and miscellaneous uses, there runs from the forebay to the power house one 24-in. and two 16-in. suction pipes.

This water is strained at the forebay by passing through strainers, so as to eliminate as far as possible the entrance of foreign matter into the equipment and piping systems.

So-called "river water" is drawn from one of these suction pipes and forced through at 6-in. yard main under a pressure of 100 ft. head by a service pump having a capacity of 600 gal. per min. This water main is connected to a 16-ft. diameter by 100-ft. high water tank, which has a capacity of 150,000 gallons. Hot water is supplied to the hospital, toilets, shops and other buildings at a temperature of 180 deg. F. This water is drawn from the Bristol water mains, heated in a pair of combined hot-water heaters and storage tanks, each of which is capable of heating 3,000 gal. per hr. from 50 deg. to 180 deg. F., and is pumped throughout the yard. Live steam for industrial use and heating purposes is supplied to all shops and buildings throughout the yard from the main power house through a 10-in. steam main which parallels the other pipe systems, and is heat insulated with a thick magnesia covering, and together with the hot water pipe and steam returns, is inclosed in a horizontally split terra-cotta pipe. This was constructed using the Underground Specialties Co.'s method of insulation of this type of transmission of steam and hot water.

A tunnel through the yard to hold all pipes, conduits and cables would have made operation easier, but to reduce this investment about 25 per cent all pipes, conduits and cables were buried with access to them only at manholes, and existing wires and pipes were used in practically 90 per cent of the places where they were found in the old structures of the Standard Cast-Iron Pipe and Foundry Co.

When all mechanical and electrical work was completed, there was a test conducted by the Emergency Fleet Corporation in conjunction with the Merchant Shipbuilding Corporation and the William Gordon Corporation, which resulted in an acceptance of the work. These tests were all in accordance with the American Society of Mechanical Engineers Code and the accompanying abstracts are of interest.

BOILER TEST

Economy

Water evaporated per lb. of coal as fired, lb.	7.547
Water evaporated per lb. of dry coal, lb.	7.639
Equivalent evaporation from and at 212 deg. per lb. of coal fired, lb.	8.955
Equivalent evaporation from and at 212 deg., per lb. of dry coal, lb.	9.063
Equivalent evaporation from and at 212 deg., per lb. of combustibles, lb.	11.013

Efficiency

Calorific value of 1 lb. of coal as fired, B.t.u.	13,451
Calorific value of 1 lb. of dry coal by calorimeter, B.t.u.	13,610
Calorific value of 1 lb. of combustible by calorimeter, B.t.u.	15,586
Efficiency of boiler, furnace and grate, per cent	64
Efficiency based on combustion, per cent	68

Heat Balance Based on Dry Coal

	B.T.U.	Per Cent
(*a*) Heat absorbed by the boiler (9.063 x 970.4)	8,795.0	64.6
(*b*) Loss due to evaporation of moisture in coal (1,230 x 0.012)	15.0	0.1
(*c*) Loss due to heat carried away by steam formed by the burning of the hydrogen (1,230 x 0.045 x 9)	498.0	3.7
(*d*) Loss due to heat carried away in the dry flue gases (29.6 x 0.24 x 410)	2,911.0	21.4
(*e*) Loss due to carbon monoxide	0.0	0.0
(*f*) Loss due to combustible in ash and refuse (0.177 x 0.322 x 14,600)	382.0	6.1
(*g*) Loss due to moisture in air (0.35 x 410x0.47)	48.0	0.4
(*h*) Loss unaccounted for	511.0	3.7
(*i*) Total calorific value of 1 lb. of dry coal	13,610	100.0

TURBINE TEST

Economy Results

	1,000-Kw. Turbine Normal Vacuum	1,000-Kw. Turbine Low Vacuum	1,500-Kw. Turbine Normal Vacuum
Superheated steam consumed, lb., by turbine per b.hp.-hr.	12.8	13.8	11.3
Superheated steam consumed, lb., per net kw.-hr.	19.40	21.28	17.04
Heat units, B.t.u., consumed by turbine per b.hp.-hr.	15,000	16,051	13,301
Heat units, B.t.u., consumed per net kw.-hr.	22,482	24,614	20,017

Efficiency Results

	1,000-Kw. Turbine Normal Vacuum	1,000-Kw. Turbine Low Vacuum	1,500-Kw. Turbine Normal Vacuum
Per cent thermal efficiency of turbine	16.9	15.2	18.3
Per cent efficiency of Rankine cycle at superheat	28.2	26.7	27.7
Rankine cycle ratio, per cent	60.0	59.9	69.0
Net work, ft.-lb., per B.t.u. consumed by turbine	131.5	123.5	148.6

Principal Data and Results of Turbine Test

(1) Dimensions	1,000 kw.	1,000 kw.	1,500 kw.
(2) Date 1918	July 13	July 13	July 10 11
(3) Duration, hours	3.5	2.5	16
(4) Pressure, lb. per sq.in., in steam pipe near throttle by gage	168.7	166.9	160.8
(5) Vaccum in condenser, inches mercury	26.97	25.49	26.7
(6) Degrees F. superheat of steam near throttle	97.5	101.2	112
(7) Total steam consumed, pounds per hour	18,346	20,343	25,768
(8) Revolutions per minute	3,570	3,600	3,568
(10) Kw. output	945.7	956	1,512.5
(13) Steam consumed pounds per kw.-hr.	19.4	21.28	17.04
(14) Heat consumed, B.t.u., per kw.-hr.	22,482	24,614	20,017

NOTE—All temperatures recorded above are average observed thermometer readings, and all calculations are based on steam tables using temperatures corresponding to the pressures.

AIR COMPRESSOR TEST

Speed

	5,715 Cu.Ft. Compressor	1,955 Cu.Ft. Compressor
Revolutions per minute	106.0	136.0
Indicated horsepower of steam end	937.0	283.0

Power

	5,715 Cu.Ft. Compressor	1,955 Cu.Ft. Compressor
Gross air horsepower as indicated in air cylinders	877.0	256.0
Indicated friction horsepower	60.0	27.0
Percentage of I.-hp. lost in friction of machine	6.4	9.5

Capacity

	Cubic Feet	Cubic Feet
Compressed air delivered per minute reduced to atmospheric temperature and pressure	4,754.0	1,537.0
Volume of free air entering low-pressure cylinder per minute	5,099.0	1,590.0
Volume of piston displacement per minute at speed of test	5,507.0	1,662.0

SUMMARY OF THE DEVELOPMENT

To summarize, the power plant serves the yard complete and the housing development in all respects with the exception of steam for group heating at the upper end and electricity at the lower end. The heating at the upper end is obtained from a separate heating plant and the electric current at the lower end from the lines of the East Pennsylvania Gas and Electric Co., the public utility that serves Bristol. The object in dividing the electrical service for the housing is because at the time the plant was constructed it was the intention to make the lower section part of Bristol and retain the upper section as a private housing development as part of the shipyard. The advent of the town of Harriman with its new hotel, hospital, school, firehouse and other public necessities, has changed all this and created a thriving and prosperous community with its busy shipyard adjacent.

In concluding it should not be overlooked that in less than four months after September, 1917, when the order was issued to proceed with mechanical and electrical work, one boiler, one turbo-generator and two air compressors were installed and in operation. Since the armistice, under the direction of the Emergency Fleet Corporation and Merchant Shipbuilding Corporation, various improvements and expansions have been made, a 60-ton electric crane has been added at the fitting-out wharf, the steel-storage area has been trebled, several buildings have been added and the temporary central heating plant in the housing development has been replaced with a more permanent structure. Under war pressure we were forced to build ships; today this industry is growing on a healthy peace basis, a war product that is helpful to us in competing for world markets.

How a Smoke Cloud Forms

By Osborn Monnett

HAVING in mind the facts as set forth in the foregoing sections, it is interesting to note the process of smoke formation over Salt Lake City and to draw conclusions that will aid in attacking the problem. This can best be done late in the fall, before the mornings get too dark to obscure the action of the smoke cloud as it forms, as shown in the illustration. On such mornings, if a point of observation is selected overlooking the city before daylight, it will be noticed that the city is perfectly clear, street lights being visible as far as the eye can reach.

About 6 o'clock in the morning, while it is yet quite dark, a smoke cloud will be seen forming over the business portion of the city. This will be observed from the fact that lights beyond this section will be obscured, as it is yet too dark to see the smoke itself. In ten minutes this cloud has increased in size and density until the more prominent lights in the downtown section have become obscured, while the lights in the outlying section are perfectly visible for miles.

By 6:20 the cloud has entirely covered the downtown section of the city and reached to a considerable elevation, becoming visible as daylight approaches. About the time that the smoke cloud reaches the maximum elevation, a flattening out process seems to occur and the cloud spreads itself over the city with great rapidity, as can be noted by the gradual obscuring of the street lights as the progress of the cloud is marked. Initial formation of the smoke cloud is made within the zone of highest concentration, and is produced by the large industrial and heating plants in this district building up their fires and getting up steam for the day's run.

An interesting and graphic account of the way the smoke cloud forms over Salt Lake City. This chapter from the report of the smoke-abatement investigation of that city is published with the permission of the director, Bureau of Mines.

By 6:30 the city is thoroughly covered with a dense, permanent smoke cloud, formed in a half-hour by the large smokers downtown, which cloud remains over the city until the air currents in the afternoon cause it to be dissipated. Illustration of this smoke cloud formation is shown in the sketch.

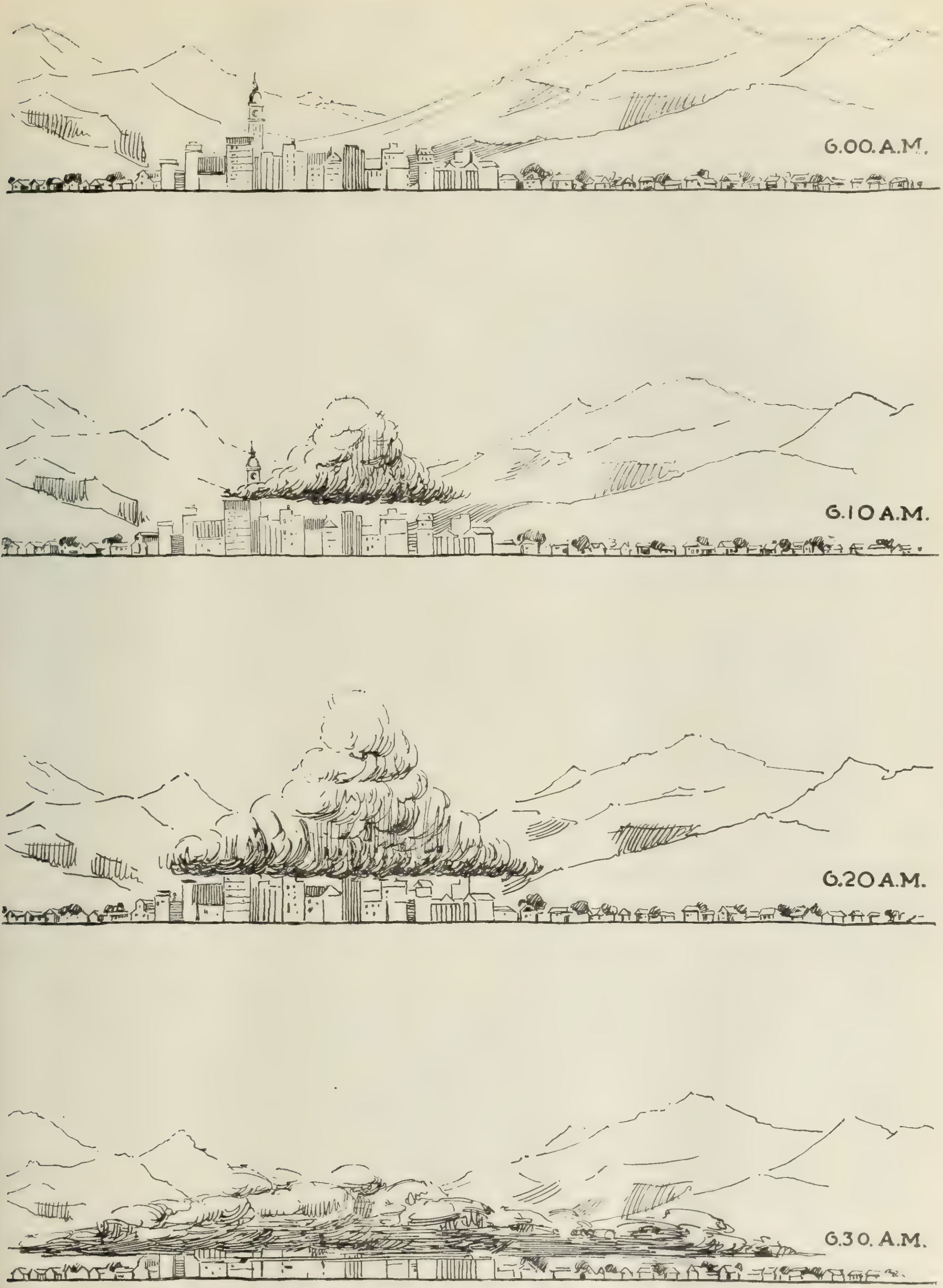
By this time it has become daylight and the first thin fingers of smoke are beginning to rise from a residence here and there. A swift trip through the residence section at this time of day will disclose only a very few residences smoking, although the sections passed through will be thoroughly covered with the smoke cloud which has been formed downtown and flattened out over the city before the domestic fires have been disturbed. Thus it is that the householder, when he rises in the morning, attributes the smoke which he sees in his vicinity to the residences in that vicinity. Later on in the morning the residences do contribute their share to the general smoke situation, but so far as the original smoke cloud is concerned they have nothing whatever to do with its formation. This early morning smoke, made without any supervision whatever, generally with the most careless methods of firing, is responsible for filling the valley in a half-hour with thick, heavy smoke.

Any scheme that aims to reduce the smoke nuisance of the city must be based primarily on the prevention of this early morning smoke. As this smoke is produced before daylight, the ordinary methods of smoke observation will not suffice. Rather, a system of policing must be developed whereby these large smokers are supervised during the early morning hours, their operators being made to realize that they will be checked up on their performance and that an inspector may drop in upon them at any moment and that they must therefore use all the equipment with which they are provided for smoke-abatement purposes. This supervision must aim at the education of the firemen in charge of the plants with respect to the starting of fires without dense smoke. Also, the cleaning of fires without the production of dense smoke must be taught, there being standard methods controlling such operations which can be used successfully for this purpose.

At the same time equipment should be provided which will enable the fireman to know the condition of the top of his stack. Such equipment is known as a smoke indicator or periscope and can be installed in the boiler room and will show at a glance whether the stack is smoking. It is absolutely essential that all important plants be equipped with a device of this character, as most of the smoke is made at such time that, even if the fireman wished, he could not get an adequate idea of whether or not his stack was smoking, though he should take the trouble to go out and look. Furthermore many of these plants are in basements, making it impracticable for the fireman to see his stack, and unless there is some provision for his information he will not know whether the means taken are sufficient to keep down smoke.

This condition is unique in smoke-abatement work and is brought about by the unusually low wind velocity in Salt Lake City during winter time. Ordinarily the smoke made before daylight in the average city is entirely dissipated before business hours, but in Salt Lake City the large volumes of smoke made at this time form the basis and backbone of the smoke nuisance throughout the remainder of the day.

With this initial smoke cloud eliminated, a wonderful improvement in atmospheric conditions will be noted at once and a condition brought about similar to that noticed on a Sunday morning when the industrial smoke is at a minimum; namely, a light haze in the valley for which residences will be mainly responsible. It will then be a simple matter to concentrate on the remaining classes of smokers to reduce them to a minimum in connection with regular smoke observation throughout the daylight hours.


6.00 A.M.
6.10 A.M.
6.20 A.M.
6.30 A.M.

SHOWING THE PROGRESSIVE FORMATION OF A SMOKE CLOUD

The illustrations show, first, how the small cloud of smoke forms in the industrial section of the city, in the early morning, how it gradually grows larger and then rapidly spreads and envelops the whole city, forming the backbone of the smoke nuisance [illegible] in early morning firing would very largely eliminate the evil during the rest of the day.

Checking Four-Wire Two-Phase Switchboard Wattmeters

By H. C. Yeaton

TO CHECK a four-wire two-phase switchboard wattmeter by the polyphase-wattmeter method, connect a portable polyphase wattmeter in the circuit as shown in Figs. 1, 2 or 3. The current terminals of the portable wattmeter are connected in series with the current terminals of the switchboard wattmeter, and the potential terminals of the portable meter are connected across the potential circuits. When current is passing through the primary of a current transformer, the secondary circuit should be short-circuited if any apparatus is to be disconnected from the circuit.

The scale of a four-wire two-phase switchboard wattmeter is usually marked in primary watts, which are actual watts or kilowatts of the circuit, and, in a balanced circuit, having unity power factor are equal to the *primary amperes* × *primary volts* × 2.

The calibrating watts of a four-wire two-phase wattmeter are the watts required to make the pointer deflect from zero to full scale and equal *Scale Range* ÷ *Potential-Transformer Ratio* × *Current-Transformer Ratio.*

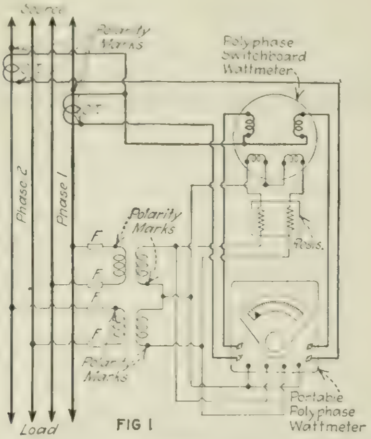


FIG 1

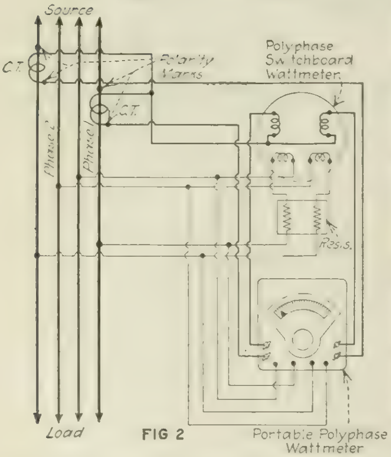


FIG 2

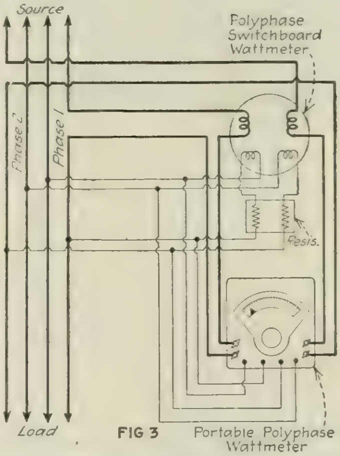


FIG 3

FIGS. 1, 2 AND 3. CONNECTIONS FOR CHECKING TWO-PHASE SWITCHBOARD WATTMETERS ON TWO-PHASE CIRCUIT

If the switchboard wattmeter is used with only current transformers, as in Fig. 2, the scale range should be divided by the current-transformer ratio only and not the product as in the formula to determine the calibrating watts.

In case the switchboard wattmeter is not used with transformers, Fig. 3, the scale range would be marked in primary watts, which would be the calibrating watts. Therefore, by checking the calibrating watts of the switchboard wattmeter with the portable instrument, the accuracy of the former may be determined. Suppose that the four-wire two-phase wattmeter in Fig. 1 is connected in a circuit of 100 amperes and 2,200 volts. Each potential transformer has a ratio of 20:1 (2,200 to 110 volts), and each current transformer has a ratio of 20:1 (100 to 5 amperes). The watts of the circuit would be 2,200 × 100 × 2 ÷ 1,000, or 440 kw., but as a 440-kw. scale would be rather an uneven ending, a 500-kw. scale would probably be marked on the instrument. If the pointer of the switchboard wattmeter indicated 200 kw., then the calibrating watts for this reading would be equal to $\frac{200,000}{20 \times 20}$ or 500. Therefore if the pointer of the switchboard meter indicated 200 kw. it would mean that only 500 watts were impressed on the instrument for this deflection. If the portable wattmeter connected on the secondary of the transformers indicated 500 watts, it would show that the switchboard instrument was indicating correctly.

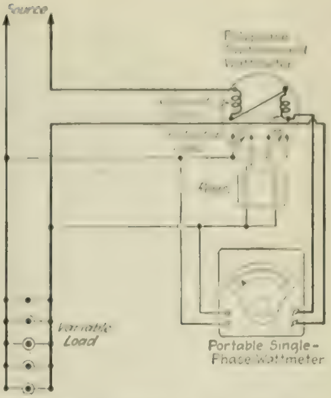

Source
Polyphase Switchboard Wattmeter
Res.
Variable Load
Portable Single-Phase Wattmeter

FIG. 4. CHECKING POLYPHASE WATTMETER ON SINGLE-PHASE CIRCUIT

The foregoing method of checking gives only one point, as it probably would not be convenient to vary the primary load, which may be a feeder circuit. However, several points may be checked during the day as the load varies on the circuit.

If it is desired to check more than one point on the scale, short-circuit the current transformers and disconnect the instrument from the circuit. Then connect the switchboard wattmeter on a single-phase circuit, using a variable load. A single-phase wattmeter should be connected in the circuit, as shown in Fig. 4. In the figure it will be noticed that the current coils of the switchboard instrument are connected in series, and the potential coils are connected across the circuit.

The current winding of the portable single-phase wattmeter is connected in series with both current windings of the switchboard instrument, and the potential terminals of the portable meter are connected across the potential. Therefore, as there are two elements in the switchboard wattmeter and one element in the portable, the total watts impressed on the polyphase meter will be twice those impressed on the single-phase meter. Consequently, the calibrating watts per element of the switchboard wattmeter will equal *Scale Range* ÷ *Current-Transformer Ratio* × *Potential-Transformer Ratio* × 2. However, if the switchboard wattmeter is used with current transformers only, then only the current-transformer ratio would appear in the formula. In case the switchboard wattmeter is not used with transformers, the scale would be marked in primary watts, which would also be the calibrating watts, and only the numeral 2 would appear in the denominator of the formula. Therefore, by determining the calibrating watts of the polyphase wattmeter from the formula, the scale readings may be checked with the portable single-phase wattmeter.

Suppose that it is required to check the four-wire two-phase wattmeter, Fig. 1, at the readings 100, 200, 300 and 400 kw. Connect the instrument on a 5-ampere 110-volt single-phase circuit, as shown in Fig. 4. The calibrating watts per element of any particular reading equals *Scale Reading* ÷ *Potential-Transformer Ratio* (20) × *Current-Transformers Ratio* (20) × 2.

Substitute the readings 100,000, 200,000, 300,000 and 400,000 in the numerator and divide by the denominator 20 × 20 × 2 (800) and we obtain the following:

Switchboard Polyphase-Wattmeter Reading in Kilowatts	Calibrating Watts per Element of the Switchboard Wattmeter	Portable Single-Phase Wattmeter Reading, Watts
100	125	125
200	250	250
300	375	375
400	500	500

Other readings can be checked in like manner, although four or five readings are usually sufficient.

Bessemer O.D. Semi-Diesel Engine

One of the greatest markets for semi-Diesel or surface ignition engines is the oil field industry. In many fields it is customary to install natural gas engines for pumping purposes. However, since the supply of gas steadily decreases the trend is toward the oil engine. Several builders now place a large percentage of their engines in this work.

The Bessemer Gas Engine Co. has developed a special type of oil engine for the oil fields. A cross-section of the O. D. engine is shown in Fig. 1. The ignition of the fuel is secured by means of the mercury vaporize described in *Power* of July 13, 1920.

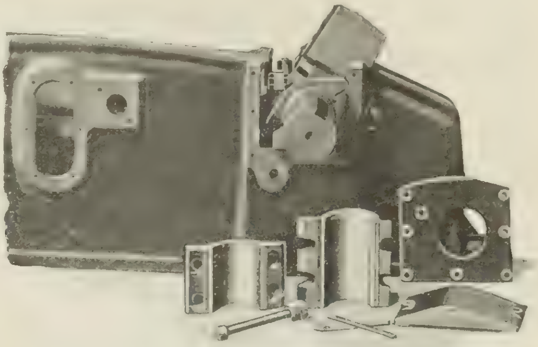


FIG. 2. MAIN BEARINGS OF O. D. ENGINE

The engine frame is considerably lighter than that of the standard Bessemer oil engine, but the cast iron is so placed as to hold the stresses below 1,800 lb. per sq.in. As will be understood by those familiar with oil field conditions, a successful engine must be rugged in design and must possess as few moving parts as possible. The

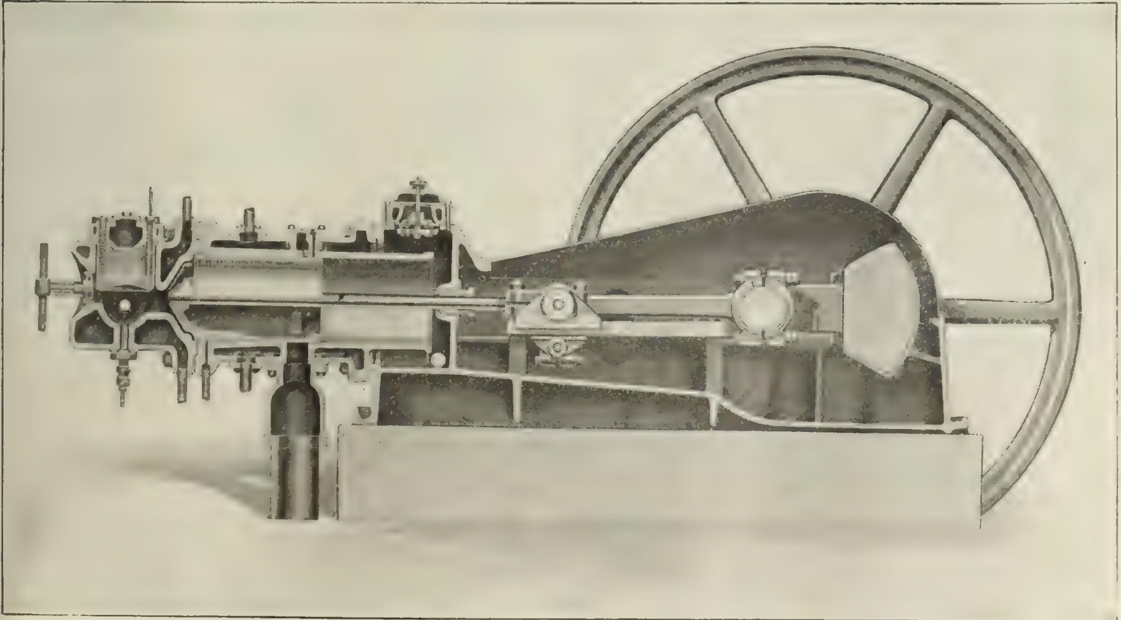


FIG. 1. BESSEMER O. D. TYPE OIL ENGINE

bearings are of the two-piece design and are deeply seated in the frame. The pressure is against the cast iron housing and not against the bearing cap bolts, as is frequently the case.

The crosshead, Fig. 4, is of the slipper type and is adjustable. In the oil fields where much grit is blowing about, the crosshead wear is rather large; this design of guide is much superior to that of the bored guide. The connecting rod follows the usual Bessemer design, having a bushed wristpin bearing and a marine crankend.

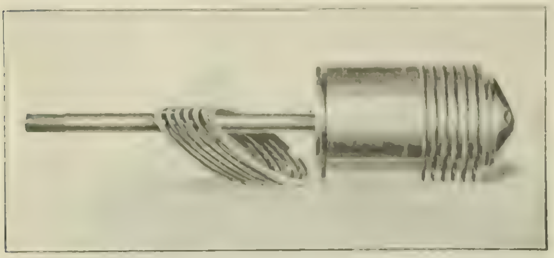


FIG. 3. O. D. ENGINE PISTON

The piston, Fig. 3, has no deflectors. To secure cylinder scavenging the outside scavenging air ports are directed inwardly at right angles to a plane passed vertically through the cylinder. The inner or cylinder ends of these ports enter the adjacent pair of ports. The air currents passing through the outer pair of ports encounter the portion of the air passing through the other air ports and give the entire air charge a twirling motion that effectually scavenges the entire cylinder of the exhaust gases. The air suction valve is of the poppet type, being somewhat similar to the Bessemer Corliss design of air valve.

The O. D. engine is a radical departure from the Bessemer traditions in that it is a dry engine, or an engine without water injection. The manufacturer still adheres to the principle of water injection and states that it was eliminated in this engine on account of the conditions under which the engine must operate. In most of the oil fields the water is very bad carrying a large percentage of grit and dirt. The water would prove very detrimental to the engine if introduced into the cylinder. Consequently the dry engine is superior for this class of work. It is seldom that an oil field engine must pull its rated load, and there exists but little danger of preignition that so often occurs in dry engines on heavy loads.

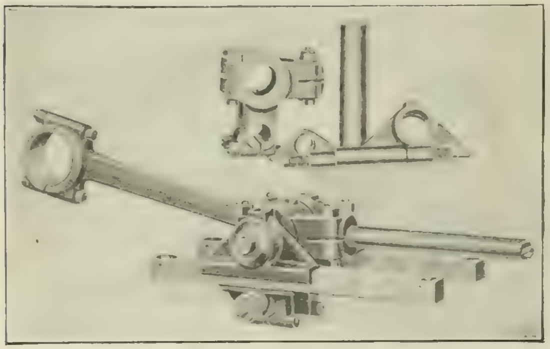


FIG. 4. CROSSHEAD OF O. D. ENGINE

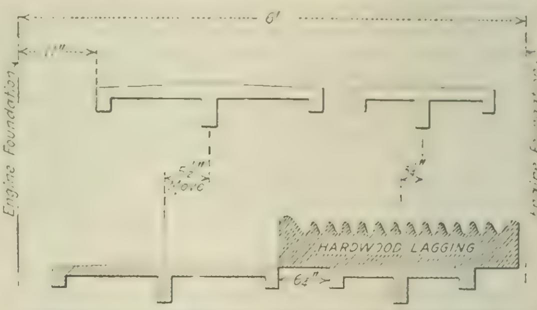
The mercury vaporizer is especially advantageous in performing work where the load may be very small for considerable periods of time. The constant temperature maintained by the mercury insures positive ignition of the fuel charge at all loads.

While the Bessemer Co. offers this engine only in the lower powers a 200-horsepower O. D. engine is in daily operation in their own power plant and carries its rated load without any signs of preignition. The cylinder size of this unit is such that piston cooling was deemed desirable. The cooling is obtained by oil circulation.

Changing Flywheel from Belt to Rope Drive

By R. J. Nagle

More power was required than a flywheel-driven 20-in. belt would transmit. The flywheel construction being of ample proportions to safely withstand the load required, it was decided to place a 6-in. hardwood lagging over the rim of the wheel, as shown in the sketch, thus increasing the diameter from 20 to 21 ft., and to extend the lagging 6 in. out over the edges of the rim, as shown, thus increasing the width of the face from 20 to 32 in. The lagging, having been shaped to conform to the crown-faced rim of the wheel and secured in place, was turned off and grooved on the face for 12 wraps of 1⅝-in. rope.



FORMER AND PRESENT POSITION OF FLYWHEELS

To apply the lagging it was necessary to move two flywheels to new positions on the shaft. The wheels were constructed in eight sections, and the hubs were forced on the shaft. One wheel was 20 ft. in. diameter with a 20-in. face; the other was of the same diameter with a 32-in. face. With a hydraulic jack having a ram approximately 10 in. in diameter and built to withstand a pressure of 250 tons per square inch, and the necessary tie bars and strong-back, a force of 250 tons was applied, but the wheels refused to move. The rim and hub bolts of the wheels were slacked off to allow for expansion and two kerosene blowtorches, having burners approximately 6 in. in diameter and 12 in. long, were procured. The shaft was covered with burlap and kept wet with a stream of water.

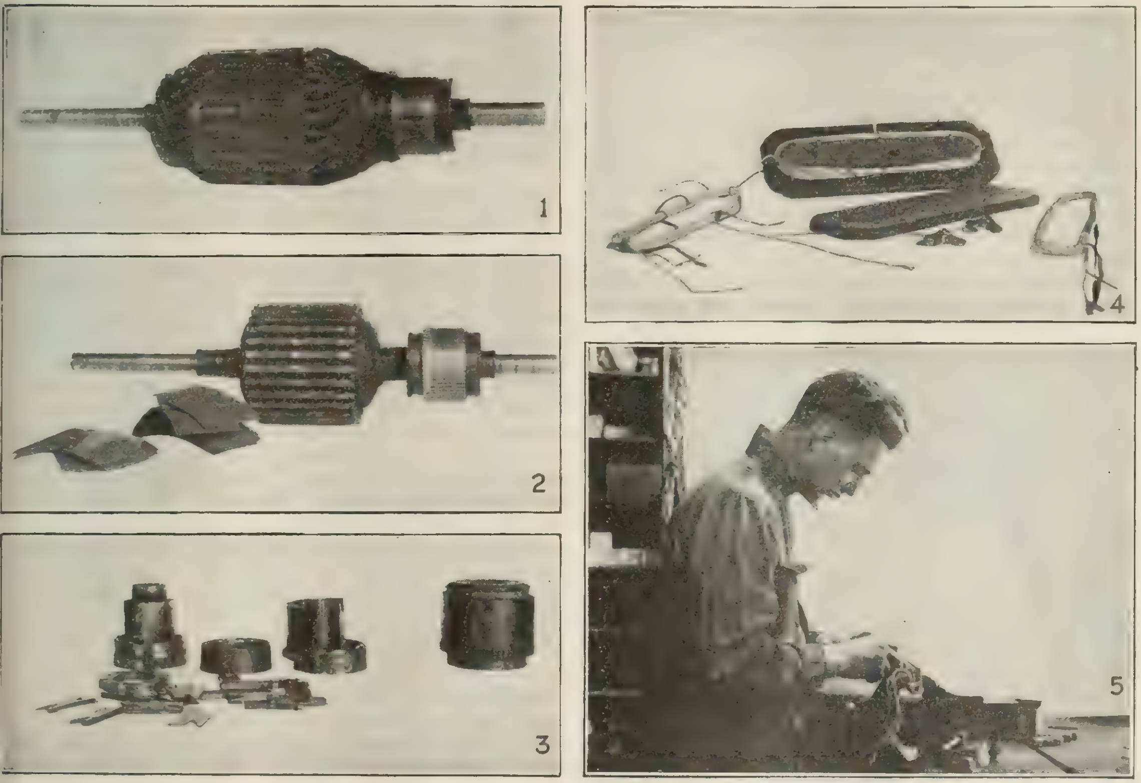
The blowtorches were then played all around the wheel hub, one on either side. After the hub was thoroughly heated, the shaft having been kept comparatively cool, pressure was again pumped up on the jack and the wheels were moved, one at a time, to the required position.

Rewinding A Direct-Current Armature

By W. A. HEFNER

The rewinding problem is approached from a practical standpoint. Taking a specific case as an example, the process is followed through from stripping the old coils off the armature to turning off the commutator after the new windings have been completed.

IN REWINDING a direct-current armature, the procedure is practically the same in each case, irrespective of the size of the machine. The dimensions of the armature would affect chiefly the number of turns and the size of wire in the coils. Where, in general, the coils in a small armature will be wound with a comparatively large number of turns of small-sized wire, the coils in a large armature will be wound with a small number of turns of large copper. Nevertheless, the events in rewinding vary only slightly with the different sizes. In this article will be discussed the rewinding of the armature shown in Fig. 1, the coils of which are wound two in parallel.



FIGS. 1 TO 5. VARIOUS STAGES IN THE PREPARATION OF AN ARMATURE FOR REWINDING

When an armature is to be rewound, the first thing to do is to remove the leads from the commutator. It is necessary at this time to determine the pitch of the coil leads to the commutator. This is easily done by placing a straight-edge on the center of any one of the slots and marking the commutator bar that lines up with this slot. Then count the number of segments between the marked bar and the segment to which the coil leads from one of the coils in this slot are connected. With this information at hand, it will be a simple matter to connect the new winding up to the commutator in the same relation as the old one was.

After the leads have all been unsoldered, break the armature band wires that hold the coils in place and carefully remove four coils for samples. One coil is kept as a pattern of the shape of the coils. The second coil is pulled out into an oblong to give the dimensions, for making a form to wind the new coils on, as in Fig. 4. The other two coils are opened up and used to determine the number of turns, number of conductors wound in parallel, size and amount of wire in the coils and the kind of insulation on the wire. With the foregoing information obtained, the remainder of the coils may be taken off in the easiest way possible, after which the core is cleaned and the thickness and kind of insulation in the slots noted. Before all the coils are taken off, the spread of the coils must be determined; that is, the number of slots spanned by one coil.

With a hacksaw blade ground to a thickness of the wire in the armature coils, the slots in the commutator, where the leads are soldered, are cleaned out. This makes it easy to put the leads of the new winding in place before soldering.

A test is next made on each pair of commutator bars with a lamp to see that they are clear of short-circuits, and each segment is tested to the cast-iron shell for grounds. In case the mica is broken down between the segments, the commutator is taken apart by removing the screws or nuts that hold the "V" rings in place. After removing the latter, any or all of the segments may be easily taken out. With a segment as a pattern, new micas are cut, and with these replacing the old ones that were broken down, the commutator is re-assembled.

In putting together the commutator, the copper and the mica segments are assembled in place on one of the "V" rings, as in Fig. 3, then the front "V" ring is very carefully put in place and the nut that holds the commutator together is tightened down. This nut is first screwed down just sufficient to hold the mica together, and the segments tested to see if they are clear of short-circuits or grounds. If the commutator insulation proves to be in good condition, a blow-torch is used to warm up the commutator to about 125 deg. F., and the holding nut is screwed down as tight as possible.

The insulation used in the slot is first a layer of fish paper about 0.005 in. thick, then a layer of oiled linen about 0.005 thick. These are cut so as to extend about one inch above the top of the slots so as to make it easier to slide the coils into place. The insulation also extends at both ends of the slots about one-quarter inch to prevent the coils coming in contact with sharp corners of the core.

The form for winding the coils on is made of three pieces of wood as shown in Fig. 4. One piece the size of the inside of the coil is shaped and nailed to a side which is about one inch larger all around than the center around which is wound the coil. The other side is held in place and three holes are drilled through, one in the center for mounting the forms and one at each end, through which bolts are put with wing nuts on, to hold the loose side in place. Four slots are cut in the sides of the form down to the center core. The slots are for putting pieces of cord in to tie the coils with before removing them from the form. In winding the coils, 4-in. long pieces of cord are cut and one slipped in each slot of the form. The end of the wire is slipped into the slot nearest to the beginning of the coil and the form revolved until the required number of turns are obtained. The four pieces of cord are then tied and the loose side is taken off and the coil removed from the core. The coil is then taped, making sure to bring the leads out at the right place, which can be determined from the old coil. After taping, the coils are formed as shown in Fig. 5, by placing one side in the vise, between two pieces of wood and holding two pieces on the other side and pulling to the shape desired. The pieces of wood should be cut the length of the slots in the armature. With the coils properly shaped, it is an easy matter to put them in the slots.

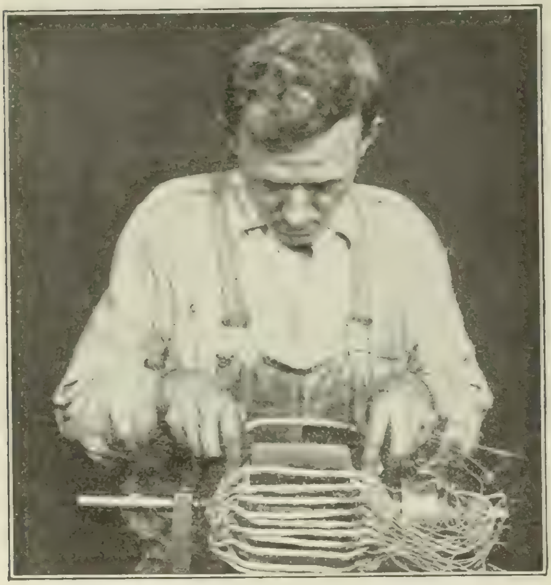


FIG. 6. TOP SIDES OF FIRST COILS RAISED SO AS TO PUT DOWN BOTTOM SIDES OF LAST COILS

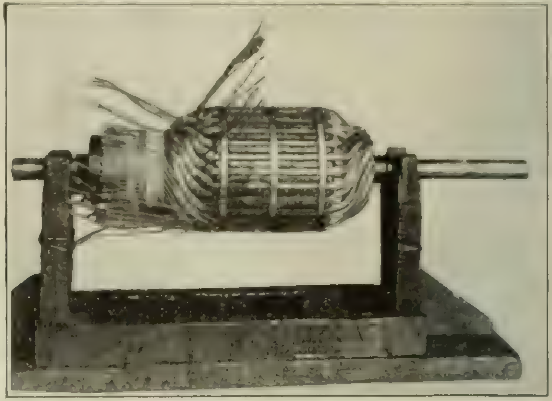


FIG. 7. BOTTOM LEADS OF WINDING CONNECTED TO CUMMUTATOR

In putting the coils in the slots, start at any slot and put the bottom side of the first coil in permanently, and place the upper side in the proper slot temporarily. The top sides of a number of the first coils placed will have to be raised to allow placing the bottom sides of an equal number of the last coils placed in the winding. By placing the top sides that must be lifted in their proper slots temporarily, it will prevent the form of the coils from being changed, as well as get the coils in the right slots at the start. This procedure is continued until a sufficient number of coils are in place to bring the top side of a coil into a slot where a bottom side has been placed. Beginning at this slot, the top sides of the coils are put in the slots permanently. This process is continued until the slot that contains the top side of the first coil is reached, then all the top sides that were placed temporarily are raised and forced up just far enough to allow sliding the bottom sides of the last coils under and putting them in place. After the bottom sides of these last coils are placed, the top sides are put down as in Fig. 6. One care that must be observed is that the coil must be placed in the slots in succession and worked in one direction around the armature.

The coils should now be tested for grounds, open circuits and also for short-circuits between coils. If this test shows all coils to be clear, then all excess slot insulation is cut off where it extends above the core and the armature is banded, using any one of the various methods for banding, but making sure that the bands are put on tight and well soldered.

Connecting the leads to the commutator is done by first placing a straight-edge on any one of the slots and marking the commutator segment that is in line with this slot. Then, from the data taken before stripping the armature, find out how many bars to the right or left of the marked segment the first bottom lead must be connected. Beginning at the slot opposite the marked segment, take one of the bottom leads and connect it into the segment determined by count. In this winding two coils are wound in parallel, therefore there will be two bottom and two top leads coming from each slot. Either one of the bottom leads may be connected first, then the other in the adjacent segment. This is continued until all the bottom leads are connected. Each coil should be tested for grounds, open-circuit and short-circuit, before and after connecting. In this way any defect in the coils will be detected before the coil is connected into the winding. Since there are two coils wound in one, it is a good scheme to locate the leads of one coil by test in each group and mark the lead with a little shellac or paint. This will greatly simplify making the connections to the commutator. In such case, when the bottom leads are put down, care should be exercised to have every other lead a marked one; that is, if the unmarked lead is put down first in one pair of coils, then it must be connected first in all coils.

After all the bottom leads are down, the throw of the top leads to the left or right is determined and they are connected. Where armatures are parallel wound, as in this case, the first top leads will be connected to the segment adjacent to the bottom lead. Where there are two coils wound in one and the leads of one coil marked and the other unmarked, the top lead of the marked coil will connect to the same segment as the bottom lead of the unmarked coil. After this the leads can be put down in succession around the commutator, alternating unmarked and marked terminals. If the connections are made properly, a marked and an unmarked top and bottom lead will come into each segment.

When the leads are all down, they should be soldered, making sure that the solder runs into the slots to insure a good connection between the windings and the commutator bars. It is good practice when soldering the leads to the commutator to have the back end of the armature higher than the commutator; then the solder will not tend to flow in back of the segment and cause short-circuit between bars. After soldering, the commutator is turned down and examined carefully to find and remove any copper or solder that may have been drawn over from one segment to the other. The armature is then tested with a millivoltmeter or telephone receiver, for defects such as short-circuit, open-circuit, grounds and high-resistance contact. If the coils have been properly connected and insulated, the complete winding should test out clear. The last step in the process is to give the armature a coat of insulating paint and bake it in an oven, after which it is ready for service again.

Operation and Adjustment of Turbine Machinery

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Md.

How would you konw that a charge of water was coming over into the turbine from the boilers? What does occasional poor regulation indicate? When the blades accumulate a coat of scale or sediment how does the turbine act? If the machine has lost its balance gradually, what may have been the cause? These are but a few of the many specific troubles dealt with in this article which is the fifth of the series.

STEAM troubles are usually more bothersome than dangerous. Leaks in the system seem to be the most familiar form. Major troubles are guarded against by design, installation and operation, so that usually they are conspicuous by their absence. Although steam machinery has been thoroughly developed in all directions during the century or more in which steam has been in harness, it will not operate with satisfaction unless given close attention. Symptoms of trouble, due to wear or other factors, should be carefully noted so that proper steps may be taken for the protection of the units.

CHARACTERISTICS OF STEAM TROUBLES

1. Sudden slowing down of a small machine, accompanied by a small amount of vibration and sometimes considerable leakage from the shaft packing. Larger machines slow down less, but vibrate more easily. Very large machines slow down less, but vibrate considerably, and in extreme cases cause stripping of the blades. This behavior usually indicates a charge of water coming over with the steam. The remedy is the prevention of boiler priming, thorough draining of pipes or perhaps elimination of water pockets in the steam line, use of a proper steam separator.

2. Vibration beginning slowly and gradually increasing. Small machines slowing down, though the speed of large machines is not necessarily affected. Cause, water collecting in the turbine casing, owing to improper draining and to wet steam. Remedy, correction of turbine drainage.

3. Regulation occasionally poor with inability to carry load. Cause, low steam pressure or insufficient vacuum.

4. Inability to carry load, at first slight and gradually becoming worse. Cause (a), sediment carried over by the steam depositing on the blades. This is a rare occurrence. Remedy, correct boiler conditions. Cause (b), steam strainer stopped. Remedy, clean the strainer.

5. Machine gradually running out of balance. Cases of this kind have occurred where acid properties of the steam have consumed the balance weights placed in exposed positions.

6. Vibration occurring at intervals with no water trouble—vibration worse at full load or when running non-condensing. Cause, expansion of piping pulling machine out of line. Remedy, firm anchoring of the pipe line and installation of flexible joints.

7. Continual good operation with sudden vibration and stopping of machine with stripping of blades.

Cause, mud or sediment collecting in a body and then coming over into the blades in a large mass.

8. Bad regulation of a steady and continual kind in machines equipped with a steam pilot valve or unbalanced valve. This has been occasioned in some instances by using lime water in the boiler, causing a deposit from the steam of a sticky sediment. Lubrication with good-grade cylinder oil, together with proper cleaning at regular intervals, will successfully meet this condition.

9. Violent vibration, usually accompanied by heating of the shaft just after fitting the packing rings or within a day's time of such work. Cause, packing rings fitted so tight so as to bind the shaft. The action sometimes occurs several hours after the rings are fitted. Remedy, proper adjustment of the packing rings.

10. General heating of the bearings, unstable oil pressure; cause, steam leaking into the bearings and there condensing. Remedy, proper shaft packing and steam deflectors.

11. Injury to machine due to closure of exhaust valve; failure of vacuum, together with stoppage at relief valve; water entering through exhaust steam passage; excessive steam pressure. These and similar troubles are not necessarily characteristic of steam turbines and therefore are not considered as requiring discussion.

LEAKS—THEIR CAUSES AND REMEDIES

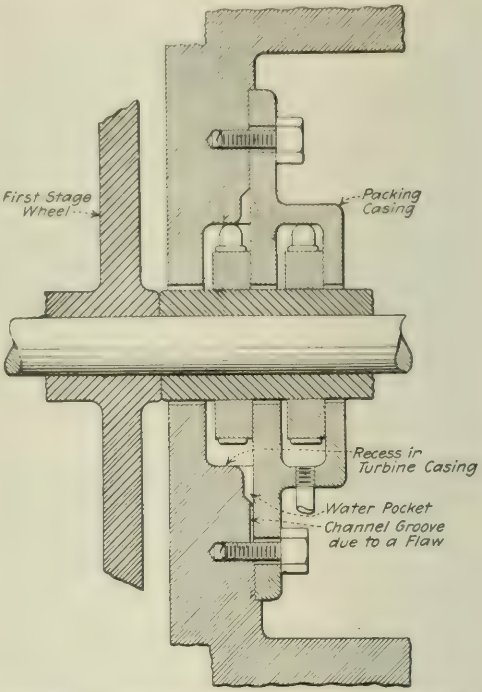
Steam leaks spoil the good appearance of an installation and to some extent represent waste of energy. Vacuum leaks are a direct menace to economical operation. Such things are small in themselves, but often time-consuming to locate and difficult to remedy.

Leaks in pipe lines are well understood, and except in cases of bad vibration or undue pipe strains there is not usually much trouble in stopping them after they are located. Pipe threads that are well cut with sharp tools hold satisfactorily when plastered with a composition such as white lead, cylinder oil and graphite, or red lead and cylinder oil, or some other "dope" that will act as a filler without corroding the threads and making them difficult to unscrew. Corrosive "dopes" such as litharge and red lead should never be used by conscientious engineers if the job is to be dismantled for repair work or inspection. Shellac and graphite, while not corrosive, will stick pipe threads so tight as to make it impossible to take them apart. Leaky valves and unions can be remedied by a little attention or by purchasing fittings that are well suited to the conditions encountered.

Leaks which often give trouble occur in ground joints. These joints are found in a turbine casing, packing casings, etc., where accurate dimensions are necessary and the thickness of the gasket would make such a difference in some dimensions as to cause trouble. Such a joint will sometimes hold when properly aligned and bolted, but it is generally necessary to apply some soft "dope" to act as a filler. The usual method is to use powdered graphite and oil.

Another way of making up such a joint is to place a heavy linen thread soaked in linseed oil along the joint and squeeze this together with a bolt pressure in the same way as a gasket. Both of the foregoing methods have the advantage of making the joint easy to clean when it is taken apart. For this purpose other soft dopes, such as white lead, powdered graphite and double-boiled linseed oil, have the same characteristic as graphite and oil.

When the surfaces are roughly machined and it is difficult to make such a joint hold, the best filler of all, in the writer's opinion, is shellac and powdered graphite, properly applied. The surfaces must be well cleaned and well cooled. This filler should be applied on both surfaces with a paint brush. After bolting together some of the shellac squeezes out. When the joint has become heated, the bolts should again be tightened, as the consistency of the shellac changes considerably on the application of heat. This filler will be found a good remedy for nearly all bad cases encountered. See that no oil is on the surface before applying the filler. A thin paper gasket can be used if all else fails. If it is necessary to use a corrosive dope, red lead and litharge mixed with glycerine will stop the leak but will make dismantling a tedious process. Such a step appears necessary in one case out of a thousand, and the trouble could probably be solved in some other manner if the situation were well studied.



JOINT THAT WAS RENDERED TIGHT WITH RED LEAD

The most difficult type of ground joint is one in which the bolted element has insufficient surface or is channeled through the surface and must hold water as well as steam. A joint of this kind is recalled which was, in addition, subject to a small vibration. This could be made to hold tight for a while, but the vibration and water together would cause a leak in a short time. The joint held best with shellac and graphite and a paper gasket. It was made to hold tight by placing some powdered red lead in the cavity, which filled with water (see sketch). When the joint began to leak after being made up in this manner, the red lead was drawn into the channel and soon caused a plug which permanently eliminated the trouble.

Refrigeration Study Course—XVI
Ammonia Piping Calculations

By H. J. MACINTIRE
Professor of Mechanical Engineering, University of Idaho

THE expansion piping of a refrigerating system has its counterpart in the boilers of the steam plant. The boilers absorb heat from the hot gases produced by the combustion of the fuel. Whereas with a single boiler the fireman has a ready means of telling about the output, yet in a battery of boilers there is no ready means—except possibly by checking up the coal burned, combined with the flue temperature and the CO_2 analysis—of telling whether one or more boilers are not loafing. Of course there is the steam meter, which gives immediately the response of any boiler to the action of draft and stoking by registering the steam output in pounds per unit of time.

In like manner the expansion piping or refrigerating coils may be "laying down" on the job, and it is even harder to tell just when this is taking place, except that perhaps results are not being obtained. The operator may be holding the suction pressure right, the condenser and all the high pressure side may be apparently in good shape, but the ammonia disappears from the receiver and the temperatures are not maintained. The trouble in these cases is that for some reason or other the ammonia is not being evaporated as it should. It is the boiling of *liquid ammonia at the proper pressure* that gives useful refrigeration. The improper pressure, the presence of oil or scale or water in the inside of the pipe and scale and ice on the outside decrease the ability of the expansion piping to function, and the result is reduced capacity—sometimes very much reduced capacity. With no flow meter the operator may not readily check the several parts of the system. If results are not obtained about the only course is to check over the possibilities for trouble and do such overhauling as seems necessary and desirable.

PLENTY OF COOLING SURFACE ALLOWED

As regards the possible demand on the refrigerating pipes all refrigerating men know that there are the so-called *live loads* and the *leakages*. They vary with each design and location. These embrace the electric lights and the animal heat of the workmen, the mechanical equivalent of heat of the fans or other machinery, the chemical heat of decay, the sensible heat and latent heats (if goods are frozen) of the new goods brought into storage, the liquefaction and freezing of steam given off by the goods (as in the chill room of a packing house) and finally the leakage of heat from the outside atmosphere, which is, of course, nearly always at a temperature considerably above the temperature carried in the refrigerated rooms.

With these varied conditions of operation—of refrigerating load and of heat transmission per square foot of pipe surface—it is naturally difficult to design the expansion piping with economy. The main consideration on the part of most engineers is to get enough surface to be sure to carry the load readily *under any and all conditions of operation.* The tendency has been to play safe, and to be sure that plenty of pipe surface is provided so that after four or five years of indifferent care and attention the machine may still give the contract load. The writer recollects the question asked by the chief engineer of a large refrigerating machine company as to the advisability of using a certain ratio of pipe surfaces, who said, "Are you sure that you can get full capacity of ice from that ice tank after the pipes are fouled by the accumulation of four or five years of oil and scale?" This is a wrong idea and time will see a certain amount of change. The refrigerating machine and piping will be sold with the understanding that these will be maintained in an efficient operating condition. It will be remembered how heavy the copper used to be in electrical machinery, and how steam turbines had better steam economy at 25 per cent overload than at full capacity. The reason for these cases was that the designers were not sure of their machines when operating under the industrial conditions in the field.

The reason for emphasizing so particularly this matter of expansion piping is to call the attention of the reader to the difficulties in the way of the engineer who is planning a new system, and also to make clear the reason for the great variation in the amount of piping one notices from time to time. Under good operating conditions there is no question but that relatively small surfaces may be used, but otherwise there must be sufficient allowance for the decrease in unit output.

THE PURPOSE OF AGITATION

Still another factor of importance in all heat exchange surfaces is that of the agitation of the surrounding fluid. The best insulating material is "still" air. In refrigeration, in steam boilers and steam condensers, there seems to be a tendency for the adhesion of surrounding air or gas and the formation of an air film that sticks to the surface and greatly increases the resistance to passage of heat through the walls of the pipes or tubes. Anything that may be done to "scrape" off this film by creating a velocity of flow to the medium will increase the coefficient of heat conduction or the capacity of the piping. This is true in the case of a radiator, a bunker coil, an ice making tank, or a cooling tower.

Expansion piping is also allowed to become covered with frost. Some engineers believe that as the diameter increases with an addition of frost the increased surface will make up for the decreased rate of heat by conduction. The reader has only to make a test to get capacity under these conditions of operation to see the fallacy of such an idea. Frost must be removed, either by scraping or by the usual methods of defrosting. One method used with success is to allow brine to trickle down the pipes, arranged as wall piping in stands; this brine will keep the surfaces wetted and at the same time will prevent the accumulation of frost. Whereas the coefficient of conduction is increased, and the necessary amount of piping is proportionally decreased, the extra labor involved in attending to the brine has prevented its general use.

As an example of the method to be used take the example of a cold storage room having walls of 2,200 sq.ft. of surface, and with a leakage coefficient (K) = 0.07 B.t.u. The storage room is designed for 34 deg. F. and for an average of 70 deg. F. outside. The live load consists of 50,000 lb. per day of goods at 65 deg. F. and 0.8 B.t.u. specific heat, and 900 B.t.u. per hr. for 8 hr. (the heat equivalent of two workmen and the lights used). Find the piping required for 24-hour operation.

Leakage loss = 2200 × 0.07 × (70 − 34) = 5,544 B.t.u. per hr.

Average goods load = $\frac{50,000}{24} \times 0.8 \times (65 - 34)$ = 51,700 B.t.u. per hr.

Average mechanical load = $\frac{900 \times 8}{24}$ = 300 B.t.u. per hr.

Air leaks during loading (estimated) = ... 10,000 B.t.u. per hr.

67,544 B.t.u. per hr.

Area piping is equal to $\frac{67,544}{2 \times 20}$ = 1,690 sq.ft. = 1,690 × 1.6 = 2,704 lin.ft. 2 in. pipe

In the problem an estimate has to be made of the loss due to opening the cold storage doors. This amount depends on the personal equation and whether anti-room doors are used. The bringing in of a large amount of relatively hot goods would raise the room temperature, but this point has been neglected as it is assumed that 34 deg. F. is obtained at the end of the 24 hr. Also a value of $K = 2$ has been taken for direct expansion and a temperature difference on the two sides of the pipes of 34 and 14 or 20 deg. F. The calculations do not account for the condensation and freezing of water vapor on the pipes, but such figures should be relatively small. The problem is given to show the factors entering into a calculation, and the results reached. The leakage through the walls may be arrived at by a method similar to that given in the article on "Insulation"* for the type of construction used in the individual case.

THE LIQUID LINE

The liquid line seldom gives trouble, and yet there are a few points about it which are worthy of consideration. The action (as regards the flow of the liquid ammonia from the receiver to the expansion valve) is the same as the flow of water from the air chamber of a pump to the flow nozzle. But for proper regulation the velocity of flow must be nominal.

In nearly every case it does not much matter what drop of pressure there is before reaching the expansion valve providing there is no tendency for vaporization to occur in the pipe due to temperature rise of the liquid ammonia and too great a pressure drop. With a condenser pressure of 150 lb. it is possible to raise the liquid a height of 540 ft. (much greater than water could be raised under the same pressure). It is possible to locate the expansion valve in any part of the usual type of building unless the friction loss in the pipes is excessive.

As a rule the velocity permitted in the ammonia feed line is from 6 to 10 ft. per sec. Knowing the tonnage required the number of pounds of ammonia needed may be calculated. The volume of ammonia is then found by referring to Table I (which gives the weight of one cubic foot) by calculating the reciprocal of the value given. If the volume in cubic inches of the liquid passing any cross section per second is known, then divide by 72 to 120 (the velocity in inches per second). The answer will be the area of the pipe required.

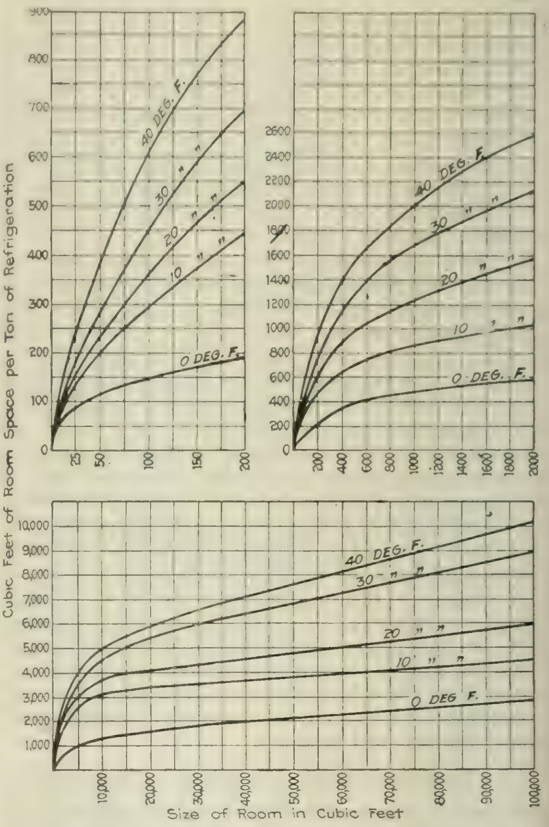
Values of coefficient of conduction "K" in B.t.u. per square foot per degree difference of temperature per hour:

Freezing Tanks

Old style feed, 12 to 15 B.t.u.
Flooded, 20 to 30 B.t.u.

Ammonia Condensers

Submerged, 30 to 40 B.t.u., old style [obsolete].
Atmospheric, 60 to 65 B.t.u.
Flooded, 140 B.t.u., bleeder type, 125 to 150 B.t.u.



VOLUME OF COLD STORAGE SPACE PER TON REFRIGERATION FOR VARIOUS SIZES OF BUILDINGS AND VARIOUS TEMPERATURES

NOTE: Numerous claims for better results are given for the "flooded" condenser but these are disputed.

Bandalot Coolers

(Counter = flow atmospheric)

Milk coolers, 75 B.t.u.
Cream coolers, 60 B.t.u.
Oil coolers, 10 B.t.u.

Brine Coolers

Shell and tube, 90 to 100 B.t.u.

Cooling Coils

Brine to unagitated air, 2 to 2½ B.t.u.; direct expansion to unagitated air, 1½ to 2 B.t.u.

One inch thickness of ice will reduce the coefficient of heat conduction to 75 to 80 per cent of the values above.

The length of direct expansion piping which may be controlled by an expansion valve is limited to its ability

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*See article No. 7 of this "Study Course" in *Power* of April 20, 1920, p. 630.

to free itself of the ammonia gas that is boiled out. In general it may be said that the practical maximum which may be used is:

1100 ft. of 1 in. pipe
1300 ft. of 1¼ in. pipe
1600 ft. of 1½ in. pipe
1900 ft. of 2 in. pipe

With brine pipes the amount of feet of pipe per coil is independent of the size of the pipe, and varies from 100 to 400 ft., depending on operating conditions.

TABLE I. WEIGHT OF LIQUID AMMONIA PER CUBIC FOOT

Temperature Deg. F.	Pounds per Cubic Foot	Temperature Deg. F.	Pounds Per Cubic Foot
85	37.10	50	38.81
80	37.35	45	39.04
75	37.60	40	39.27
70	37.85	35	39.50
65	38.09	30	39.72
60	38.33	25	39.95
55	38.57	20	40.17

Table II will be found convenient for calculations or for checking. Various room temperatures and boiling temperatures of the ammonia are used, giving a variety of pipe lengths per ton of refrigeration. As a general rule (except for short seasonal operation) it is wiser to have high suction pressure and relatively high piping ratios; in other words, an economical operation rather than a low first cost. In Table II the sizes of pipe considered are 1¼ and 2 in., but the brine pipe is figured for 1¼ in. pipe only, whereas the direct expansion (d.e.) is figured for both sizes. Should it be desired to find the length of pipe for some other size, say 2 in. brine, divide the length of pipe as given in the table by the ratio of the external areas of the two pipes. For example, should it be desired to find the length of 2 in. pipe per ton for a room to be held at 20 deg. F. and with a suction pressure of 10 lb., gage pressure, then taking (see Table II) the value 540 ft. and divide by $\frac{2.3}{1.6}$ (the ratio of the external surfaces) and the answer is 378 ft. of 2-in. brine pipe.

As a convenience curves are added. This set of curves is only useful for approximate work and for preliminary estimates. It is possible, however, to get fairly good results from them, provided the conditions found in the particular cases are not abnormal.

TABLE II. LINEAL FEET OF PIPE PER TON OF REFRIGERATION TO COOL AIR

This table is based on a coefficient of heat transmission (*K*) of 2.5. If any other value of *K* is desired multiply by 2.5 and divide by value preferred. If no frost accumulates on pipe multiply lineal feet by 0.6

Suction pressure, lb.		45	40	35	30	27	25	22	19	15	12	10	7	4.7	1.4	—2.4
Temp. ammonia, deg. F.		30	26	22	17	14	12	8	4	0	—5	—8	—13	—18	—25	— 35
Temp. brine, deg. F.	Kind of Pipe	38	34	30	25	22	20	16	12	8	3	0	- 5	—10	—19	— 30
Room Temperature 65 deg. F.	2 in. d.e.	220	198	179	160	151	145	135	126	119	110	106	99	93	86	77
	1¼ in. d.e.	314	282	256	229	216	208	193	180	170	157	151	141	133	123	110
	1¼in. br.	400	349	309	270	252	240	221	204	190	178	167	155	144	129	114
Room Temperature 60 deg. F.	2 in. d.e.	257	227	203	179	168	161	148	138	129	119	114	106	99	91	81
	1¼ in. d.e.	368	324	290	256	239	229	212	197	184	170	162	151	141	130	116
	1¼ in. br.	491	416	360	309	285	270	246	225	208	190	180	167	155	137	120
Room Temperature 55 deg. F.	2 in. d.e.	308	266	234	203	188	179	164	151	140	129	122	113	106	96	86
	1¼ in. d.e.	440	380	335	290	269	256	244	216	200	184	175	163	152	137	123
	1¼ in. br.	635	515	433	360	328	309	277	251	230	208	197	180	167	146	127
Room temperature 50 deg. F.	2 in. d.e.	385	321	275	234	214	203	184	168	154	140	133	122	114	103	91
	1¼ in. d.e.	550	459	393	337	306	290	264	240	220	200	193	175	163	147	130
	1¼ in. br.	900	675	540	432	386	360	318	284	258	230	216	197	180	157	135
Room temperature 45 deg. F.	2 in. d.e.	514	406	335	275	249	234	208	188	171	154	145	133	123	110	96
	1¼ in. d.e.	735	580	478	393	356	334	297	269	244	220	207	190	176	157	137
	1¼ in. br.	1540	982	720	540	470	432	373	327	292	258	240	216	197	169	144
Room temperature 40 deg. F.	2 in. d.e.	770	550	428	335	297	275	241	214	193	171	161	145	133	119	103
	1¼ in. d.e.	1110	785	612	478	425	393	344	306	276	244	232	207	190	170	147
	1¼ in. br.	5400	1800	1080	780	600	540	450	386	338	292	270	240	216	184	154
Room temperature 35 deg. F.	2 in. d.e.	1540	856	592	427	366	334	286	248	220	192	179	160	145	129	110
	1¼ in. d.e.	2220	1220	845	610	523	477	409	355	314	274	256	229	207	184	157
	1¼ in. br.			2160	1080	830	720	569	470	400	337	308	270	240	200	166
Room temperature 30 deg. F.	2 in. d.e.		1925	962	592	481	427	350	297	256	220	202	179	160	140	119
	1¼ in. d.e.				845	688	610	500	424	366	314	288	256	229	200	170
	1¼ in. br.				2160	1350	1080	772	600	490	400	360	308	270	220	180
Room temperature 25 deg. F.	2 in. d.e.			2566	962	700	592	452	367	308	256	233	202	179	154	129
	1¼ in. d.e.				1375	1001	846	645	525	440	366	233	288	256	220	185
	1¼ in. br.						2160	1200	830	636	410	432	360	308	246	196
Room temperature 20 deg. F.	2 in. d.e.				2566	1283	962	642	482	385	308	275	233	202	171	140
	1¼ in. d.e.						1375	917	689	550	440	393	333	289	244	200
	1¼ in. br.							2700	1350	900	636	540	432	360	277	216
Room temperature 15 deg. F.	2 in. d.e.					7700	2566	1100	700	514	385	334	275	233	193	154
	1¼ in. d.e.								1000	734	550	477	293	333	276	220
	1¼ in. br.								3600	1543	900	520	540	432	318	240
Room temperature 0 deg. F.	2 in. d.e.									7700	1540	962	592	527	308	220
	1¼ in. d.e.											1375	846	754	441	315
	1¼ in. br.												2160	1080	569	360
Room temperature —10 deg. F.	2 in. d.e.												2570	962	514	308
	1¼ in. d.e.													1375	735	441
	1¼ in. br.														1200	540

d.e. means direct expansion
br. means brine
The values for piping above are for natural draft circulation of air. If forced circulation, multiply by 0.5 to 0.6.

Alaska Coal for Navy

The Secretary of the Interior has returned from his trip to Alaska, fully convinced that it has the coal necessary for its own industries and soon will be in a position to supply the Navy in the Pacific with a coal the equal of Pocahontas. While in Alaska, Secretary Payne ordered the construction of a washing plant at the Eska mine which will greatly improve the low grade coal.

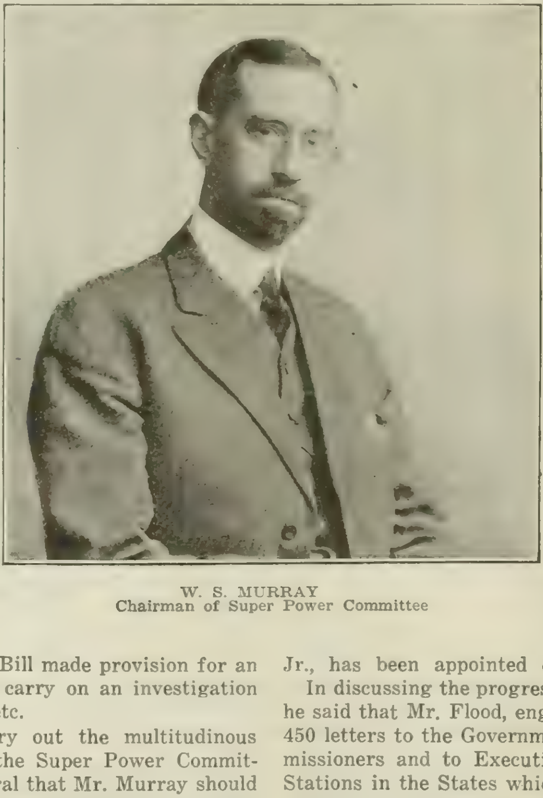
The Navy coal will come from the Chickaloon mine. This property, which is on a branch of the Alaska railroad thirty-seven miles from the main line, also was visited by Secretary Payne. He reports that no less than 400,000 tons of coal are exposed. Just at present the future of that particular mine is somewhat in doubt, due to the faulting of the vein.

Secretary Payne expects to have a committee actively at work in the very near future studying ways and means of stimulating all industries in Alaska.

W. S. Murray—Father of the Super-Power Plan

The super-power plan will affect the operation of industries and railroads in the region extending from Boston to Washington and inland from the coast about 150 miles. By future development of water power, and the location of large steam-driven electric stations at tidewater and at points near the mouth of mines it is estimated that the present power requirement could be served by one-third of the present power generating capacity. In other words, this means that the load factor now averaging not greater that 15 per cent will be lifted to nearly 50 per cent. It is of national importance also that by such a coordinated power arrangement not less than 30,000,000 tons of coal, the equivalent of $150,000,000, will be saved annually, besides decreasing in almost equal amount the annual expense of maintaining the inadequate power machinery now in operation.

GENERAL economic conditions resulting from the war have forcibly drawn the attention of engineers to the necessity of a careful study of our power problems to the end that our former wasteful methods might be replaced by a more efficient generation, transmission and use of electricity and, in the final analysis, effect a substantial conservation of our diminishing fuel supply. In such a study the individual plant must necessarily be subordinated to the problem as a whole. During the last few months this subject has attained added importance in view of the constantly increasing demand for power and the rising price of coal. The matter had been discussed sporadically but it awaited someone to offer concrete data as to possible savings and a definite plan of procedure. Consequently when W. S. Murray, consulting engineer of New York City, came forward with his outline of a Super Power System destined to eliminate the economic waste in our present power system, national interest was immediately aroused and Congress in its Sundry Civil Bill made provision for an appropriation of $125,000 to carry on an investigation of the plan, make surveys, etc.



W. S. MURRAY
Chairman of Super Power Committee

In order to properly carry out the multitudinous details of the investigation the Super Power Committee was formed. It was natural that Mr. Murray should be selected as its head and he was appointed by the Secretary of the Interior. There was needed broad vision, enthusiasm and energy. Mr. Murray possesses these qualifications, and has the advantage of a number of years of study on this project. His work in the past is sufficient evidence of his ability to do things on the super scale.

From the time when he completed his electrical engineering studies at the Lehigh University until today Mr. Murray has been doing and planning work on a large scale. For seven years following his graduation he was associated with the Westinghouse Electric & Manufacturing Co. in the departments of manufacturing, engineering and construction. Here he received a thorough practical training. He severed his connections with this company and opened a consulting engineering practice in Boston, where he remained for four years. At the end of that period he accepted the position of chief electrical engineer of the New York, New Haven & Hartford R.R. in full charge of electrical engineering and construction details of the New Haven electrification. He successfully completed this tremendous task, costing the New Haven R.R. $25,000,000, and a short time later was made consulting engineer in charge of all features of electrical operation.

Mr. Murray has organized his engineering force into three departments of investigation: (1) Railways, (2) Industries and (3) Power and Transmission. He has appointed as the respective heads of these departments, Cary T. Hutchinson, Henry W. Butler and L. E. Imlay. Henry Flood, Jr., has been appointed engineer-secretary.

In discussing the progress of the Super Power Survey he said that Mr. Flood, engineer-secretary, had sent out 450 letters to the Government and Public Service Commissioners and to Executives of Railway and Central Stations in the States which the Super Power Zone includes and their instant and favorable response gave indication of the interest and desire to help in every possible way to furnish the necessary data.

Mr. Murray is the author of many papers on electrical subjects which have been read before numerous engineering societies.

He still finds time to take an active interest in the American Institute of Electrical Engineers, of which he was vice-president from 1913 to 1914. He is also a member of the Bankers Club, the Engineers Club of New York and the Graduates' Club of New Haven.

Organization and Plans of Super-Power Committee

THE United States Government has recognized the appeal made by a committee representing the engineers of this country who appeared before the Appropriations Committee of the House of Representatives in April to present the case of the Super-Power System, and both branches of Congress have now approved the Super-Power Survey for the zone on the North Atlantic seaboard between Boston and Washington and inland from the coast averaging 150 miles and have granted an appropriation in the amount of $125,000 with which to carry on the work.

Mr. Murray in a recent interview said that in the area between Boston and Washington and inland from the coast 150 miles, which is less than 5 per cent of that of the United States, there is installed a machine capacity aggregating 17,000,000 horsepower; 10,000,000 of this is required to run the industries; 7,000,000 is required to operate the railroads.

The part, therefore, that the Government is playing in this matter is only to finance an administrative and engineering force to show clearly what these wastes are; and this force has been organized and is known as the Super-Power Survey, with headquarters at 709 Sixth Avenue, New York City.

The diagrams here shown give the form of organization by which the power survey will be conducted. As the object of the investigation and report is necessarily divided into two principal features—(a) an allocation of and the amount of wastes in labor, fuel, and other materials as at present applied to the railways and industries in the zone, and (b) the design of a regional system by means of which these wastes will be eliminated, it seemed of special importance that the investigation should be divided into three departments, namely, power and transmission, railways, and industries. To that end three departments were created and a division chief appointed to head each, with an engineer-secretary assigned to the duty of collaborating with these division chiefs in the collection of field data and preparing the data as nearly as possible for report text. The services of the Chief Hydraulic Engineer of the United States Geological Survey and of the Chief Mechanical Engineer of the Bureau of Mines will also be contributed in part to the engineering staff of the Super-Power Survey.

It was desirable to obtain the counsel of men who would be representative of power producers and power consumers and of the people as a whole representing a national power policy. Therefore an advisory board was appointed of men representative of the above classes, and to that end the Secretary of the Interior officially invited to membership on such a board men who would be representative of New England railroads, New York railroads, engineering, technical publicity, the National Electric Light Association, the American Electric Railway Association, the American Railway

MEN WHO WILL DIRECT THE SUPER-POWER SURVEY

Upper row from left to right: Lorin E. Imlay, C. T. Hutchinson, Henry W. Butler, Harold Goodwin, Jr., L. A. Whitsit, N. C. McPherson, James H. McGraw. Lower row: C. H. Pierce, Henry Flood, Jr., W. S. Murray, Otis Smith, Prof. L. P. Breckenridge, N. C. Grover

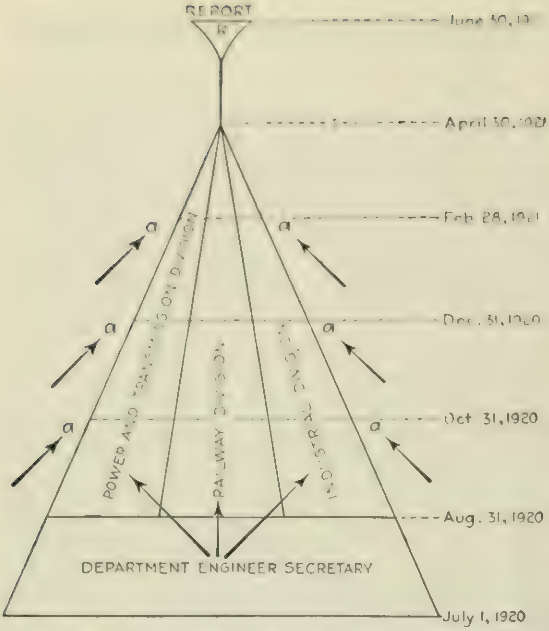


FIG. 1. FUNCTIONING OF ORGANIZATION

Association, and the National Industrial Conference Board.

Meetings of the Advisory Board, which will be attended also by the Director of the United States Geological Survey and the Chairman of the Engineering Staff, will be called not less than every two months, at which time the Chairman of the Engineering Staff will present the progress of the work during the two previous months and the proposed procedure during the succeeding two months. In such manner the engineering staff will constantly have the advantage and value of the counsel of such an advisory board. Prof. L. P. Breckenridge, of Yale University, has consented to serve as chairman of that board.

Referring again to the diagrams: Fig. 2 gives a fair idea of the Super-Power organization, as above described, for the conduct of the power survey; Fig. 1 is an attempt to show the functioning of the organization as shown in Fig. 2. On these diagrams "F" is a focus toward which the entire organization will be working, that is, as of May, 1921, when all fundamental data necessary to the compilation of the report, with maps and diagrams, must have been collected. The triangular divisions are the power and transmission, railway, and industrial departments of investigation. The base section of the triangle represents the department of the engineer-secretary, and shows, by arrows, his collaborating arrangement with the three division chiefs in the preparation of report text. The arrows indicated by the letter "a" indicate the effect of advice from the advisory board in shaping the report and bringing it to a focus, and the horizontal zones throughout the total triangle indicate the bi-monthly meetings of the advisory board with the engineering staff regarding past progress and future procedure. As indicated by this diagram, the time between April 30 and June 30 will be devoted to the final preparation of report text with its accompanying maps and diagrams for presentation June 30, 1921, when the Congressional appropriation terminates the matter will then be in the hands of Congress and the committee will dissolve.

PERSONNEL

A. John Barton Payne, Secretary of Interior.
B. George Otis Smith, Dir. U. S. Geological Survey.
C. W. S. Murray, Cons. Engineer, New York.
D. E. G. Buckland, Vice-Pres. N. Y., N. H. & H. R.R.
E. A. T. Hardin, Vice-Pres. N. Y. Central R.R.
F. Appointment not made.
G. John H. Pardee, Pres. Am. Elec. Ry. Assn.
H. L. P. Breckenridge, Head Dept. Mech. Eng., Yale.
I. J. H. McGraw, Pres. McGraw-Hill Pub. Co.
J. Appointment not made.
K. Magnus W. Alexander, Mgr. Dir. Nat'l Industrial Conference Board.
L. Henry Flood, Jr., Cons. Engineer, Pittsburgh.
M. L. E. Imlay, Cons. Engineer, Niagara Falls.
N. Cary T. Hutchinson, Cons. Engineer, New York.
O. Henry W. Butler, Cons. Engineer, New York.
P. N. C. Grover, Chief Hydraulic Eng. U. S. Geological Survey.
Q. O. P. Hood, Chief Mech. Engineer, U. S. Bureau Mines.
R. J. J. Madigan, Chief Clerk U. S. Geological Survey.

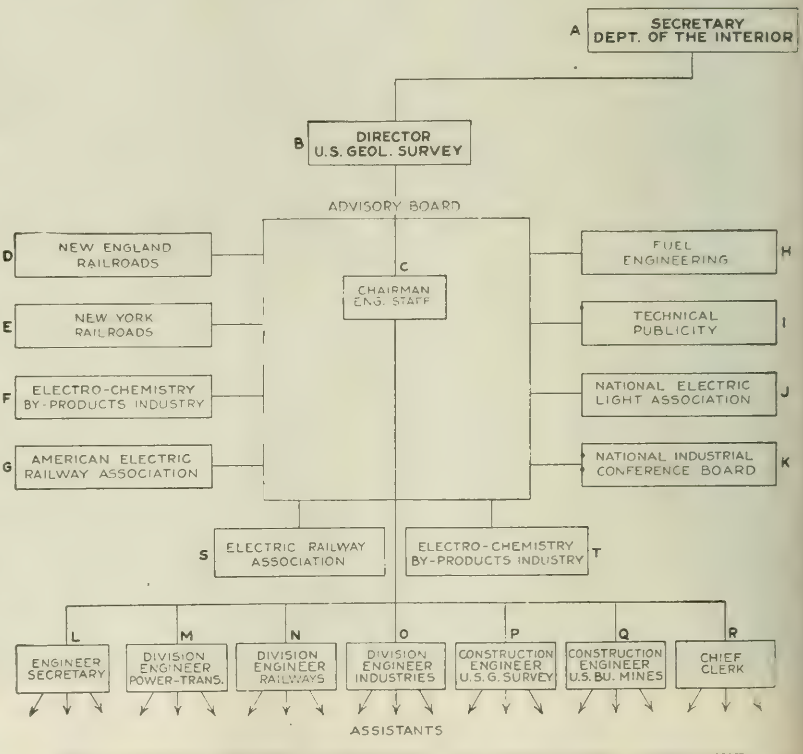

A SECRETARY DEPT. OF THE INTERIOR
B DIRECTOR U.S. GEOL. SURVEY
ADVISORY BOARD
C CHAIRMAN ENG. STAFF
D NEW ENGLAND RAILROADS
E NEW YORK RAILROADS
F ELECTRO-CHEMISTRY BY-PRODUCTS INDUSTRY
G AMERICAN ELECTRIC RAILWAY ASSOCIATION
H FUEL ENGINEERING
I TECHNICAL PUBLICITY
J NATIONAL ELECTRIC LIGHT ASSOCIATION
K NATIONAL INDUSTRIAL CONFERENCE BOARD
S ELECTRIC RAILWAY ASSOCIATION
T ELECTRO-CHEMISTRY BY-PRODUCTS INDUSTRY
L ENGINEER SECRETARY
M DIVISION ENGINEER POWER-TRANS.
N DIVISION ENGINEER RAILWAYS
O DIVISION ENGINEER INDUSTRIES
P CONSTRUCTION ENGINEER U.S.G. SURVEY
Q CONSTRUCTION ENGINEER U.S. BU. MINES
R CHIEF CLERK
ASSISTANTS

FIG. 2. CHART SHOWING PERSONNEL OF SUPERPOWER COMMITTEE

EDITORIALS

From War Service to Industrial Pursuits

DURING the war many industrial centers sprung into existence practically overnight, to meet emergencies of various kinds. In most all of these were power plants, many of which represented no small achievements in modern engineering, not alone from the standpoint of the short period and adverse circumstances under which these plants were built but also in their design. However, many of these plants have already been dismantled or are passing out of existence, except for what may be salvaged, and must be charged up to the necessary cost of carrying on the world's greatest war to a successful conclusion for ourselves and our allies. There are nevertheless numerous industrial power plants, that were the direct outcome of the war, still in existence and are serving peace time industries. An example of one of these plants is that of the Merchants Shipbuilding Corporation at Bristol, Pa., described in this issue.

As a result of the conditions encountered when the power plant was built it was impossible to remove an existing plant used to supply power to a foundry on part of the site where the shipyard was constructed. This made necessary the building of the new plant around three sides of the old plant. The extremely long steam header—590 feet in length—necessary on account of the distance from the boiler and engine room, is one feature worthy of passing interest in this plant, all the joints of which are butt-welded. The fact that these joints have given satisfactory service, even when made under stress of war, is another testimony of the possibilities of autogenous welding.

A feature in this plant that is somewhat at variance with modern tendencies in air compressor drives is that all seven air compressors are located in the power plant and steam driven, which no doubt when operated condensing as these are can show an overall efficiency comparable to that of a motor-driven compressor. As the author states, "if it had not been possible to locate the compressors in the power house and operate them condensing synchronous motor driven units would no doubt have been installed." Where the power factor is low it would apparently have been better practice to have operated at least one or two of the compressors by synchronous motors, having sufficient capacity to not only drive the machines, but also to correct the power factor to near unity. Such operation would probably not have required any more generator capacity than at the present time and might have made possible a lower water rate for the turbines. That a power factor correcting device can be installed in the form of a static or a synchronous condenser at less cost than a synchronous motor, as stated by the author, is open to question, especially when the synchronous motor is designed to operate at its most economical load; seventy per cent mechanical load and the same per cent reactive component load. These two loads combined will only require the equivalent capacity of one hundred per cent mechanical load.

This point has not been raised to question the engineering judgment of those who designed and built the plant, but rather point out that under conditions not so urgent as those during the stress of war refinements of design may be taken advantage of, that were not warranted in the design of this plant. As the author points out, "Apparatus obtainable, rather than the best combinations of sizes for the load conditions determine the selection." A study of the acceptance test figures given will show, although the equipment was obtained where most convenient, the plant's efficiency compares favorably with those of the same capacity built under more advantageous conditions. One of the most gratifying features is that this plant is to continue to operate as an adjunct to one of America's new industries which is a heritage of the part we played in the world's greatest conflict.

Nationalize the Fuel Supply

A SURE and plentiful supply of fuel is one of the first requisites to national security and well-being, the assurance of which is a proper and legitimate activity for a people in its collective capacity.

With the application to the eternal struggle against the forces of nature of accumulated knowledge and experience and scientific discovery; with the employment of the marvelous tools and machinery at our command; with facilities for handling, storing and distributing which have never been equaled; with uses found for many portions of the product formerly thrown away; with all the economies of aggregation which should result from doing things upon a big scale; a consumer ought to be able to exchange his day's work for more of the commodities of life than ever before. There is no physical reason for the high cost of living.

The grand-scale development in production and exchange of the past half century has not been accompanied on the part of the public, by any intelligent, controlling, directive effort toward over-all efficiency.

The production of the nation's fuel supply can no longer be left to the undirected and ununified discretion of competing individuals, nor its distribution to the erratic machinations of those whose acknowledged aim is to exact profit from rather than to expedite its handling.

The demand is known or ascertainable; the sources of supply are visible and controllable. There should be intelligent authoritative correlation, the one with the other. The means of storing periodical production in excess of current consumption should be applied to smoothing out disparities between contemporaneous supply and demand, and the machinery of distribution should be so organized that the product would proceed systematically from producer to consumer by the cheapest route and without reselling, except by the retailer. The eventual price to the consumer should be cost plus a fair profit.

Such a system involves nothing more than the application of principles and methods already in daily use. Any good industrial engineer or manager, given the authority, could put it into operation. It is not utopian nor unduly paternal. It would be simply the organizing, systematizing and correlating by the people, of the processes upon which their sustenance depends; and which, they have very cogent reasons to believe, have gotten beyond the ability or the willingness of individual or corporate enterprise effectively and economically to administer.

The Engineer and the Super-Power System

Before any intelligent solution of a problem can be offered, it is first necessary to be able to allocate to each factor entering into the analysis its correct value. We know there are tremendous wastes going on all over the country in the generation and distribution of power from fuel but the allocation of those wastes, just what their exact values are, are only conjectures or estimates. At the present time it is estimated that three hundred million dollars per year can be saved by a proper system of generation and distribution of power to the industries along the Atlantic seaboard between Washington and Boston and one hundred to one hundred and fifty miles inland but, up to the present time at best this is only an estimate. What is required before any progress can be made toward a solution is facts and this W. S. Murray and his committees composed of eminent engineers have attempted to obtain. This committee is known as the Super-Power Survey, and details of this organization are published elsewhere in this issue.

This committee is peculiar for many reasons. It is one of the few that is to operate under Government direction on engineering work that is composed entirely of engineers. The tremendous economic importance of a correct solution of the power problem in the super-power zone alone, is one that should warrant the hearty co-operation of every American engineer, but the fact that this is an opportunity for the engineers of the country to show that they are well fitted to fill positions of national importance should make the successful carrying out of the work which Mr. Murray has so energetically undertaken, doubly merit their support. Congress has appropriated one hundred and twenty-five thousand dollars to finance this committee to show what the wastes are. If the committee accomplishes this the appropriation will be warranted many times over.

Generally, in such projects as this several years lapse before definite action is taken if at all. But in this case it has been only a matter of months, which is another indication of the influence engineers may exert when they get squarely behind a movement.

This undertaking is not alone of particular interest to those living along the North Atlantic seaboard, but to the entire country. Railway congestions in this district did not alone affect the industries located in this region but practically the entire nation. Consequently, the Super-Power Survey at present under way, merits national support.

Making the Best of What You Have

THESE are active days for power plant men. There are problems of many kinds confronting them. Of these, coal presents one of the most serious. The problem has several corners to it, for not only is it difficult to get the particular kind of coal one wants, but the price of whatever is obtained is sure to make one gasp.

The plant must be kept running. This is the engineer's job. It must be kept running as economically as the best of men can make it run. Combustion is a decidedly complex operation even in its simplest form. But the economical burning of coal unsuited to stoker and furnace in the usual industrial power plant is an operation which requires considerable skill and knowledge. There are thousands of plants the engineers of which are today confronted with this perplexing situation. Obviously the equipment cannot be changed every time another carload or boatload of coal comes in. One must make the best of what one has. But to do so the man in charge must have a through knowledge of the fundamentals of practicable combustion. He who has had the ambition to study it enough to know more than was sufficient to carry him through the exigencies of a moment can now "cash in" with his accumulation of knowledge of the burning of various grades of fuel.

While it is particularly true that in these days every plant calls for individual treatment in the solution of combustion problems, nevertheless this very condition offers opportunity for considerable good to be done by group effort. It at the meetings of the various engineering organizations those having problems would present them for discussion at the meeting, he who was in difficulty would not only be helped out, but he would be the means of enlightening many of his fellows.

There is many a meeting room where an Orsat apparatus is hidden away on some high back shelf, dust laden and with its rubber connecting pieces cracked and dry. There never was a more opportune time to bring that instrument into the light and demonstrate its working before the meeting. Make a real demonstration by connecting it with a few samples of gas brought to the meeting room by those who have the gas collectors.

Rumors again were rife last week to the effect that the President soon will appoint a Fuel Administrator. This was attributed to pressure from the public utilities and from the fact that the Attorney General had not been able to get all those interested in the coal trade together in a fair price conference. While no authentic denial could be obtained either at the White House or the Department of Justice, the improvement in the coal situation tended to cause the rumor to be discredited in many quarters. At this writing, it is expected that the Attorney General shortly will announce a fair price for coal.

The engineer that keeps the instruments for operating the steam equipment of his plant in reliable condition and neglects the electrical is doing only half the job. Frequently it is possible to make large savings by a proper analysis of the electrical requirements but this cannot be done unless the instrument records are reliable.

CORRESPONDENCE

Should the Main Belt Break, What Would the Engine Do?

I have witnessed the effect of the main belt breaking at two plants on two different types of engines. In each case water was to blame for the accident. High water had filled the wheel pit and loosened the belt splices in one case, and in the other a burst water pipe caused the belt to skid and catch in the main hanger housing, tearing down a section of shafting and ripping the belt in two. In both instances the valve gear had been readjusted a short time prior to the accident; otherwise, no doubt the engines would have overspeeded and perhaps wrecked the plants.

In the first case the 24 x 48-in. engine was turning at 60 r.p.m.; the steam valves were of the poppet type, Fig. 1. Previous to my taking charge of the plant a young man had been operating, and his limited experience had been on Corliss valve gears. "It was perfectly legitimate to allow the steam valves to open not quite the amount of lap," he was informed, "should the governor rise to the high point." So he applied the same principle to the poppet valve, but the poppet valve has no lap.

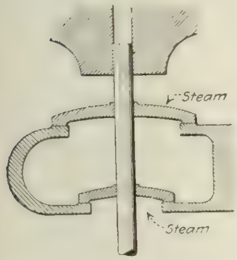


FIG. 1. POPPET VALVE

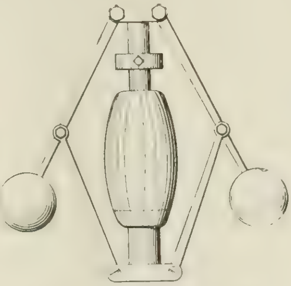


FIG. 2. COLLAR TOO LOW

On taking charge of the plant my thoughts were—Do the safety valves blow at the required point and does the governor shut off steam when at its maximum high position? I found that the safety valves operated as they should, but the second condition was far from satisfactory, as the valves were open fully an eighth of an inch with the governor, Fig. 2, in its maximum high position. This was not enough to overspeed the engine, as the friction load was heavy, but should the main belt break and no attendant be near, a wreck might follow.

On shortening the cutoff gear to just clear the lifting lever, I found that I was robbing the engine of about 80 hp. at full load, but I raised the steam pressure to compensate and so was able to pull through until I could change the governor's levers from *A* to *B* (see Fig. 3). This gave a long cutoff when necessary and no lift of the valves when the governor was at its high point, Fig. 4.

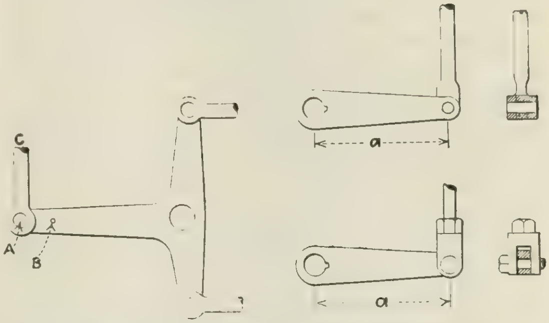


FIG. 3. CHANGED GOVERNOR ARM

That this change was a wise move was proved when the belt pulled apart from overstrain, lapped about an overhead steam pipe under 100-lb. pressure, pulled it down and finally wound up on the flywheel. While this performance was going on it was impossible to get into the engine room, but by looking through a window the crank could be seen turning its sixty turns just as smoothly as though it were still pulling its load.

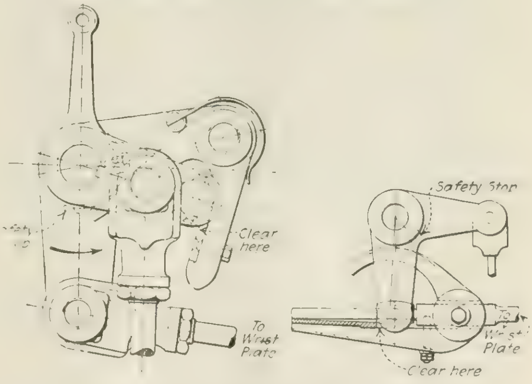


FIG. 4. LATCH BLOCKS SHOULD CLEAR WITH GOVERNOR IN HIGH POSITION

Had the main belt or the broken steam pipe fouled or damaged the governor, thus causing it to drop to running position, of course there would have been a different story to tell. This governor was geared from the valve-gear shaft and had no safety stop.

The second case was a 16 x 36-in. engine, of the gridiron-valve type, running at 70 r.p.m. It was possible to pull clutches at various points and so reduce the friction load to a minimum. There was no way of increasing or decreasing the speed of this engine except by changing the governor pulley. The speed had been 68, and 70 or 72 r.p.m. was desired, so the vertical stem was shortened a trifle, which allowed a longer cutoff. When I say no way of increasing or diminishing speed, I mean no legitimate way that would still protect the engine from overspeed should the governor have reason to rise to the high point.

By lengthening the cutoff the engine was out of control of the governor on an extremely light load. When the valves were properly set and the cutoffs properly adjusted, the speed was reduced to 68 r.p.m., so a larger pulley was put on the governor and the desired speed, 72 r.p.m., was obtained. Later, when the water pipe burst and soaked the belt, causing it to skid and do much damage, the engine, freed from its load, only increased its speed very slightly.

As in the former case, had the main belt or pieces of the broken shafting hangers wrecked the governor, of course perfect valve adjustment would not have counted.

It is a mistake to allow an engine to open the valve even the amount of lap when the governor is at high point, because the very slightest amount of steam admitted will overspeed the engine on no load, especially if it operates condensing.

If the engine will not carry its load and still release fully when the governor is in its high position change its leverage to get a greater travel of the cutoff gear. I stand in greater fear of a slipping governor belt than of a broken main belt. If the truth were known, probably more engine wrecks are caused by slipping governor belts and valves opening the amount of the lap than by anything else.

New York City. C. W. PETERS.

Still Another Long Run

I read with interest what was published relating to a long run of a steam turbine, in the May 18 issue of *Power*, and also the account of a 126-day run of a water-wheel driven generator, published in the June 29 issue. They have nothing on the reciprocating engine.

We have a 17 and 34 x 42-in. Nordberg tandem-compound Corliss engine direct-connected to a No. 10 Connersville Blower and used for smelter purposes, with about 42 oz. pressure. This engine made practically a continuous run from 3 o'clock p.m., Oct. 22, 1919, when it was shut down for inspection and keying up, until 1 o'clock p.m., Jan. 28, 1920, when it was again shut down for two hours for smelter repairs. The engine was keyed up and put in operation again and ran till March 17.

During the first period the engine was shut down one hour for smelter repairs on the night shift, but there was no inspection or keying up done. This engine has practically continuous work, and I would like to hear from anyone who can beat it. E. H. BEAVERS.

Mapimi, Durango, Mexico.

Conduit Rheostat Used To Handle 1,800 Amperes

When a large generator partly burned out and it was necessary to remove the coils to reinsulate them, the first obstacle encountered was the heating of the coils to soften the insulation so as not to damage the latter when pulling out the former. There was needed about 6 volts to heat the coils, and as there were no rheostats available to handle this current, it was decided to use a 250-volt 500-kw. motor-generator set, located next to the damaged generator. The motor-generator set was driven by an induction motor, therefore there was no chance of regulation from the motor end, nor could the generator be controlled from its own shunt field, because of the low voltage, so it was decided to insert some resistance in the circuit between the two machines as shown.

Conduit being available, and also the easiest to handle, we connected thirteen lengths of ¾-in. end to end and bent it in the shape of a U, so as to have each terminal at the machine. When this was tried out, the voltage of the generator could be reduced to 140 volts, with 1,800 amperes flowing in the circuit, but the conduit in a few minutes became red hot and some of the coupling almost a white heat.

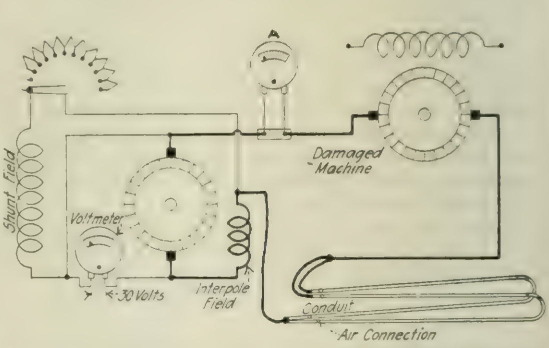


DIAGRAM OF GENERATOR AND RHEOSTAT CONNECTIONS

The next move was to use some 1-in. conduit, which we connected in two runs of seven lengths each, and bent them in a U shape. Before they were connected, the thread of each end and the couplings were cleaned. The ends of each loop were flattened and drilled to make the connection. We also drilled and tapped one hole in each loop, to make a connection with an air hose so as to circulate air through the conduit for additional cooling, as shown in the figure. After being bent, all ends of the conduit did not come even, so one end of each loop was bolted together and connected to the generator, while two separate cables from the other two end were run to the damaged generator as in the figure.

Thirty volts were obtained at the generator terminals when supplying 1,800 amperes. This could be controlled very nicely with the shunt rheostat and could carry it indefinitely as long as air was circulated through the conduit. A very interesting feature was discovered when the shunt field was opened. It was found that the generator would deliver about 2,200 amperes at 30 volts. Presumably, the excitation was supplied from the interpoles. A. N. SIMMONS.

Detroit, Mich.

Elevator Worm-Shaft Bushing Worn Caused Sparking at Brushes

The brushes in an elevated motor gave trouble by frequent sparking. Ths motor was the 4-pole consequent-pole type (Fig. 1), having only two exciting coils. The machine had been recently rewound for 240 volts, replacing the original 120-volt winding. It was thought that the voltage between the segments was too high and that this was the cause of the sparking. Later developments, however, proved these conclusions to be wrong.

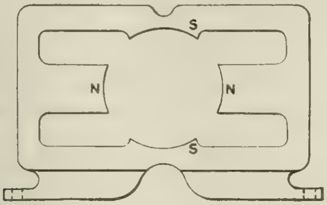
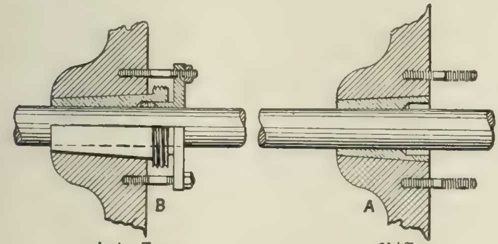


FIG. 1. FOUR-POLE CONSEQUENT-POLE STYLE OF FIELD FRAME

While watching the brushes and commutator after an attempt to stop the sparking, it was noticed that the air gap between the polepiece and the armature changed at different loads or positions of the car. This change did not take place with any regularity, and frequently the car would make several trips before the armature would be drawn to one side near a polepiece having an exciting coil.

We examined the field pole to see if it was loose in the frame, but there was no trouble here; then a side pressure with a lever was applied to the armature shaft where it was coupled to the elevator worm shaft, and it was found that it could be moved about 0.1 of an inch. Here then was our trouble and it was a serious one too, for this deflection had not only been the cause of sparking, but had caused an armature shaft to break at the coupling at an earlier date. As the brake wheel was at the outer end of the motor shaft, there was nothing to hold the car when the failure occurred at or near the coupling, and only the safety appliances were left to stop the car from falling. Later types have the brake wheel attached directly to the worm shaft. When the armature shaft broke, the car was lightly loaded and the counterweights being heavier than the car and load caused the latter to race in the up motion until sufficient speed was attained to operate the safety.



Later Type

Old Type

FIG. 2 OLD AND NEW TYPE OF BUSHING

It was decided to put a new bushing into the gear-case bearing. As this was the only elevator in the building and was used for both passenger and freight service, it was necessary to make the repair as quickly as possible. It was short work to disconnect and move the motor away and pull the coupling from the worm shaft, but when we came to remove the bronze bushing, we were up against it.

This was a Sprague machine and must have been one of the first manufactured, for the bronze bushing only came flush with the casting, as shown at *A*, Fig. 2. Later types of this make have an extension of the bushing, on the outside of which is a threaded section and a capstan nut by which the bushing can be readily pulled out as at *B*, Fig. 2. To get the older type of bushing out, it would be necessary to remove the worm shaft and split the bushing or drive it out from the inside of the gear case.

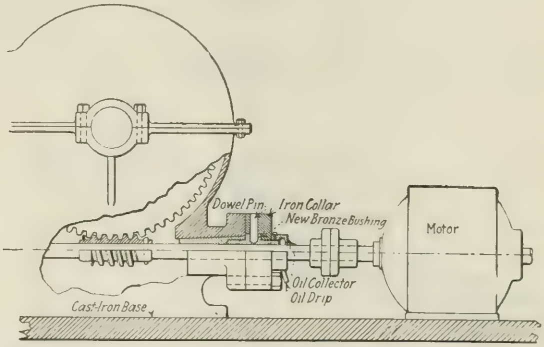


FIG. 3. SECTIONAL VIEW SHOWING HOW DRUM-SHAFT BEARING WAS REPAIRED

A previous experience made us hesitate about pulling the worm shaft through the worms, it having taken two days to jack one out. The machine was tandem geared, as in Fig. 3, and the bearings, after the bushings were removed, were not large enough for the worms to pass through; consequently, the worm shaft could not be removed without pushing it through the worms. It was decided to fit a new bushing into the space formerly left for the packing and extend it out the same length as the bearing of the old bushing. The bore of the space left for packing, having had no wear, would be concentric with the original bearing and would bring the new bushing into position to carry the worm shaft in its original relation with the worm gears.

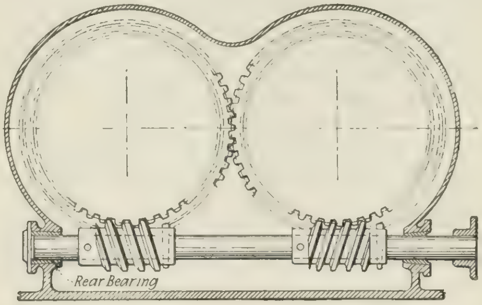


FIG. 4. TANDEM WORM AND SPUR GEAR

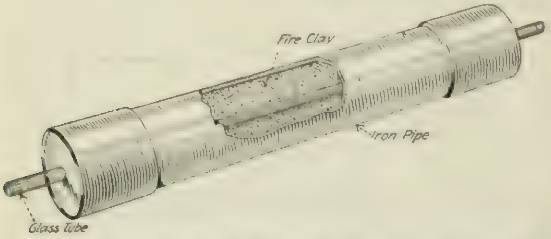
An iron collar was machined and a bronze bushing forced and doweled in, as shown in Fig. 4. No packing was provided for, but an oil-collecting collar, with drip pipe, was supplied instead, as is shown. This repair was completed by having the elevator out of service for two days. It has stopped all brush troubles, runs cool, is safe and satisfactory in all ways.

Washington, D. C. D. ALFRED MANSON.

Home-Made Gas-Sampling Tube

Some months ago, while making various kinds of engineering tests, I had occasion to take snap samples of gas over the fire, and in different passes of several large water-tube boilers.

At first thought the only solution for taking hot gas samples over the fire in the furnace of the boiler seemed to be to purchase an expensive high-temperature porcelain tube. It would have taken weeks and perhaps months to secure such a tube, and it would be costly and very delicate for this class of work, so I set about to provide a tube that would answer the purpose.



GAS-SAMPLING TUBE MADE OF GLASS TUBE AND PIPE FITTINGS

A 6-ft. length of ¾-in. iron pipe was threaded at each end and fitted with pipe couplings, and a ¾ x ¼-in. pipe bushing was inserted in the outer end of each coupling. A ¼-in. glass tube 6 ft. 4 in. long was slipped through the bushings on the ends of the pipe, and the pipe was fastened in a vertical position. The bushing was screwed out of the upper end of the pipe and the pipe filled with a grout made of fireclay and water. The bushing was then replaced, bringing the glass tube central in the pipe. The improvised tube was then placed in a horizontal position on the top of one of the boilers and allowed to remain there about three days, at which time the moisture was evaporated from the grout.

With this arrangement I was able to secure samples of gas in the furnace of the boiler about six feet above the fire. A. J. MACKENZIE.

Crafton, Pa.

Kept the Engine in Good Condition

Having recently given my main 16 x 18-in. Corliss engine a thorough inspection, I thought it might be of interest to other engineers to know the result. The engine is around twenty-one years old and has been in my charge about seventeen years. For some time we have been rather short of power, particularly in the boiler room, and the little bird that somehow gets to the office of the "Boss" must have been busy, as a request for some indicator diagrams, a somewhat unusual one, too, resulted in my supplying what was desired.

The accompanying diagrams show what was found and that with only a very trifling adjustment. Diagram, Fig. 1, is a friction load only, the 125-kw. generator being belted to the engine. Notice the evenness of the two diagrams. Fig. 2 shows a light load of 400 amperes. Fig. 3 is near the economical capacity, with a load of 690 amperes. Fig. 4 is over the rated load, carrying, as it does, 875 amperes. Figs. 5 and 6 show very much overload, or 900 and 925 amperes respectively. All the diagrams show very even steam distribution and, what is seldom seen, all loads are well balanced.

The engine exhausts into a heating system, and this accounts for the high back pressure. There is a slight indication of leakage, and further testing showed that such existed, but not sufficient to warrant any work being done on either piston or valves.

The cylinder was calipered and showed wear at the head end 0.017 in.; in the middle, 0.007 in., and at the crank end, 0.01 inch.

I have always been an advocate of good cylinder oil, and this examination showed the result of it, the cylinder being a brown, glossy color, also the piston rod and the valves. The inside of the piston was clean, with no sign of crusty matter such as I have seen taken from pistons. The piston was found to be central in the cylinder and all signs showed, what I had claimed, that the engine was in first-class condition.

About seven pints of cylinder oil is used per week of 52½ hours. This is handled by a force-feed lubricator.

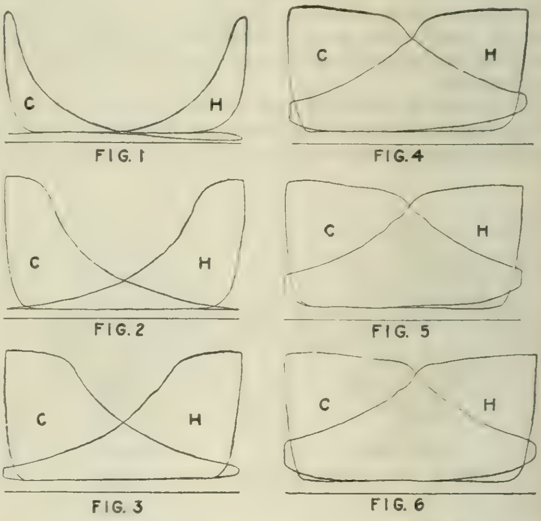


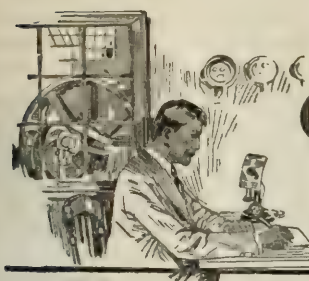
FIG. 1 FIG. 4 FIG. 2 FIG. 5 FIG. 3 FIG. 6

LOADS FROM FRICTION TO HEAVY OVERLOADS

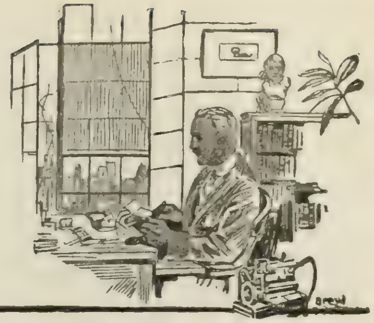
A home-made oiling system supplies oil from a tank, supported over the main bearing, to all bearings excepting the outboard bearing, eccentric and wristpin, which are lubricated with grease for the sake of cleanliness and convenience of application. The oil is collected in pans, and a channel in the floor under the crankpin, which drains through a pipe laid in the concrete floor to a pail in a nearby pit, the net consumption of oil being about one gallon per day.

The ascertainable expense for all repairs for the period of twenty-one years, including replacement of parts, is about $250. I think this is very low.

Trenton, N. J. HARRY H. YATES.



INQUIRIES OF GENERAL INTEREST



Gallons Capacity of Cylindrical Tank—What is the formula for estimating the gallons of capacity of a cylindrical tank? M. R.

Where D = the diameter of the tank in inches and L = the length in inches, the complete formula is

$$\text{Number of U. S. gallons} = D^2 \times 0.7854 \times L \div 2.31,$$

or the shorter form,

$$\text{Number of U. S. gallons} = D^2 \times L \times 0.0034.$$

Determining Leakage of Piston and Valves—What is the best method of testing for leakage of the piston and valves of a Corliss engine? B. H.

Let steam in one end of the cylinder and open the indicator cock at the other end and leakage of the piston can be detected by escape of steam. By closing the valves and opening both cocks, leakage of the valves can be detected. Leakage of the exhaust valve is shown by steam blowing out of the exhaust pipe when steam is admitted to the cylinder, with the indicator cocks and exhaust valves closed.

Formula for Estimating Heat Value of Coal—How is the heat value of coal estimated from the chemical analysis of the coal? D. A. B.

The heat value of coal may be calculated from its ultimate analysis with a probable error not exceeding 2 per cent, by Dulong's formula:

$\text{Heat value in B.t.u. per pound} = 146\ C + 620\ \left(H \frac{0}{8}\right) +$ $40\ S$, in which C, H, O, and S are respectively the percentages of carbon, hydrogen, oxygen and sulphur shown by the analysis.

Advantage of Riding Cut Off Valve—What is the advantage of a riding cutoff over a single automatic cutoff valve? R. M.

For medium and slow speed engines, it is desirable to have uniform points of release and compression. With a single valve, the points of release and compression must vary with the point of cutoff. With a riding cutoff the main valve determines the lead, point of release and point of exhaust closure and these are constant, as the main valve is operated by a fixed eccentric. The duty of the riding cutoff valve is simply to close the ports in the main valve and effect the point of cutoff, as determined either by hand adjustment or by the governor, depending upon whether the engine is a throttling or an automatic cutoff engine.

Obtaining Sample of Flue Gas Analysis—At what point of a boiler setting should samples of flue gas be taken for CO_2 determination? J. F.

Samples of flue gas are usually taken from the breeching between the boiler and stack, and preferably where the gases are just leaving the boiler. The sampling tube should be made of a small size of pipe with a number of $\frac{1}{8}$ in. holes drilled in its sides, and extended nearly all the way across the breeching, so the sample of gas collected will represent the average of flue gases discharged to the stack.

Discharge of Steam Jets—What quantity of steam at 100 lb. boiler pressure would be used by a steam jet having four nozzles each $\frac{1}{16}$ in. dia. discharging into a boiler ash pit? C. H. T.

The discharge would be given approximately by Napier's rule for flow of steam through orifices when the final absolute pressure is less than 58 per cent of the initial absolute pressure, namely,

$$\text{Flow in pounds per second} = \text{absolute initial pressure} \times \text{area orifice in sq.in.} \div 70$$

Having an initial absolute pressure of 115 lb. per sq. in. and 4 orifices, each $\frac{1}{16}$ in. dia. their total area would be $\frac{1}{16} \times \frac{1}{16} \times 0.7854 \times 4 = 0.00307 \times 4 = 0.01228$ sq. in., and by the formula the discharge would amount to $115 \times 0.01228 \div 70 = 0.02017$ lb. of steam per second, or $0.02017 \times 60 \times 60 = 72.6$ lb. per hour.

Resistance in Series with Storage Battery—A battery made up of 16 cells requires a charging current of 25 amperes. What value of resistance must be connected in series with the battery to charge it on a 110-volt circuit. B. W.

Neglecting the internal resistance of the cells, which is very low, the external resistance $R = \frac{E-e}{I}$ where E is the charging circuit voltage, e the voltage required by the battery at the beginning of charging (normally 2 volts per cell) and I the charging current. At the beginning of the charge in this problem, e will equal about $2 \times 16 = 32$ volts. Therefore the external resistance $R = \frac{110-32}{25} =$ 3.12 ohms. If it is desired at any time to charge the battery at less than 25 amperes the external resistance will have to be increased in inverse proportion to the current.

Proximate and Ultimate Analysis of Coal—What is the difference between proximate analysis and ultimate analysis of coal? W. N. S.

The proximate analysis assumes coal to contain four different and separate ingredients called fixed carbon; volatile hydrocarbon or volatile matter or simply volatile; moisture; and ash. The percent of moisture is determined by maintaining a small quantity of finely ground coal at a temperature of about 200 deg. F. The material lost in this manner is assumed to be moisture and is reported as such. Volatile matter is determined by heating a sample from which the moisture has been driven or a fresh sample, for which purpose the coal is held at a red to white heat, with exclusion of air until there is no further loss of weight. Fixed carbon is found by combustion of a sample from which the moisture and volatile have been driven off; and ash is the designation of the incombustible material left after determining the fixed carbon. The sum of the volatile, hydrocarbons, and fixed carbon is called the combustible. When sulphur is to be reported it must be determined by a separate analysis. The ultimate analysis is a thorough chemical analysis for determination of the percentages of carbon, hydrogen, oxygen, nitrogen and sulphur and the percentage of ash in dry coal.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Willans Line*

By Alexander Jude

In the early days of the so-called high-speed engine it was shown by the late Mr. P. Willans that the total steam consumption of a throttle-governed engine plotted against load was a straight line. This characteristic line is known as the Willans Line. Moreover, the Willans Line is straight whether the load be plotted on a brake-horsepower basis or on a kilowatt basis, the generator losses also following practically a straight-line law. Obviously, by running a no-load test on an engine and one test at any selected load, and then drawing the Willans Line through the two points thus determined, we have the necessary data to compute or predict the steam consumption at any load.

This characteristic has been proved to hold also for all throttle-governed turbines, and its application to the problems of turbine design is pointed out in this article.

The multiple valve type of governing is applicable only to impulse turbines and is practically serviceable only in those turbines having a Curtis or a compounded velocity wheel for the first stage. Briefly, in these designs the full nozzle arc is cut up into fractions, each fraction being served by a separate and comparatively small throttle valve, so that the full steam-chest pressure is nearly maintained at all loads above that corresponding to the first fraction, the idea being that the full available head of steam shall be employed as much as possible. Now, the no-load consumption is practically the same, whether there be any number of nozzle valves or none at all. The reason is that the first stage blade system works at its lowest efficiency, which is very bad in any case, and, the bulk of the other stages doing negative work, there is little to choose between one bad condition and another. Further, all consumptions have a common origin at no-load no-speed. It has been the custom to state that the total consumption line in this case is a curve convex downward. This statement is not correct, but the true consumption line consists of a series of Willans Lines, there being a step-up at each valve opening, as indicated in Fig. 1. It is obvious that at any load throttle governing alone is taking place, and if, say, three nozzle valves are then open and kept open under governor control down to no-load, or rather beyond no-load to the point of being quite shut, the line would be a b c d, as shown in Fig. 1.

The steps shown in the heavier line are those caused by successive openings of the throttle valves as the load increased. At the initial opening of any valve the nozzle stream is too weak to operate efficiently, and it is not until the pressure immediately behind the blade rises sufficiently to produce a workable head that the incoming nozzle arc is of any service. There is, therefore, an inefficient step in the proceedings visualized by a step in the Willans chart. This step obviously is not vertical, but curved to the right and merging into the straight Willans Line as shown.

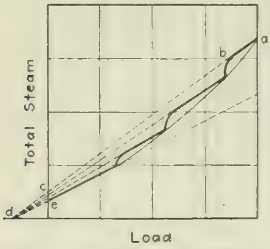


FIG. 1. WILLANS LINES FOR MULTIPLE-VALVE GOVERNED TURBINE

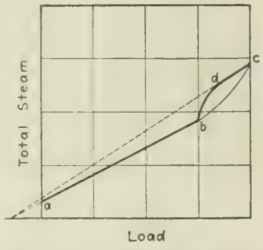


FIG. 2. WILLANS LINES FOR TURBINE WITH BY-PASS OVERLOAD VALVE

The same remarks apply to a bypass overload on any turbine. The consumption line extended to bypass overload is therefore not the conventionally assumed curve a b c in Fig. 2, but the curve a b d c.

In connection with bleeder turbines when no steam is being bled, the steam consumption will obviously be higher than that of an ordinary turbine because of the increased high-pressure disc and blade friction. In Fig. 3 the point A represents the consumption of an ordinary turbine at a given load, while a point A' will represent that for a bleeder turbine. The Willans Line for a bleeder turbine may then be represented by the line A' B'. This line should be continued to the no-speed no-load point at X'. Under the conditions that all the steam is taken out at the bleeder connection, the distance XC represents the steam consumption at the load X and the line CEX' is the Willans Line for the machine running under conditions that require all the steam to be bled. Suppose, now, that at the load X one-half of the steam is bled out; then one-half does the work under the conditions represented by XA' and the other half according to the difference between XA' and XC, so that the starting point is at D, halfway between A line and C. If the quantity of steam bled remains constant for partial loads, then, by the Willans law, the line through D must intersect the line CX' at N, so that PN equals one-half of XC. From the geometry of the case it follows that DN is parallel to $A'B$ and DN is the Willans Line for the bleeder condition that an amount XR passes out at any load down to P. Below that point, of course, the required quantity cannot be passed out and the heating mains must be supplied from some other source.

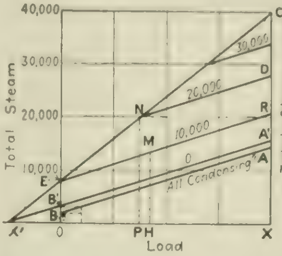


FIG. 3. WILLANS LINES FOR BLEEDER TURBINE

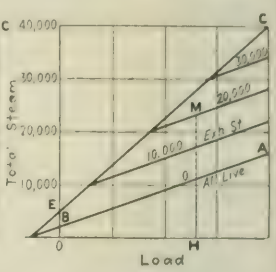


FIG. 4. WILLANS LINES FOR MIXED PRESSURE TURBINE

The chart for mixed-pressure turbines is similar to that for a bleeder turbine. In Fig. 4, CE is the Willans Line for all exhaust steam and AB that for all live steam. For any given amount of available exhaust steam the various Willans Lines are, as shown, parallel to the line AB for all live steam. For example, in the chart if 20,000 lb. of exhaust steam is available, the steam consumption at the load X would be about 28,000 lb., requiring about 8,000 lb. of live steam. At fractional load, say at load H, with 20,000 lb. of exhaust steam available, the total steam requirements would be as represented by HM, or 23,000 lb., and the live steam requirement is 3,000 lb.

The investigation of steam hose, described in a paper by John M. Bierer at the annual meeting of the American Society of Heating and Testing Materials, has for its object a determination of the relative values of seamless tubes compared with multiple-plied tubes, and the relative values of simple plied duck compared with a construction of fewer plies of duck supplemented by plies of braiding. Experimentally, these relations were determined by testing under steam pressure until failure, hose in which all elements were constant in the particular test, except those of which the relative values were to be determined. From the tests, it is concluded: (1) That a steam hose with seamless tube is superior in endurance to a hose with tube built up in plies. This is due to a splitting and separation at the joint necessarily formed in the construction of a plied tube. (2) That a steam hose with its fabric element a simple duck of several sufficient plies is superior in endurance to, and practically as good in contraction and expansion as, a hose made of less plies of duck supplemented by plies of braiding.

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*Abstract of an article in the May 28 issue of *The Engineer*.

Better Utilization of Sub-Bituminous and Lignite Coals*

By S. M. Darling
Fuel Engineer, United States Bureau of Mines

The Nation's coal resources of all ranks total 3,553,637,100,000 minable tons of 2,000 lb., 1,051,290,000,000 tons, or nearly one-third, being lignite. Of this lignite 964,424,000,000 tons is in North and South Dakota and northeastern Montana, approximately 23,000,000,000 tons in Texas, 7,404,300,000 tons in Alaska, and relatively smaller quantities in several of the other Western and Southern states. The lignite tonnage given includes only group 3 (true lignite); it does not include group 2 (sub-bituminous coal), which in earlier days was called "black lignite" and classed with group 3.

TABLE I. AVERAGE PROXIMATE ANALYSIS OF LIGNITE

	Arkansas	Texas	N. Dak.
Moisture, per cent	29.73	28.63	27.13
Volatile hydrocarbons, per cent	37.87	32.53	29.11
Fixed carbon, per cent	23.95	30.43	36.16
Ash, per cent	8.45	8.41	7.60

The Alaska lignite closely resembles that of Texas and North Dakota. The sulphur content of the lignite in these fields rarely exceeds 1 per cent. The average heating value is about 7,500 B.t.u. per pound.

To burn high-volatile coals on furnace grates is wasteful. For many years leading engineers and chemists have decried the waste of burning bituminous coal raw; they have time and again shown that it is far more economical to break up the coal by means of carbonization, into its constituents—solid carbon, gas, ammonia, oils and tars—thus releasing these valuable products for use in their appropriate fields.

Instead of trying to burn the raw lignite in the primitive and wasteful ways now employed, the lignite should be treated so as to yield several products, each peculiarly adapted to a particular commercial need, as follows:

Dried lignite, for use on automatic stokers and in fuel-gas producers. Because of its more or less soft and comminuted condition, the dried lignite cannot be handled advantageously by hand, but it can be used satisfactorily by mechanical means.

Powdered fuel, from the dried, pulverized lignite, for use in cement kilns, under locomotive boilers, and in other large furnaces. Because of its high-volatile content this pulverized lignite makes an exceptionally good powdered fuel. The pulverized lignite can be used also in fuel-oil burners in conjunction with fuel oil. An oil mixture containing 30 per cent dried and finely pulverized lignite will still act as a fluid and can be burned as a liquid fuel. This would not only conserve petroleum resources, but would effect a saving in the cost of raising steam.

Dried lignite briquets, for large hand-fired industrial furnaces and heating plants. Where it is necessary to handle the dried lignite with a fireman's shovel, it should be briquetted. Tests of these dried lignite briquets in commercial boiler furnaces have proved them to be equal to good Middle West bituminous coal. An admixture of about 12 per cent of coking coal in the briquet is essential to hold the briquet together in the furnace.

Sulphate of ammonia and producer gas. The raw lignite, just as mined, when consumed in byproduct gas producers of the Mond type, yields sulphate of ammonia, producer gas, and some tars of undetermined value; there is no solid residue except ash. On the average, lignite carries about 1.40 per cent nitrogen. If this nitrogen were commercially recovered as sulphate of ammonia the yield would be about 70 to 80 lb. per ton of lignite. The gas yield per ton of lignite would be 60,000 to 70,000 cu.ft. of about 140 B.t.u. per cu.ft. This gas could be used as a furnace fuel or in a gas engine to produce power. If used in the latter manner, it would yield 700 to 800 hp.hr. per ton of lignite gasified.

The large way to utilize lignite is to carbonize it; that is, break it up into its four main divisions of gas, oils and tars, ammonia, and solid residue, the latter being practically charcoal. The fact that the lignite does not coke in the sense that bituminous coal cokes, but rather crumbles, on being carbonized, makes possible a continuous and comparatively inexpensive carbonizing process. Moreover, lignite parts with its volatile content more readily than does bituminous coal. And it is not necessary to subject the lignite to the high temperature required to produce commercial coke from coal. The gas is practically all driven off from the coking coal while the charge is still a black, intumescent mass, but it is necessary to carry the temperature several hundred degrees higher to procure a firm, hard coke. This increase in temperature is not necessary or desirable with the lignite. The entire process is mechanical; the fuel need not be handled by manual labor from the time the lignite is loaded into the mine car until the briquets are en route to the consumer. The costly element of labor is reduced practically to that required for directing mechanical operations.

TABLE II. THE PRODUCTS OF CARBONIZATION OF LIGNITE

Gas, per ton of lignite, cu.ft	10,000
Oil and tar, gal	15
Ammoniacal liquor, gal	65
Carbon residue, lb	955

Lignite vs. Coal Gas

	Lignite Gas	Coal Gas
Carbon dioxide	15.9	1.34
Illuminants	3.5	4.42
Oxygen	0.2	0.03
Carbon monoxide	19.5	6.75
Menthane	16.1	34.60
Hydrogen	43.9	59.19
Nitrogen	0.9	2.67
Candlepower	3.2	16.00
B.t.u. per cubic foot	440.0	630.00

A little more than one-half of the gas is necessary to carry on the carbonizing process; the balance can be used as a city gas for cooking, or for lighting if burned in a mantle, or for furnace fuel, or for generating power by means of a gas engine. Or, if desired, the entire 10,000 cu.ft. can be devoted to these purposes, and the carbonizing carried on with lignite producer gas from a fuel-gas producer.

As to power obtainable, of the yield of 10,000 cu.ft. per ton of lignite carbonized, 6,000 cu.ft. are required to carry on the process, leaving a surplus, costing nothing, of 4,000 cu.ft., of 400 B.t.u. per cu.ft., or a total of 1,600,000 B.t.u. A good gas engine uses about 10,000 B.t.u. per horsepower-hour, hence the surplus gas from each ton of lignite carbonized would yield 160 hp.hr. This power is comparable in cost with that derived from natural gas and is fully as cheap as most hydro-electric power.

OIL AND TAR PRODUCTS

Profitable disposition in this country for the oil and tar products remains to be determined. The simple distillation products of the oil can be put to many uses, such as fuel oil for furnaces and internal-combustion engines, gas enriching, flotation and other oils.

From the several fractions, by exhaustive distillation and treatment, there may be derived hundreds of synthetic products in the way of paraffine, acids, antiseptics, photographic chemicals, aniline dyes, perfume, drugs, preservatives, etc.

Light hydrocarbon oils of the class including benzol make a serviceable motor fuel, and their effectiveness is somewhat increased when mixed with gasoline; the light oils from lignite can be used economically in this way and thus in a measure eke out the failing supply of gasoline. The indications are that the consumption of motor fuel within the next decade will be double the present gasoline production. In many quarters alcohol is looked upon as one of the ultimate sources, if not the main source, of motor fuel. Commercial alcohol and gasoline are not readily miscible; alcohol and benzol are; and, after the benzol is added to the alcohol, the mixture will take up a high percentage of gasoline. It may be well that a large use for the benzol production will serve as the connecting link between gasoline and alcohol, aiding in the introduction of alcohol as a staple market commodity.

The ammonia is contained in the gas and gas water; it may be recovered as ammonium sulphate—a valuable fertilizer—as anhydrous ammonia, for refrigeration and other commercial purposes, or it may be treated as a source of ether nitrogen products, some of which are of vital importance in the manufacture of explosives. For the production of power carbonized lignite is fully equal to anthracite, charcoal, or bituminous coke, the standard fuels for such purposes. This carbonized lignite can also be burned satisfactorily on the automatic stokers and grates used to consume the smaller sizes of anthracite.

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*Abstract of paper read before the International Railway Fuel Association, Chicago, May, 1920.

Raw lignite is not serviceable in a locomotive firebox, and it is doubtful whether any form of lignite briquets can be manufactured cheaply enough to compete as a locomotive fuel with the bituminous and sub-bituminous coals now in use. The dried, pulverized lignite can be so used.

Chemical Industries to Play Part in Superpower Scheme

While it is recognized that the railroads must afford the principal market for electric current which may be developed if the Boston-Washington superpower plan should become a reality, it is recognized by those in charge of the superpower survey that the chemical industries will play fully as important a part in the scheme. This is due to the fact that the matter of locating central plants will depend on whether or not they are to be coupled with byproduct plants. The general impression has been that the big power plants would be located at the mine mouth, but if the byproducts of the coal are to be utilized, it is evident that the plant must be near the market for the byproducts. The chemical industries also are being relied upon largely to equalize the load factor. While these industries are large consumers of current, it is believed that they can arrange to take their maximum requirements at night and their minimum requirements during the hours of peak loads.

The survey will take into consideration the possibilities of developing nitrogen fixation. The possibilities of attracting electric smelting and refining industries and other power-consuming activities, including the heating of glass, will be given careful and prompt consideration.

An interesting incident of beginning the study of the load factor is the fact that the peak load in New York City for the week is on Tuesday morning, when the principal portion of the week's ironing is done.

Government Coal Inspection

Government inspection of coal came a step nearer realization recently when the Sewells Point Tidewater Coal Exchange entered into negotiations with the Bureau of Mines for just the sort of classification of coal on a scientific basis as was in mind when the fuel inspection bill was drafted. That bill never was introduced, due largely to the hostility of coal producers. Apparently there is a trend among producers to accept the contention that the proper classification of coal is a producer's problem. It is admitted that the glaring weak point in the war-time Tidewater Coal Exchange was the lack of a thorough coal classification. This depends on inspection and analysis. When iron ore sold for less than the present price of coal there was absolutely no thought of selling it without its having been analyzed. Coal producers are beginning to see, it is believed, that they have a valuable commodity which should be sold on the basis of an analysis.

Oil Engine Installations

A misconception exists among engineers as to the total amount of oil engine installations in the United States. The figures given below closely approximate the total horsepower installed; the errors are slight and are due to lack of data from two or three minor manufacturers. Motorship installations are not included.

Diesel Oil Engines	255,000 horsepower
Surface-Ignition Oil Engine	752,300 " "

Of the Diesels at least 10 per cent have been replaced by more modern engines. While no data is available in respect to the surface-ignition plants which have been replaced or discarded, probably 10 per cent of them are no longer in use. If the average fuel consumption is 7½ horsepower-hours per gallon of fuel, the yearly requirements would total 20,000,000 barrels of fuel. In view of the enormous consumption of gasolene in the automobile industry, it is apparent that the oil engine demand plays but a small part in the oil industry.

British Regulating Coal Export

The amount of coal being exported from British ports is being regulated by the Government to the last pound. The British exports for March and April of this year compared with 1913 were as follows:

	1913	1920
March	5,598,775	2,406,151
April	5,929,947	2,139,261

That there is a vast difference between the policy of the British Government and ours can be seen from the fact that America's coal is being offered by British operators and factors all over the world.

Rodding of concrete consists in repeatedly pushing a pointed rod into the concrete. This has the effect of expelling the entrapped air and excess water and of compacting the concrete. In so doing, the strength of the concrete is materially increased. The beneficial effect of rodding was noted in a number of experiments made in 1917 by G. A. Parkinson, assistant testing engineer, University of Texas. Since then, other tests have been made which demonstrate further the advantages of rodding concrete. Three series of these tests are described in a paper, by F. E. Giesecke, presented at the annual meeting of the American Society of Heating and Testing Materials. The first series is intended to show the general effect of rodding. The second series of tests is an investigation into the effect of the number of and the interval between roddings. In the third series concretes of different cement content are investigated, to determine the relative effect of rodding on each. In all the tests it is conclusively demonstrated that rodding substantially increases the strength of concrete. In many cases this increase is more than 100 per cent. It is therefore seen that rodding has an important bearing on actual construction, either by increasing the strength of the concrete or by effecting a saving in cement.

Geological Survey figures show a total bituminous-coal production of 10,225,000 net tons during the week ending July 3; 305,000 tons less than the preceding week. Production during the first 158 working days of the last four years has been as follows: 1917, 278,000,000 tons; 1918, 288,000,000 tons; 1919, 218,097,000 tons; and 1920, 262,727,000 tons. The year 1920 is thus 15¾ million tons behind 1917 and 26¾ million tons behind 1918, but is over 40 million tons ahead of 1919. Production of coal in the United States for the first six months of the present year is estimated by the Geological Survey as follows: January—Anthracite, 7,366,000 tons; bituminous, 48,698,000 tons. February—Anthracite, 6,335,000 tons; bituminous, 40,127,000 tons. March—Anthracite, 7,240,000 tons; bituminous, 46,792,000 tons. April—Anthracite, 6,543,000 tons; bituminous, 37,939,000 tons. May—Anthracite, 7,745,000 tons; bituminous, 39,753,000 tons. June—Anthracite, 7,641,000 tons; bituminous, 43,710,000 tons.

Reports to the Interstate Commerce Commission and to the Car Service Commission indicate that there has been a very decided improvement in car supply at all mines from Illinois eastward. On many railroads, all records for daily loadings have been broken. Better dumpings are reported at lower Lake ports. Even the Pennsylvania Railroad, after having piled up a deficit of more than 5,000 cars, is now meeting its late obligations. In order to do this, the Pennsylvania lines have had to embargo considerable other business and have had to eliminate the return loading of coal cars in many instances.

An estimate made for the National Coal Association places at $200,000,000 the additional freight which will be paid on coal, as the result of the railroad rate increase.

Society Affairs

The Pennsylvania Electric Association has arranged to hold its annual convention at Bedford Springs, September 8-11 inclusive.

The Michigan Section, N. E. L. A., will hold its convention at Ottawa Beach, Mich., Aug. 24-26. Papers and addresses on many subjects of interest to the public utility industry will be delivered.

The Cleveland Engineering Society will make its mid-summer trip to Detroit Friday, August 27-29. Members making the trip will be the guests of the Detroit Engineering Society on August 28. Visits will be made to the Ford Blast Furnace Plant and the Ford Motor Co.

The Executive Committee of the Southeastern Geographic Division of the N. E. L. A., which comprises the states of Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee and Porto Rico, has voted to hold its 1920 Convention at Miami, Fla., on Nov. 17 to 19 inclusive.

The New England Division of the National Electric Light Association will hold its twelfth annual convention at Mount Kineo House, Kineo, Me., Sept. 13 to 16 inclusive. An interesting program to include sports and dancing has been arranged and a number of important papers will be read.

The Northwest Electric Light & Power Association will meet at Spokane, Washington, Sept. 8 to 11. Franklin T. Griffith of the Portland Railway Light & Power Co. will address the meeting on the subject of "Successful Public Utility management of the Future." Other interesting papers will follow and the reports of various committees will be read.

The Nebraska Section of the National Electric Light Association has arranged to hold its annual convention in Omaha, Sept. 8 and 9 at which time reports of the activities of the section during the past year will be read and action taken that will result in the Nebraska Section becoming a part of the Middle West Geographic Division of the N. E. L. A. This Division will consist of the states of Iowa, Missouri, Kansas and Nebraska.

The Public Relations section of the N. E. L. A. appointed committees dealing with all phases of public relations at the second meeting of the Executive Committee at Toledo, Ohio, Thursday, Aug. 19. The full program of the Section was outlined and discussed, particular attention being given to the publicity program already tentatively arranged, and which will begin immediately following the meeting.

The American Peat Society will hold its thirteenth annual meeting at Madison, Wis., Thursday, Friday and Saturday, Sept. 2 to 4. Headquarters will be at the Park Hotel where special rates to members have been obtained by the entertaining committee. Papers will be read and excursions have been planned to give members the opportunity of observing growing crops on peat lands in the vicinity of Madison.

The 1920 Annual Meeting of the The Americn Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th Street, New York City, from December 7th through to December 10. Sessions will be held on the subjects of Appraisal and Valuation and the Application of Engineering to Woodworking. The newly founded professional sections on Management Power, Fuels, Machine Shop, Railroads and Textiles will also conduct sessions to consider the vital problems in their field. In addition a number of valuable papers will be presented at General Sessions. A memorial session for Dr. Brashear is planned, as a fitting tribute to his life and work.

The American Welding Society at a meeting of members of the welding trade in Chicago, held in the rooms of the Western Society of Engineers, on Tuesday evening, Aug. 3, organized a Chicago Section of the society. There were about seventy-five in attendance, representing many railroads terminating in Chicago, and also many of the larger local industries. The following officers and directors were elected: Chairman, M. B. Osburn; vice-chairman, O. T. Nelson; secretary-treasurer, L. B. Mackenzie. Directors, E. Wanamaker, H. B. Bently, Andrew Oliver, W. M. Brady, Harold Cook, W. A. Slack, K. R. Hare, J. M. Jardine, W. H. Bleecker, Jr., Oliver Mitchell, Walter L. Senhort, Don B. McCloud.

Meetings will be held on the second Tuesday of each month in the rooms of the Western Society of Engineers, and those interested in the subject of autogenous welding by all methods are invited to attend.

Personals

Lorin E. Imlay has been appointed division engineer in charge of the power transmission division of the super-power zone engineering staff.

W. H. Edmundson, chief engineer at the Old Colony Brewery, Fall River, Mass., for the last two years, and chief engineer of the U. S. S. "Philippine" during the war, has accepted a position with the New England Oil Refinening Co., of the same city, as mechanical superintendent.

Irving E. Moultrop, assistant superintendent of the constructional Bureau of the Boston Edison Electrical Illuminating Co. has been elected as a member of the Engineering Foundation Board by Engineering Council to succeed the late E. Gybbon Spilsbury.

George M. Bassford, president of the Locomotive Feed Water Heater Co., New York, and formerly a member of the American Society of Mechanical Engineers Council has been elected a trustee of the A. S. M. E to succeed the late E. Gybbon Spilsbury to serve the unexpired portion of the term ending January, 1923.

New Construction

PROPOSED WORK

N. H., Portsmouth—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for removing and reconstructing 2 boilers with stokers and stoker engine at the Navy Yard here from Frank Eisinger, 141 7th Ave., Brooklyn, New York City, $26,553; Shevlin Engr. Co., 110 West 34th St., New York City, $64,758.

Mass., Attleboro—William R. Walker & Son, Archts., 17 Custom House St., will soon award the contract for a 4 story, 95 x 140 ft. bank and office building including a steam heating system on Park St. for the 1st Natl. Bank.

Mass., South Byfield—The Dummer Academy plans to construct a central heating plant, etc. About $250,000. Noted July 20.

Conn., Windsor—The School Comn. will receive bids until September 7 for a 2 story, 90 x 155 ft. high school including a steam heating system. About $200,000. S. Brown, Chn. Whiton & McMahon, 36 Pearl St., Hartford, Archts.

N. Y., Great Neck, L. I.—The Bd. Educ. will soon receive bids for two 2 story schools including steam heating systems. About $400,000. F. Dickerson, Pres. W. S. Bessell, 56 West 45th St., New York City, Archt. and Engr.

N. Y., New York—The New York Edison Co., Irving Pl. and 15th St., is having plans prepared for a transformer station on 75th St. About $500,000. W. Whitehill, 12 Elm St., Archt. and Engr.

N. Y., New York—The Wendel Estate, c/o R. D. W. Swopl, 175 B'way, is having plans prepared for a 6 story loft and office building including a steam heating system at 444 5th Ave. About $500,000. John B. Snooks & Sons, 261 B'way, Archts. and Engrs.

N. J., Homestead (West Hoboken P. O.)—Andrews, Tower & LaValee, Archts. and Engrs., 33 Lyman St., Springfield, Mass., will soon award the contract for a 5 story, 85 x 205 ft. factory including a steam heating system for the Amer. Chocolate Products Co., 206 B'way, New York City. About $350,000.

Pa., Bellevue (Pittsburgh P. O.) — The School Dist. will receive bids until August 30 for two 25 hp., 1,200 r.p.m., 3 phase, 60 cycle, 220 volt slip ring motors with variable speed controller, bed plates and pulleys. Address James W. Graham, 545 Teece Ave., Secy.

Pa., Philadelphia—The American Coal & Ice Co., c/o Isaac Stevens, 4651 Pa[illegible] St., is in the market for machinery for the manufacture of ice.

Md., Baltimore—The Bd. of Awards, c/o City Register, will soon award the contract for furnishing and installing new cast-iron, hot water, sectional manifold water tube boiler, etc., in the palm house here. W. F. Courts, Madison Ave., Park Engr.

Md., Orangeville (Baltimore P. O.)—The Columbia Graphophone Co., Woolworth Bldg., New York City, plans to install a 7,000 hp. generator at its plant here. Noted March 30.

Va., Portsmouth — Irving D. Ireland, Archt. and Engr., will receive bids until August 25 for a 30-ton ice-making plant and a 50-ton cold storge plant. Owner's name withheld.

Va., Richmond—The Colonial Pressing & Cleaning Co., 1639 West Broad St., is in the market for one new or used steam pressing machine, Hoffman preferred. L. S. Chatman, Mgr.

Va., Richmond—The Mullin Motor Garage Co., 436 West Main St., is in the market for an electric motor. L. A. McMullin, Mgr.

Va., Richmond—Stebbing & Paulie, 1643 East Broad St., is in the market for electric motor, vises and air compressor. New or used.

Miss., Tunico—The city will receive bids until September 8 for a 100,000 gal. reservoir, triplex pumping unit and pump house including a 380 g.p.m. triplex pump and crude oil engine. About $15,000. A. L. Dabney, Randolph Bldg., Memphis, Tenn., Engr.

Tenn., Sweetwater—The Durex Chemical Corp. is in the market for 400 hp. additional boilers. H. B. Gilman, Mgr.

O., Cleveland—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will soon award the contract for furnishing and installing one new horizontal tubular return high pressure boiler at the U. S. Marine Hospital, East 9th St. and Lakeside Ave., here.

Ind., Richmond—The Wayne Co. Memorial Comm. is having plans prepared for a 4 story, 150 x 250 ft. memorial building including a low pressure heating system, etc. About $600,000. Study & Farrar, Arcade Bldg., St. Louis, Mo., Archts.

Mich., Detroit—Baxter, O'Dell & Halpin, Archts., 1024 Hammond Bldg., will soon award the contract for a 1 story, 65 x 100 ft. factory including steam heating equipment for the Amer. Machine Products Co., 18th and Howard Sts. About $45,000.

Mich., Detroit—The Detroit Council 305 Knights of Columbus Bldg. Co., 930 Woodward Ave., plans to build a 3 story clubhouse including steam heating equipment. About $500,000.

Mich., Detroit — The Natl. Alloys Co., Woodbridge St., plans to build a 1 story, 60 x 100 ft. foundry including an electric motor for power, etc. About $25,000. Horace H. Lane, Dime Bank Bldg., Engr.

Mich., Sunfield—The village plans to vote on a $15,000 bond issue for an electric light plant including equipment. W. R. Clark, Albion, Engr.

Ill., Harvey—The Whiting Fdry Equipment Co. plans to build a boiler room and is in the market for 2 new 506 hp. boilers. A. J. Haines, Asst. Supt.

Wis., Hartford—The Bd. Educ. plans to build a 4 story, 130 x 300 ft. junior high school including a steam heating system. About $500,000. Judge Sawyer, Chn.

Wis., Peshtigo—The Oconto Service Co. is having plans prepared for a 26 x 29 ft. addition to the power house. T. A. Pemperin, Pres. Mead & Seastone, Madison, Engrs.

Ia., Mason City—The Masonic Cathedral Association plans to build a masonic temple including a steam heating system. About $250,000.

Ia., Vinton—The city voted $45,000 bonds to build additions to the waterworks and electric light and power plant. A new engine and generator will be installed in same.

Minn., Cannon Falls—The Cannon Falls Milling Co. plans to build a dam to furnish power for its use along the Cannon River here. E. O. Holmsted, 822 Flour Exch., Minneapolis, Mgr.

Kan., Bonner Springs—The Bonner Portland Cement Co., 900 Victor Bldg., Kansas City, Mo., plans to install transformers in its station here. P. R. Ladd, Chief Electrician.

Kan., Salina—The Weslyan University is having plans prepared for a college building. Plans include an addition to the power plant. About $100,000. Study & Farrar, Arcade Bldg., St. Louis, Mo., Archts.

Neb., Atkinson—The City Clerk will receive bids until August 28 for a power house, etc., in connection with the proposed waterworks improvements. About $25,000. W. E. Standeven, 616 Peters Trust Bldg., Engr.

S. D., Volga—The city had plans prepared for an electric light plant.

N. D., Grand Forks—The North Dakota Industrial Comn. will receive bids until August 30 for installing piping and all auxiliary equipment in power plant at terminal elevator here. C. L. Pillsbury Co., 805 Metropolitan Life Bldg., Minneapolis, Minn., Engr.

N. D., Minnewaukan—The village will received bids until September 8 for the installation of an electric light plant.

Mo., Carthage—The city sold $100,000 bonds to enlarge the water and electric light plant. John N. Marsh, Treas.

Mo., St. Joseph—The Western Tablet Co., 11th and Mitchell Sts., will receive bids about September 15 for a power house. About $35,000. R. and E. R. Meier, 203 Lincoln Bldg., Archts.

Okla., McAlester—The Abbort Pike Lodge is having plans prepared for a 5 story Masonic temple including a steam heating system. About $500,000. Thompson & Harding, 504 Southern Trust St., Little Rock, Ark., Archts.

Okla., Oklahoma City—The Missouri, Kansas & Texas Ry. of Texas and the Wichita Falls & Northwestern Ry., Ry. Exch. Bldg., St. Louis, Mo., plans to build several buildings including a machine shop and power plant, etc. F. Ringer, Chief Engr.

Okla., Tulsa—The 1st Methodist Episcopal Church will soon receive bids for a church including a steam heating system. About $250,000. Wight & Wight, 400 1st Natl. Bank Bldg., Kansas City, Mo., Archts.

Okla., Tulsa—Thompson Bros. and Hughes will receive bids until September 1 for a 10 story, 100 x 200 ft. office building including a three boiler heating plant. About $750,000. Herbert L. Bass, 801 Hume Mansur, Indianapolis, Ind., Archt.

Cal., San Francisco—The Amer. Can Co., 120 B'way, New York City, is having plans prepared for a factory including a steam heating system. About $500,000.

Ont., Ford City—The Fisher Body Co. of Canada plans to build a 4 story, 90 x 192 ft. factory including a steam heating boiler, etc., on St. Lukes Rd. Albert Kahn, Walker Rd., Walkerville, Archt.

Ont., Owen Sound—The Lovat Brick & Tile Co., Lovat, plans to rebuild its plant which was recently destroyed by fire and is in the market for a boiler and engine, etc. About $20,000.

CONTRACTS AWARDED

Me., West Pownal—The Maine School for the Feeble Minded has awarded the contract for an extension to the heating plant to the Johns-Manville Co., 55 High St., Boston, Mass., and the Willy Calhoun Co., Portland, Me., at $25,000.

N. H., Nashua—The Nashua Mfg. Co. has awarded the contract for altering the boiler plant to the Nashua Bldg. Co., 95 Temple St., at $25,000.

Mass., Arlington—The Bd. Educ. has awarded the contract for the installation of a heating and ventilating system in the proposed junior high school here to the Ross, Chase Co., 263 Sumner St., Boston, at $27,958.

Mass., Cambridge—The City Hospital has awarded the contract for the installation of a steam heating system in the proposed 3 story, 77 x 140 ft. hospital on Cambridge St. to Lynch & Woodward, 287 Atlantic Ave., Boston, at $16,670.

Mass., Stoughton—The Panther Rubber Co., Suffolk St., Chelsea, will build a 2 story, 60 x 70 ft. manufacturing plant addition including a steam heating system on Monk St. About $350,000. Work will be done by day labor.

Mass., Taunton—The Municipal Lighting Comn. has awarded the contract for an addition and extensive improvements to the electric plant on West Water St. to the Westinghouse Electric Co., 6905 Susquehanna St., Pittsburgh, Pa., at $400,000. Noted July 20.

Mass., Quincy—The Bethlehem Shipbuilding Corp., Fore River, has awarded the contract for a 1 story, 22 x 35 ft. addition to its power house, etc., to the Aberthaw Constr. Co., 27 School St., Boston, at $75,000.

R. I., Phillipsdale—The Amer. Electrical Wks. has awarded the contract for a 1 story, 15 x 40 ft. transformer building to Bowerman Bros., 630 Grovenor Bldg., Providence.

N. Y., Brooklyn—The Kalman Constr. Co., 1779 Pitkin Ave., will build a 1 story, 100 x 150 ft. garage including a steam heating system on Avenue J. About $300,000. Work will be done by day labor.

N. Y., Brooklyn—The New York Edison Co., Irving Pl. and 15th St., will build a sub-station on Grand Ave. Work will be done by day labor.

N. Y., New York—The New York Edison Co., Irving Pl. and 15th St., will build a transformer station on the Bowery. Work will be done by day labor. Noted June 8.

N. Y., New York—The New York Edison Co., Irving Pl. and 15th St., will build a sub-station on Cedar St. Work will be done by day labor. Noted April 27.

N. Y., Yonkers—The Yonkers Electric Light & Power Co. has awarded the contract for the construction of a transformer station on Dunwoodie Ave. to Fitzpatrick & McArthur. Noted June 8.

N. J., Dover—The Construction Division, War Dept., Wash., D. C., has awarded the contract for a small heating plant at the Picatinny Arsenal to Lustig & Weil, 103 Park Ave., New York City, at $12,300.

N. J., Newark—The Clark Thread Co., Clark and Ogden Sts., has awarded the contract for two factory buildings including a steam heating system to John W. Ferguson, United Bank Bldg., Paterson.

Va., Hampton Roads—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has awarded the contract for an electric underground distributing system at the Naval Operating Base here to John R. Proctor, 74 Cortlandt St., New York City, at $34,880. Noted March 30.

Ala., Florence—The United States Engineer's Office, War Dept., Wash., D. C., has awarded the contract for 4 generators, etc., for the Wilson Dam to the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., at $779,400.

Ill., East St. Louis—Darling & Co., 4201 South Ashland Ave., Chicago, has awarded the contract for a fertilizer plant including a high pressure steam heating system to the Austin Co., 208 South La Salle St., Chicago, at $500,000.

Ill., Hillsboro—The Bd. Educ. has awarded the contract for a 2 story, 150 x 150 ft. high school including a low pressure heating system and power plant to Jesse Gedney, Arcade Bldg., St. Louis, Mo., at $201,214.

Ill., Melrose Park—The Heppes Nelson Roofing Co., 4500 Filmore St., has awarded the contract for a roofing manufacturing plant including a 1 story, 50 x 60 ft. boiler house, etc., to the Austin Co., 208 South La Salle St., Chicago, at $400,000.

Minn., Albert Lea—The city has awarded contract for 2 motor driven centrifugal pumps with automatic controls, 2 air compressors and 2 motors with belt drive, 1 horizontal driven double suction centrifugal pump, etc., to John W. Hildred & Co., 33 East 3d St., St. Paul, at $6,210. Noted June 29.

Minn., St. Paul—The Bd. Educ., City Hall, has awarded the contract for the installation of a steam heating system in the proposed 2 story, 60 x 128 ft. school on Hamline Ave. between Jefferson and Lansing Sts. to the Hankee Heating Co., 925 Merchants' Natl. Bank Bldg., at $14,814. Noted July 27.

Kan., Salina—The Masonic Temple Association has awarded the contract for a 5 story Masonic temple including a steam heating system to the Eberhardt Constr. Co. at $750,000.

Mo., Kansas City—The Kansas City Light & Power Co., 3rd and Lydia Sts. has awarded the contract for a 2 story, 46 x 57 ft. sub-station to the Fogel Constr. Co., 618 Reliance Bldg. Noted July 20.

Ore., Portland—The Amer. Can Co., 120 B'way, New York City, has awarded the contract for a factory including a steam heating system to A. W. Quist at $750,000

NEED COMPETENT MEN?

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POWER

Volume 52 New York, August 31, 1920 Number 9

I am Power

By Ralph B. Mix

LONG ages have I roamed the Universe, at will. Hither and yon, free and unchecked, Monarch of Earth, and Sky, and Sea. I dwell in the air, among the stars, in the seas, and in every atom and molecule that makes up this place that Man calls Earth. I am omnipotent, and omnipresent.

For ages have I watched the puny efforts of Man, and laughed him to scorn. I used to roam about his habitation, Earth, peeping at him from every rock, and tree; darting down to him from the skies; mocking him, and challenging him to follow me. Yet Man knew me not. His eyes were blinded with a false sense of his own greatness. He gloried when he had felled a single tree, and lo, I swept a forest from my path. He moved a rock, by dint of much effort, and lo, I moved a mountain from its base. He travelled a few weak miles in a day, and lo, I flashed across a continent in an instant. He piled a few rocks and trees upon each other, and called it a home, and lo, I dwelt in the Infinite Spaces of the Unknown.

Man was my slave, my plaything. He bowed down to me and obeyed my will. I tore his habitations, the works of his hands, from their places. I destroyed him with fire. I took his life. I was at once his Master, and his God.

Then Man began to think. One day I was roaming the Heavens, as was my wont; darting to Earth and back again, in capricious freedom, toppling over the works of Man, as a teasing youth would topple over the block castles of a child, when Man, my slave cried out as I passed, "Come hence. I would know you better." I was appalled at his audacity, furious with anger. I rushed Earthward, vowing to myself, "Now will I destroy this Fool, once and forever." And lo, I could not. For Man had discovered my secret powers. Man had begun to think.

And now, alas, what has Man done. He has rebelled against me, captured me, and made me his slave. He has taken away my right to destroy at will. He has perfected methods, whereby his handiwork is protected from my caprices. He has chained me to every Man-made device known to him. I serve him in city, town and hamlet. I run his factories, and I work his farms. I toil where once he labored by the sweat of his brow, while Man sits by, and controls me with a touch. I gave him light to add more hours to his day. I prepare and cook his foods. At his bidding I exhilarate Life, and at his bidding I destroy life. I carry his voice from ocean to ocean, and from continent to continent. I lift him, and convey him o'er land and sea, yea even through the skies, where once I reigned supreme. Daily, he is devising new tasks, new duties, for me, seeking to find my limitations, that he in turn may laugh. But, Ah! he never can.

Man, with all his new found talents, can never conquer me. Let him study and experiment. I shall remain a Mystery. Let him seek to destroy my limitations. I have none. I am omnipotent. I am All and in All. Let him devise new tasks and new labors for me, daily, for a million years. I shall carry them all into fulfillment and laugh. Man has chained me, made me his slave, yet never will he understand, whence I came or whither I go. Man still bows in admiration before my accomplishments, and still I laugh. Man has controlled, but he can never conquer.

I AM POWER.

Soot and Its Abatement by the Use of Salt

By B. S. Murphy
Superintendent of Power, Hudson and Manhattan Railroad Company

Soot, in its broader sense, includes all solid matter that leaves the ignited fuel bed with the gaseous products of combustion. This article discusses how the amount and character of this material varies with the kind and size of coal, rate of forcing fire and character of service. Some of the troubles due to soot are explained and the method of treatment and results from using common salt are given from actual experience in a large railway power plant.

The Jersey City Power Station of the Hudson & Manhattan Railroad is an anthracite-burning plant using the small steam sizes of coal, and on account of the high draft necessary to get the desired rating—200 per cent or over—a large amount of the minute coal particles, more or less consumed, are blown out of the boiler furnaces and lodge on the heating surfaces as flue ashes or soot. Some eighteen months ago we made experiments on the removal of this material by means of the gases produced by the burning of common salt in the boiler furnaces. These experiments were so successful that they have been incorporated as part of our regular boiler-room routine. Though all our experiments were with anthracite, the results would without doubt be applicable to bituminous coal, which gives a different soot-end product.

True soot is an amorphous carbon, but in the following we will use the term in a much broader sense. We will consider that soot is all the solid matter that leaves the ignited fuel bed with the gaseous products of combustion. Part of this solid matter will be combustible; this will be carbon deposits in some form, and the rest will be more or less incombustible "flue ash." The carbon deposits will be those that escape combustion in the furnace and find lodgment in such locations that there is not enough heat to ignite them or there is insufficient oxygen to support the combustion if ignited, this latter being due in many instances to the covering of the carbon after lodgment with an insulating layer of ash from itself or by further deposits of soot in the form of flue ash. The kind of fuel and the nature and magnitude of its impurities will be the controlling feature in the type of soot deposited, and the amount of these deposits will be governed by the kind and size of the fuel and the operating furnace conditions.

Bituminous coal or fuel oil will give the true soot or amorphous carbon. The greater the amount of volatile matter the greater will be the quantity given off, and the poorer the furnace condition the greater will be the quantity of carbon that will not be ignited but will be deposited on the relatively cool heating surfaces and, being a good insulator, will have a tendency to still further decrease the furnace economy. If the furnace condition is as good as possible, some combustion will take place in this mass and the result of this will depend on characteristics of the impurities. If the fusing temperature of these impurities is relatively low, clinker will form, which will in time bridge from tube to tube, seriously increasing the resistance to the passage of the flue gases. On the other hand, with other combinations of impurities the soot may burn to a soft dust, which, while an insulator to heat, does not adhere so strongly as the clinker or carbon soot.

The soot-end product from the combustion of anthracite will be in a variety of forms that will not have much resemblance to each other. The combustible soot, in place of being the soft sticky flakes of amorphous carbon, will as a rule be small, hard, tough granules of coke. The extent of this deposit will depend on the size of coal and the combustion rate, and for the small sizes and high rates there will be enormous quantities to be disposed of, much greater than will be found with the soft coal in stationary practice, and as a rule much greater than the non-combustible portion. To give some idea of the quantity of this combustible soot and its heat content, when the Jersey City Station boilers were hand-fired a serious attempt was made to reburn this soot, and it may be of interest to note the results of a boiler trial with soot as a fuel. The general boiler data are given in Table I.

TABLE I. HAND-FIRED BOILER DATA

Make	B. & W. 900 hp. horizontal water tube
Working pressure, lb. sq in	180
Heating surface	Four drums, 42 in. dia. x 23 ft. long; 432 4-in. tubes, 18 ft. long. Total surface, 9,000 sq.ft.
Grates	Four doors per boiler, 190 sq.ft. of surface, inclined dumping grates.

The boilers at this station were erected with the soot requirements in view and have an extra-large combustion space in back of the bridge wall, which has a chute at the bottom leading to the narrow-gage ash tracks in the basement. The soot from these chambers was run into the ash cars and from them dumped into the coal hoist and elevated to a special bunker, then passed through a grinder, where it was mixed with bituminous coal and then hand-fired in the regular manner. The results of one of several of such trials is given in Table II.

TABLE II. TEST WITH SOOT AS FUEL

Date	Dec. 4, 1912
Duration of test, hours	8
Dry soot fired, lb	23,196
Bituminous coal mixed with soot, lb	4,446
Bituminous coal mixed with soot, per cent	16.2
Total fuel, lb	27,642
Actual water evaporated, lb	208,894
Actual evaporation per pound of mixture, lb	7.55
Water evaporated from and at 212 deg. F., one pound of mixture	8.40
Boiler horsepower developed	843
Corresponding rating, per cent	93.9
Ash, ratio of weight of refuse from the ashpit to the weight of the mixture, per cent	14
Soot, ratio of the weight of soot removed from the rear connections to the weight of mixture, per cent	17
Refuse, total of ash and soot, per cent	31

From these data and comparisons of costs it would appear that we could almost cut the fuel cost in two by the use of the soot mixed with the bituminous coal as a binder. However, in 1913 we had to abandon this, as the firemen were working in this soot up to their shoe tops at all times and could not be induced to continue the work. In smaller plants it could be used by mixing in with the anthracite coal on the floor, but in these cases the boiler rating is usually too low to make large quantities of soot. In large installations if a cheap binder was available it would make good briquets.

THE INCOMBUSTIBLE PORTIONS OF SOOT

The incombustible soot from anthracite resembles the bituminous flue ashes chemically, but is found in a vast variety of different forms—red, brown, gray and black granules or in dust of these colors, and also forms the clinker on the heating surfaces or furnace masonry and is equally as good an insulator for heat transfer. The form varies with the size of the coal particles and the furnace-operating conditions, while the color will depend on the chemical make-up of the impurities. The formation of the clinker will depend on the furnace temperature and on the fusing point of the ash.

There is little to choose between the incombustible anthracite or bituminous soot. The combustible soft-coal soot adheres to and covers more surface than that from hard coal and is, perhaps, for this reason, a better heat insulator, but the latter under high rating is vastly more in volume, in stationary plants, and for this reason is more bothersome.

THE SOOT PROBLEM IN LOCOMOTIVE PRACTICE

In locomotive practice, with the extremely high rates of combustion and the necessary draft, great quantities of soot are made with soft coal—quantities that equal in volume, if they do not exceed, that from the small sizes of anthracite in stationary plants. Some interesting data were found on the magnitude and make-up of this locomotive soot during the locomotive tests of the Pennsylvania Railroad in St. Louis in 1904. At the locomotive test plant the engines were so arranged that all the soot would be retained. Before the test started, the front end was cleaned, and after the run the resultant accumulation of cinders was removed and weighed. The lighter portions or sparks were caught in a smoke jack arranged with baffles and located over the locomotive stack. The combined weight of these two gave the amount of soot for the trial. The quantity was found to vary with the type of locomotive and in the same locomotive with the speed and load. In fact, many tests had to be abandoned on certain engines, owing to the front end filling up to such an extent as to completely kill the draft. This was especially true on the German engine tested, and to some extent on a French engine, as both of these were designed to use briquets in place of the run-of-mine bituminous used at the plant.

LOCOMOTIVE SOOT DATA

To give an idea of the soot features of locomotive practice, Table III shows a rather excessive case found in testing the DeGlehn four-cylinder balanced compound, Atlantic-type engine, P.R.R. 2512, Test 510. This pictures the locomotive soot question in a most severe case. Ordinarily, the percentage of the front-end refuse would run about the same as for an anthracite stationary installation with the small sizes and high ratings, say from 5 to 12 per cent for the fuel fired. The calorific value of the soot given is rather lower than the average, and the variations will be from these figures to as high as 13,000 B.t.u. for coal of about the value given in the table.

In firing anthracite coal the amount of soot depends largely on the draft. Under hand-fired conditions the draft will depend largely on the load and to a certain extent on the burning characteristics of the fuel. At the Jersey City station hand firing was originally employed, using screenings of about the following make-up: 2 per cent through a 9/16-in. and over a 9/32-in. screen, 4 per cent through 9/32-in. and over 5/32-in., 39 per cent through 5/32-in. and over 3/32-in. and 55 per cent through 3/32-in. The load had morning and evening peaks requiring operation at 120 to 130 per cent of rating for periods of 1½ hours. To carry this load required a draft of 6 to 7 in. of water, and a large amount of leveling of the fires was necessary.

TABLE III. LOCOMOTIVE CINDERS AND SPARKS

Speed of locomotive, equivalent m.p.h.	57.4
Revolution of drivers, r.p.m.	140
Draft in smoke box, w.g. inches	1.64
Furnace temperature, deg. F.	1,737
Smoke-box temperature, deg. F.	558
Rate of combustion, dry coal per square foot of grate surface per hour, lb	52.74
Duration of test, minutes	120
Coal fired, lb	3,651
Cinders and sparks (soot), lb	1,227
Cinders and sparks, per cent of coal	33.6
Kind of coal	Scalp level—run-of-mine bituminous
Calorific value, dry coal, B.t.u. per lb	14,892
Calorific value of cinders, B.t.u. per lb	10,655
Calorific value of sparks, B.t.u. per lb	8,958

SPECIFIC FIRING CONDITIONS FAVOR THE FORMATION OF SOOT

The condition in the furnace became analogous to the burning of pulverized fuel, a relatively large amount of the coal never striking the grates at all, but igniting in the air as it left the fireman's scoop. Some particles are completely consumed in this manner, while others are only coked and are carried by the excessive draft over the bridge wall, where some lodge. The rest goes through the different passes with more or less finding lodgment on the heating surfaces; a still smaller amount lodges in the economizer, and finally some goes up the stack. Every time the leveler is used, it stirs up a small cloud of minute coal particles, and of course whenever a hole develops in the fuel bed, a miniature volcano is formed, adding its quota to the mass of suspended fuel.

The result of all this was that we had to contend with enormous quantities of flue ashes and coked coal, which at times would be as much as 12 per cent of the fuel fired. Our boiler installation was designed with this in view, and we have extra-charge soot chambers back of the bridge wall connected by pipe chutes with the ash basement, so that this accumulation may be run off two or three times a day the same as the furnace refuse. This took the bulk of the soot, although there was a large quantity that never reached the soot chamber but lodged on the tubes. This we attempted to remove with a hand lance, the boilers not being equipped with mechanical soot blowers.

EFFECT OF STOKERS ON THE SOOT PROBLEM

These boilers have now all been equipped with stokers, and the formation of soot is reduced in quantity. There is not the original opportunity for the air to get under the small coal flakes as they enter the furnace, and as there is no leveling required the surface of the fire is not being continually agitated and the small particles broken loose. On the other hand, the stokers are worked to higher ratings, over 200 per cent, for longer time periods, and even with the most careful regulation of the air and the depth of the fuel a certain amount of the coal is always being blown off.

The result is that from a maximum of 12 per cent and an average of about 6 per cent, with hand fires, the amount that we can classify as soot with the stokers has been reduced to about 7 per cent as a maximum and 3 per cent as an average. However, that is not all gain, for some of the soot is now mixed with the ash, having a tendency to increase the combustible in the ash. This is due to the ash space at the back of the grates that allows the soot that falls short of the bridge wall to fall into the ashpit. From this it is apparent that a considerable step in the soot reduction with anthracite is the doing away with hand fires and going to stokers, but there is still enough made to impair the steaming quality of the boilers by insulating the heating surfaces and choking off the draft.

A New Trouble Peculiar to Stoker Operation

There is, however, another trouble with soot that bothers more with stokers than with hand-fired boilers; that is, the formation of long clinker, or what is locally known as "whiskers." These clinkers start at the side walls, arches or tubes and grow until at times they are 6 in. long on the side walls and 18 to 24 in. on the arches or tubes. The side-wall formation interferes with the contour of the fire and at the same time causes holes through the fuel bed along the sides of the grates, and of course the clinker on the arches and bridged across the tubes obstructs the free passage of the gases and also has a tendency to cause masonry failures if the growths become too great.

These clinkers cannot be called soot, but their formation is from the same cause, the blowing about of the small ignited coal particles that adhere to the interstices of the brickwork or to the metal of the heating surface and the ash from which, when in contact with the firebrick, tends to fuse the two together, possibly at a fusing temperature lower than either would fuse by themselves. There is some of this clinker formation found in hand-fired boilers, but not to so great an extent as with the stokers. This is due to the much greater furnace temperature usually found in the stokers. In order to avoid this growth at the fire line, we use in the stokers two courses of carborundum brick, which on account of their greater fusing temperature have not quite the tendency to start the clinker. Another advantage of the special bricks is that, due to their greater mechanical strength, there is not as much danger of their spalling under the rough handling necessary to knock off the clinkers after they once form.

Effect of Soot Deposition on Heat Transmission

With hard coal it is absolutely necessary to remove the bulk of the soot by mechanical means; it has to be handled like so much ash from the furnace, but with both coals some special means must be used to clean the fire side of the heating surfaces or else the soot will insulate these surfaces to such an extent as to cut down the boiler efficiency. Actually, we may find a difference of from 50 to 100 deg. F. in flue-gas temperatures between a sooted and a clean boiler, which perhaps will account for a loss of from 0.5 to 3.0 per cent in over-all boiler economy. If we assume that this loss would be 2 per cent and that the plant was using coal at $4 per 2,240 pounds, then per 1,000 boiler horsepower of output we would look for a saving of 18 cents. This figure in itself appears small, but it will more than pay for the salt used for cleaning the heating surfaces. The increase in the boiler output, the decrease in the time out for external cleaning and the freedom from the clinker formation would be clear gain.

Some Troublesome Features from the Operation Standpoint

The foregoing effects of fouling pertain to the results on the boiler-operating efficiency as effected by the reduction in the heat transfer due to poorer conduction and may be considered for this reason as bearing more on the fuel costs than on the boiler-operation conditions in the boiler room. From the operation standpoint the two most troublesome features are the bulk of the soot, both combustible and noncombustible, in the case of the small sizes of anthracite, and the clinker formation from both bituminous and anthracite.

The great bulk of the hard-coal soot has to be met with when high ratings and small sizes are used, and no soot blower or other apparatus will help in the slightest. It has to be considered the same as the excessive refuse when using coals high in ash and handled in a similar manner; it must be removed as often as possible, at least every watch, and every installation will have to be considered by itself for the most economical method of handling, and this may broadly be divided into getting it out of the boiler and then getting it away from the plant. The clinker formation on the tubes and heating surfaces may be kept down to a minimum by the use of mechanical soot blowers, but only where the jets from such blowers may reach; this still leaves a large surface for their growth, with the resultant evils. The clinker formation on the arches and side walls will not, as a rule, be affected by the jets from a soot blower, and this is one of the worse conditions.

Salt Treatment Suggested by United States Railroad Administration

We first experimented with the use of salt for cleaning the fire surfaces on the recommendation of the Mechanical Section, Division of Operation of the United States Railroad Administration, in January, 1919, on our hand-fired boilers at the Jersey City Station. At this time we were short on boilers in the middle of winter, with very poor labor and poorer coal, and the boilers were all very badly sooted up. The result was apparently a dismal failure, for we could notice no great removal of clinker or soot, and apparently it adhered as strongly as ever. However, we did not consider that we had given the method a fair trial, so after taking the boiler out and giving it a good external cleaning, we salted regularly until the next cleaning. During this period of 22 days, covering 528 hours, a total of 500 lb. of salt was used at intervals varying from 72 to 240 hours. As a result the metal surfaces were much cleaner than usual and where the clinker formation did exist it was easily broken off. This was especially noticeable up in the tube bank itself, where the surface is almost impossible to reach by hand. At this time we were changing over all the boilers from hand-fired to stokers, and as the salting worked out so well, we then adopted it as part of our boiler routine with the stokers, as well as with the remainder of the hand-fired units until they were changed.

The general method of using the salt with the hand-fired boilers, was as follows: At some off hour during the day, when the boiler may be spared from steam making, about an hour and a half before the cleaning of the fires, the draft was removed and the fire banked. The charge of salt was then spread evenly over the whole surface of the fire, and the draft was not returned or any coal added until all the fumes had disappeared and no sign of salt remained on the fuel bed. The action may be noticed for one-half to one hour after the application. From time to time the leveler is used, as the reaction slows, to stir up the salt that may have some tendency to cake over. The fire is then cleaned in the regular manner, built up and returned to steam making. The salt deadens the fire, and as no coal may be added during this cleaning period the treatment should be given only at such times as the boiler may be spared.

SALT-TREATMENT METHODS WITH STOKERS

With the stokers the method has to be modified but slightly. The coal gates on the chutes leading to the spreaders are closed, the contents of the hoppers run out and the draft shut off. The front is then lifted down and the salt spread evenly over the surface of the fire with a scoop the same as for a hand-fired furnace, leveled when necessary to completely consume the salt. When all the gases have been dissipated, the front is lifted back into place, the coal gates are opened, draft cut back, grates put in motion and the boiler returned to steam making again.

All this work is done by the stoker operators, so there is no additional labor charge and, better yet, there is no difficulty in getting the men to do this, for it is not laborious and they soon see that it is a help to themselves. With other types of stokers than chain grates some little modification would be necessary, but this is fairly simple for any installation.

BEST RESULTS FROM ICE-CREAM SALT

Some of our first experiments were with rock salt, and apparently this is not quite so efficient as ice-cream salt, as there may be a greater moisture content in the former, this having a tendency to add clouds of steam to the gases, which are at the best inert. We have also used a cheap grade of granular salt, but apparently the results are not so good.

Our practice now is to give each boiler on the line one hundred pounds of ice-cream salt every seven days, the salt often used as we receive it, although it is good practice to keep some quantity ahead in a dry place. This would make for one month, or the scheduled period between external cleanings, about four hundred pounds of salt, and the ratio and costs are given in Table IV.

TABLE IV. SALT USED PER MONTH PER BOILER

Kind	Ice cream
Amount in pounds	400
Amount per square foot of grate surface, lb.	1.75
Amount of square foot of heating surface, lb.	0.045
Amount per 100 horsepower of builder's rating, lb.	45
Cost of salt per pound	$0.01225
Cost of salt per month	$4.90
Cost of salt per 100 hp. of builder's rating per month	$0.55

We figured before that we could expect a tangible saving of 18 cents per 1,000 boiler horsepower delivered, with vastly more than this that we could not express in dollars and cents. Then, at this rate of output, for thirty days the saving would be approximately $130 and the cost of salt $5.50. Of course this difference is not all net gain, because other means of cleaning are necessary, and if for this reason we assume that we gained only one-half of this saving by the salt, or $65, we would still have a wide margin to cover the cost of the salt.

THEORY OF THE ACTION OF THE SALT

The action of the salt in the removal of soot is primarily chemical, for the salt when spread on the fire is broken up by the action of the heat into its components of sodium and chlorine, both in their gaseous state, and it is the reaction of these gases on the soot, both the combustible and non-combustible, that is depended on for the cleaning. It is for this reason that by the use of salt we can get results that are impossible from any mechanical or manual cleaning, for these gases will travel over every square foot of the heating surface and reach locations impossible of access by any other means.

As mentioned before, the flue ash, and especially the clinker make-up, is much more complex than the combustible soot and consists of silica (SiO_2), alumina (Al_2O_3) and iron oxide (Fe_2O_3). We must, therefore, have a reaction that will support and augment combustion to dispose of the combustible or carbon portion and also gases that will chemically react with the clinker formation so as to dispose of them. Both of these requirements are very well found in the gases from the destruction of the salt.

ACTION OF THE CHLORINE GAS

The chlorine gas on account of its acidic characteristics will react with the iron oxide of the clinker, forming ferric chloride, which should burn off at the high temperatures found after the boiler is taken off the bank; this will cause a disassociation in the mass of the clinker, making it fragile and incapable of sustaining its own weight, thus causing it to fall. This is especially true with the clinker formation on the tubes or other iron surfaces, where the reaction will take place at the base of the mass or the junction of the clinker with the more or less oxidized iron surface, and will undermine the structure. Hydrochloric acid will throw down the SiO_2 out of composition, and owing to this reaction there will be set up in the mass a considerable mechanical tension, which will break off the "whisker" or at least make it adhere less strongly. Either or both of these reactions are enough to destroy or weaken the clinker and make it capable of removal by some mechanical means, as a steam jet, so it is immaterial whether any reaction takes place with the alumina.

The foregoing is what we consider takes place with the incombustible portion. It cannot do the impossible, consume incombustible matter, but it does break it down from the heating surfaces or masonry and make possible its removal by some mechanical means, and in many instances the residual fine dust is actually carried away by the velocity of the furnace gases of combustion.

The action during the salting period is quite noticeable, and for some three to four hours after the boiler is returned to steam making it will be noticed that clinker and dust are falling on the grates.

We have found the results most beneficial, so much so that the fireroom crew will soon complain if by any chance the salt supply is allowed to run out. We consider that this in itself is about the best proof of its benefit and that it shows the ease of application, for the present-day laborer is not looking for extra duties unless he can notice the benefit to himself.

ACTUAL RESULTS FROM THE TREATMENT

We do not claim that this method is a cure for all soot difficulties. It is not. Neither do we advocate the abandonment of all mechanical cleaning methods, either while the boiler is in service or when out for its regular external cleaning. We do claim that it removes from the heating surfaces and the furnace walls a large amount of clinker and soot, that it removes soot from locations it is impossible to get at by hand or other mechanical means, that it loosens the clinker and the adhered flue ash from the furnace and boiler surfaces so that it may be readily blown off by a steam jet for the daily cleaning, from the furnace walls, so that where necessary it may be broken off by a slice bar with less ill effects to the masonry and from all surfaces that are gone over during the external cleaning. We advocate the continued use of the hand lance for installations that are not equipped with mechanical blowers.

A Diesel Engined Flour Mill

UNTIL four or five years ago the majority of the flour mills of the country were driven by Corliss engines. Although the power cost per barrel of flour ranged from 20 to 30 cents it was generally assumed that no other prime mover could compete with the Corliss engine. Increasing coal prices and higher labor charges now compel the mills to give more attention to power plant companies. The favorable results secured in other industries where Diesels have been installed have caused a considerable demand for oil engines in the mills.

A great number of the smaller mills of less than 100 horsepower capacity have installed hot-bulb or surface-ignition engines. The somewhat high fuel consumption of this type together with certain inherent characteristics that are peculiar to the surface-ignition engine prevent its employment in the larger powers. As a result the Diesel engine has been chosen in the larger mills.

KEPT ACCURATE OPERATING DATA

It is always difficult to secure actual data on Diesel plants and most of the information that has been published has been based on estimated costs. Fortunately the Page Milling Co. of Topeka, Kansas, have kept accurate data on the power costs of their Diesel engined mill. Their figures are tabulated herewith. This mill contains a 385-hp. McIntosh and Seymour four-cylinder vertical Diesel which drives the mill machinery through a rope transmission system. The engine has been in operation for four years and runs twenty-four hours a day, being shut down on Sunday. During this period the load was varied from 50 to 80 per cent of the engine rating, the average load being about 65 per cent. Much of the excellent service secured is due to the fact that the engine has never been overloaded. In this matter the Page Co. emphasizes the necessity of always having the engine capacity greater than the load requirement.

During 1919 the power costs were as follows:

Barrels of flour, bbl	124,000
Wages, per bbl flour, in cents	3.82
Fuel oil, per bbl flour, in cents ($1.58 per bbl.)	2.21
Lubricating oil, per bbl flour, in cents	.31
Incidentals, per bbl flour, in cents	.11
Repairs, per bbl of flour, in cents	1.73
Depreciation, 10 per cent per bbl. of flour, in cents	2.23
Interest and taxes, 8 per cent per bbl. flour, in cents	1.78
Total cost in cents	12.19

The item of repairs is somewhat larger than is customary. This covers the expenses of a man from the factory to install new camshaft gears and replacement of the steel support of the main driven rope sheeve.

The fuel oil was purchased at a contract price of $1.58 per barrel. At present the open market quotes oil at $3.65. The difference increases the fuel cost to 5.89 cents per barrel of flour and the total power charge becomes 15.09 cents. This compares more than favorably with a steam plant which can hardly do better than 30 cents per barrel with coal prices at the present level. The repair charge will not exceed those of a steam plant. The wage charge is commendable as it indicates that the plant force are receiving wages that are equal to those paid steam plant engineers.

TROUBLES WERE NOT SERIOUS

During the four years of operation no serious troubles have occurred. The principal difficulty has been the wear of the camshaft gears. The helical teeth tend to force the vertical governor shaft and the camshaft apart. The upper governor shaft bearing wears rapidly, but has now been replaced by a babbitted bearing. The engineer formerly in charge of the plant ran the engine with excessive clearances between the valve rocker arms and their respective cams. This served to place strains on the gears which increased the wear of the gear teeth. The gear teeth are now lubricated through an oil line from an overhead tank; a heavy stream of oil is deposited on the teeth as they come into mesh.

The main pistons apparently have worn but little; all the rings have been renewed once, with the further renewal of nine more rings during 1920. No bearing trouble has ever been experienced. The engine's operation is very satisfactory and it is possible that 10 per cent is entirely too high a charge for the wear on the engine.

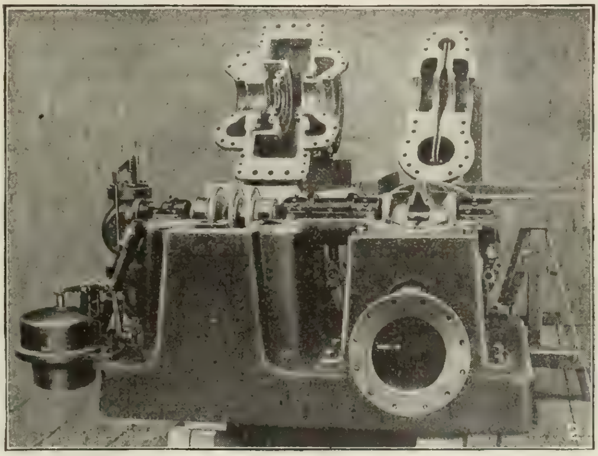
The engineer who is accustomed to large airy engine rooms would probably criticize the cramped quarters. The engine room is very limited; the working space about the engine is entirely out of keeping with the investment in the engine. Diesel engine rooms should be generous in proportion, since many times parts of the engine must be handled quickly. The visitor is struck with the position of the exhaust pipe. This pipe is entirely within the engine room, the exhaust pipe passing through the roof. As a consequence the roof and side walls have caught fire. In erecting a Diesel plant the exhaust should pass out of the engine room before entering the exhaust pot. One very destructive fire occurred in a pipeline pumping station because of this defect.

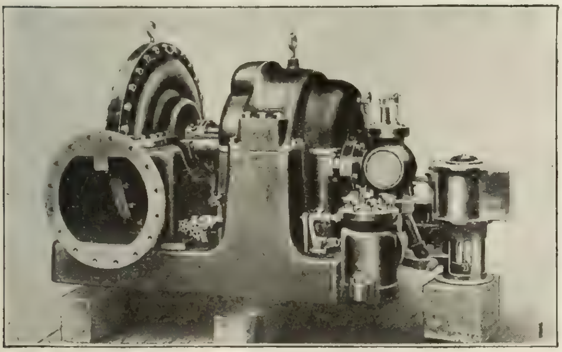
The record of this plant is noteworthy. Such plants tend to overcome the prejudice of the steam engineer. Few, if any, steam plants can show a year's record of repair costs as low as does this plant. With coal prices advancing the flour mills will do well to investigate the Diesel engine.

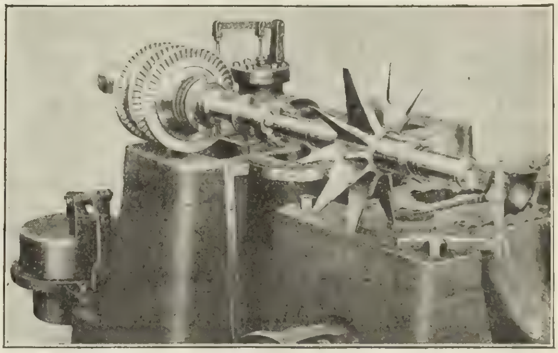
Single-Stage Turbo-Blower Operating Normally at 22,000 R.P.M.

Capable of Compressing in a Single Stage 4,000 cu. ft. of Free Air per Min. to 21 lb. per sq. in. with the Rotor Running at a Tip Speed of 1,400 ft. per sec.—The Turbine Develops Normally 300 hp. and Weighs 6.7 lb. per Horsepower

HIGH-PRESSURE superheated steam, the steam turbine and alloy steels have made possible rotative speeds that a few years ago were beyond the engineer's wildest dream, and the speed at which steam turbines and other power machinery operate, are being increased. There was recently designed and built by the Rateau Battu Smoot Co., New York City, a turbo-blower, Figs. 1 to 3, that operates at a normal speed of 22,000 r.p.m. and when tested before shipment, to the Famatina Mining Co., Argentina, S. A., was operated at 26,000 r.p.m. When operating at 22,000 r.p.m., this machine will compress in a single stage 3,000 cu.ft. of free air per minute to 15 lb. per sq.in. It is difficult to comprehend just what a speed of 26,000 r.p.m. means. In the short period of one second, the time that it takes the second hand on a watch to move one division, the rotor makes 433 revolutions. The diameter of the turbine's motor is 9¾ in. and that of the blower 12½ in. At 26,000 r.p.m., this gives a tip speed to the latter of 1,400 ft. per second. If it were possible for this rotor to run across a plane surface, it would travel at the rate of 16 m. per minute, or over five times as fast as the fastest airplane. At this rate it would travel around the earth at the equator, a distance of 25,000 miles, in 26 hours.







FIGS. 1 TO 3. ASSEMBLY AND PARTS OF TURBINE AND BLOWER

Fig. 1 shows the complete unit assembled—turbine on the left. In Fig. 2 the top casing is raised, but in this case the turbine is on the right. The rotor is removed from the bearings and is resting on the lower half of the casing in Fig. 3. The 6-in. rule standing vertical on the right hand end of the casing gives an idea of the size of the revolving element which only weighs 138 lb. One hundred of this is in the turbine rotor and 38 lb. in the blower rotor. The entire machine weighs 5,500 lb. Of the total weight 2,000 lb. is on the sub-base, 1,500 lb. in the blower and 2,000 lb. in the turbine. Since the turbine is normally capable of developing 300 hp. its weight per horsepower is only about 6.7 lb. The old Centennial engine, which was a feature at the Exposition held in Philadelphia, 1876, weighed 1,400,000 lb. and developed 1,400 hp. or 1,000 lb. per hp.; approximately 150 times as much as the turbine under discussion. In the case of the turbine, the normal speed is 22,000 r.p.m. and that of the old Centennial engine 36 revolutions per minute. As to the compactness of the machine, an idea can be had from the fact that the entire unit can sit in a floor area 7 × 4½ ft.

The entire blower end of the rotor, both shaft and blading, is made from a nickel-chrome-magnesium steel, heat-treated, forging, the radial blades being machined an integral part of the shaft. Such a wheel has the maximum rigidity and is so designed that at all points the stresses are far below the elastic limit of the metal—a factor of safety of 3.5 being used. Some idea of the centrifugal force in the blower blades may be gained from the fact that one ounce weight on the end of the blade will exert a radial pull of approximately 3.75 tons.

On the turbine end, the rotor has three wheels all machined an integral part of the shaft. This like the blowing rotor is made from a nickel-chrome-magnesium steel heat-treated forging. The blades are machined from a solid bar of the same material used in the wheels and inserted into the latter. The first wheel receives steam at boiler pressure, 150 lb. gage and 100 deg. superheat, and is then discharged to the low-pressure wheels in parallel. Normally the turbine is to operate condensing on a vacuum of 25 inches. When so operated it has a water rate at normal load of 16.7 lb.

Both rotors are connected by a rigid coupling and are so designed that the critical speed is above 36,000 r.p.m. All bearings are lubricated by oil under pressure.

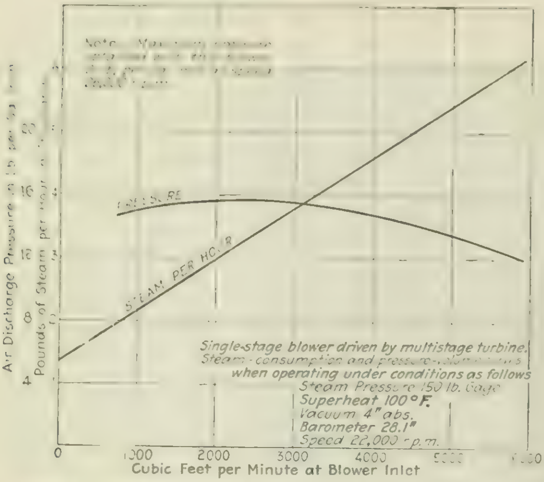


FIG. 4. PERFORMANCE CURVES OF TURBO-BLOWER

Governing of the unit is obtained by means of a small centrifugal fan machined an integral part on the end of the turbine shaft. The discharge of this fan operates a Rateau Battu Smoot regulator of constant volume, consequently there are no flyballs or gears in the governing mechanism.

The flexibility of this machine is of considerable interest, inasmuch as it can be operated to supply from 1,000 to 6,000 cu.ft. of air at pressures varying from 12 to 16 lb.

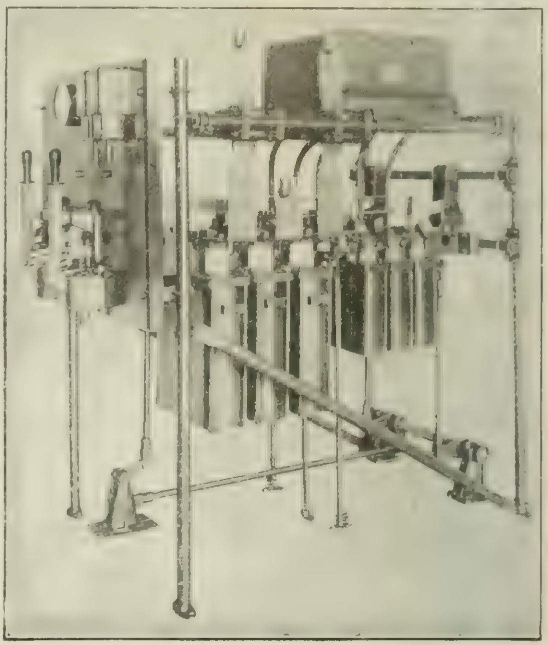
Very elaborate tests were made before shipment and the normal performance of the turbine and blower are shown on the curves, Fig. 4. At a speed of 26,000 r.p.m. the machine delivered 4,000 cu.ft. of air at a maximum pressure of 21 pounds. During its operation at full speed and overspeeds, the machine operated without the slightest vibration, it being quite impossible to obtain readings from a vibration tachometer. The results of these tests show that two machines of this type working in series can be made to compress air to 100 lb. pressure in small units, and three machines in series would give a compression as high or higher than 100 lb. for large size machines.

The Famatina turbo blower is constructed on somewhat similar lines to a machine that has been in operation for more than two years at the plant of the Omaha Gas Co., Omaha, Nebraska.

Low Voltage Panel for Starting Induction Motors

There has recently been placed on the market a line of standard unit induction-motor starting panels for use with either wound-rotor or squirrel-cage motors, operating on three-wire non-grounded systems. They are built by the General Electric Co. and designed for such work as controlling motors which are driving compressors, blowers, centrifugal pumps and similar machinery. Protection from sustained heavy overloads is provided by time-limit relays which operate the oil circuit-breakers, but which due to the time-limit feature prevent the motors being shut down on instantaneous overloads. There is also an undervoltage device which opens the breakers in case the line voltage falls to a predetermined value below normal. This prevents the damage that might ensue, if the motor was left on the line when full voltage was re-established and the operator had failed to take the proper precautions.

Panels designed for motors having an internal starting resistance can be fitted with an additional device to insure the proper use of such resistance, so as to protect both the motor and the resistance from damage due to improper starting. This device prevents the oil circuit-breaker being closed until the maximum starting resistance is in the circuit and automatically trips the breaker open, if the motor should be left running with the resistance either wholly or partially in the circuit. Protection of motor start by compensators that do not have self-contained switching arrangements is furnished by a time-limit mechanical interlock which serves several purposes. In the first place, it prevents the closing of the main breaker before the starting breakers have been closed and then opened. Secondly, it insures that the main breaker is closed within a short fixed time after the starting breakers have been opened.



MOTOR STARTING PANEL

Steam-Engine Operation and Maintenance—Lubrication of Valves and Saving of Used Oil

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

GOOD steam-engine cylinder oil is usually compounded from mineral oil and tallow or tallow oil; it is sometimes adulterated by the addition of cheap vegetable oils. Mineral oil without a certain percentage of animal oil is not suitable for cylinder lubrication, as it is so easily affected and washed off by moisture in the steam. Tallow or tallow oil should not be used alone on account of the fatty acid contained, which would attack the cylinder walls. An all-round mixture that gives good results is 94 per cent of mineral oil and 6 per cent of tallow. The flash-point of cylinder oil, or the temperature at which the vapor of the oil will ignite, should be at least 150 deg. higher than the temperature of the steam entering the cylinder. This point must be taken into account in cases where a change is made from saturated steam to superheated steam, which would also command a change in the lubricant.

Efficient lubrication of the valve or valves of an engine is just as important as that of the piston and cylinder if the valves have sliding surfaces, as the common slide valve, piston and rotary valves. The seats of poppet valves do not require lubrication, in which respect they are much superior to other kinds of valves. Piston valves are easily lubricated as the pressure between valve and seat is slight. The common slide valve, however, requires copious lubrication, more so than any other valve, on account of its long travel and unfavorable position on the side of the cylinder. No lubricant will stay for any length of time on the vertical surfaces of this kind of valve; it runs off and is carried out with the exhaust.

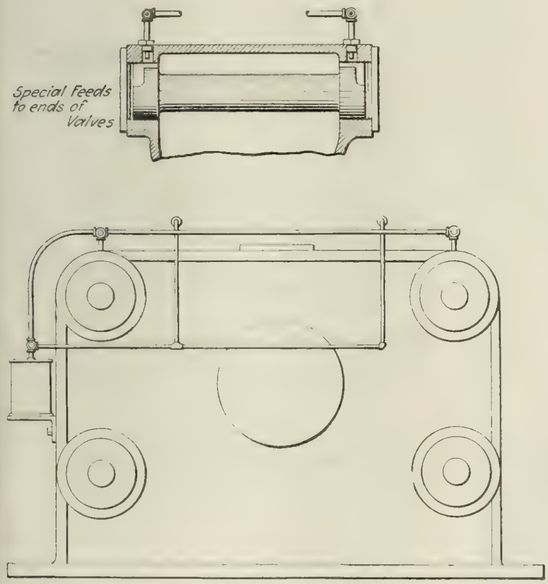


FIG. 1. OILING ARRANGEMENT FOR CORLISS-ENGINE CYLINDER

The lubrication of Corliss valves is often a problem and requires careful study and experimenting, especially on the larger sizes. On account of the great length of some of these valves it is difficult to keep their sliding surfaces covered uniformly with the lubricant. This is particularly true of the ends of the valves which are not touched by the flow of the steam and for lubrication must consequently depend on any small amount of oil which will spread sideways along the seat or depend on a special supply fed to these parts independent of other sources.

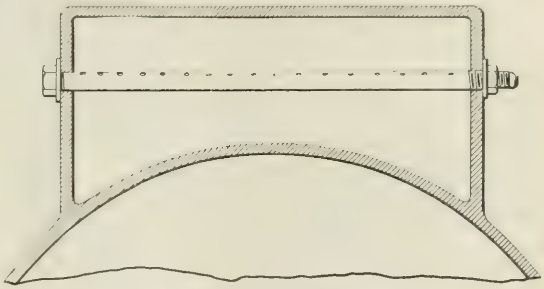


FIG. 2. OIL PIPE WITH SMALL HOLES, LOCATED IN STEAM CHEST

An efficient oiling arrangement for a Corliss-engine cylinder in which particular attention is paid to the lubrication of the ends of the steam valves is illustrated in Fig. 1. The use of a multiple sight-feed oil pump is indicated with one feed for each end of the steam chest and a special feed to each end of the steam valves. The oil fed into the steam chest will be diffused by the steam and serves to lubricate the exposed parts of the steam valves as well as the cylinder and piston, while an occasional drop of oil fed to the valve ends will be sufficient to keep them coated with a film of lubricant. It is only necessary to lubricate the steam valves; the exhaust valves, if placed below the bore of the cylinder, will be sufficiently oiled by the lubricant contained in and carried along with the exhaust steam.

On large Corliss-engine cylinders, 60 in. in diameter and over, one simple oil feed at each end of the steam chest is not sufficient to lubricate the valve and cylinder. The oil must be spread out over the full width of the steam chest. This can best be accomplished by brass pipes, one inserted at each end, as shown in Fig. 2. The oil is forced into these pipes and discharged through a row of small holes in an upward direction. Being well preheated, it is readily taken up and diffused by the steam.

It has been asserted that 50 per cent of the lubricating oil purchased is wasted, and an inspection of some of the old-time engine rooms will probably bear out the assertion. The conditions in some places are hardly believable and certainly inexcusable, especially if the high cost of oil and availability of modern systems of lubrication and filtration are taken into account. At a comparatively small cost an oiling system that would pay for itself in a year or two could be installed in many engine rooms, not to mention the better service, cleanliness and reduction of wear of the engine parts.

On simple engines a small oil reservoir of four or five gallons' capacity can be placed on a stand and fastened to the frame of the engine, as shown in Fig. 3, with pipes leading to the different oilers, cups or sight feeds. The used oil is drained into a tank under the floor, where some of the dirt taken up by the oil will settle and from which water carried along with the oil can run off into the sewer. A small pump driven from the rocker arm or some other convenient moving part forces the oil back into the tank, which should contain a strainer and a filter to separate out all impurities. All kinds of refinements and elaborations can be introduced in a system of this kind, they depend mainly on the amount of oil in circulation and on the degree of purity desirable in the used oil. The main thing is to keep the dirt away from the lubricated parts of the engine and prevent it coming in contact with the oil; the moving parts should, therefore, be protected and inclosed by dustproof oil shields. Since in a well-designed and carefully installed oiling system the loss is small, the oil should be fed to the bearings in a solid stream and to other parts, as the crosshead pin, the crankpin, the crosshead guides and the eccentrics, in large quantities without causing actual splash. Fine particles of oil are frequently carried to the floor or other places by air currents set up by the moving parts of the engine.

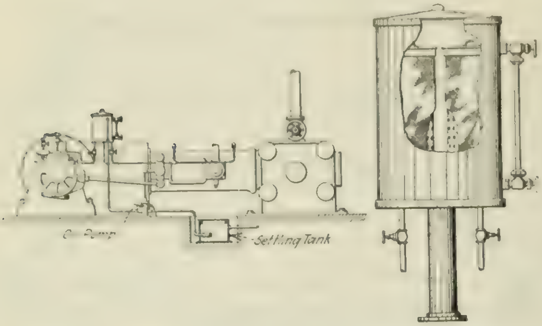


FIG. 3. OILING SYSTEM AND OIL RESERVOIR FOR SIMPLE ENGINE

The filtration and purification of used oil is simple, and an engineer can rig up an apparatus himself without much expense. A large oil-storage can or even a good-sized galvanized iron ash can, about 20 in. in diameter by 30 in. high, with a cover, can be converted into a filter, as shown in Fig. 4. A pan of galvanized iron or tin plate is placed in the top of the can, supported by lugs riveted near the upper edge, and a ¾-in. malleable-iron pipe flange, curved to suit, is riveted on the side of the pan into which a nipple is screwed, which projects outside the can. To this a funnel is attached by means of an elbow for pouring the used oil into the pan; a strainer of fine wire mesh placed in the funnel will keep the coarser impurities from entering the pan. A 1½-in. pipe flange, threaded from both sides, is riveted to the bottom of the pan, into which two pieces of pipe are screwed, the lower one to within about 3 in. from the bottom of the large can and the upper one to about the same distance from the top. The end of the lower pipe is threaded and a pipe flange screwed on with a circular perforated plate of tinned or galvanized iron resting on it. A perforated pan is set into the reservoir containing the used oil, the bottom and sides of this pan are covered with filtering cloth on the outside; the filter cloth may be muslin, felt, canvas or any other suitable woven material which will retain the fine impurities carried along with the oil. The oil to be filtered is poured through the funnel into the reservoir, which acts as a settling basin. In rising, it penetrates the filtering cloth and collects in the perforated pan, from which it descends through the central tube into the bottom of the can, which is partly filled with water. It spreads in a thin film over the bottom of the circular plate and rises through the perforations in drops to the surface of the water. In this way the oil is cut up into small particles, each of which is thoroughly washed in its ascent through the water. The purification process will be considerably improved if the water is heated. This can be effected by means of a steam coil placed either inside or outside near the bottom of the can. Suitable cocks must be provided for draining and for drawing off the filtered oil. The pans can be easily removed and cleaned and so can the filter cloth be cleaned or replaced by new material when necessary. There are a number of efficient oil filters and purifiers manufactured, but the expense of installing one of them is sometimes the reason for not making any attempt to save the used oil. However, all used oil intended for use over again should be filtered.

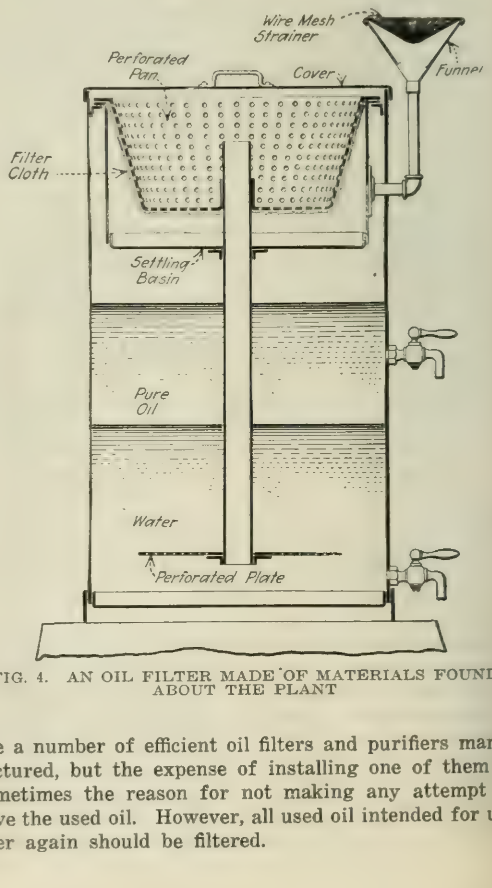


FIG. 4. AN OIL FILTER MADE OF MATERIALS FOUND ABOUT THE PLANT

Electric Motors for Driving Rubber-Mill Machinery

BY WILLIAM H. EASTON
Industrial Engineer,
Westinghouse Electric and Manufacturing Company

Advantages of motor drive are discussed and then the various types of motors applicable to rubber-mills are considered. Direct-current motors are entirely satisfactory, but in general the alternating-current types are preferred for a number of reasons.

ELECTRIC motor drive has been recognized as the most satisfactory for rubber-mill machinery ever since 1899, when the initial installation was made in the plant of the B. F. Goodrich Co. In fact, very few lineshaft-driven plants have been built during the last twenty years and most of the old plants that are still in existence have changed over to the motor drive. The special advantages of motor drive, as compared with older lineshaft-and-belt drive, are that it makes possible increased production, reduced expenses and improved working conditions.

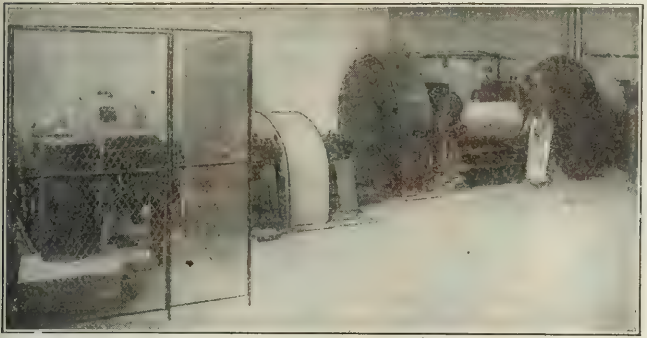


FIG. 1. HIGH-VOLTAGE 200-HP. WOUND-ROTOR MOTOR DRIVING MIXING MILLS. SCREENS INCLOSE THE HIGH-VOLTAGE EQUIPMENT

The use of motor drive permits an increase in the efficiency of the plant as a whole. Each machine or mill-line is driven by its own individual motor and, being mechanically independent of all other machines, can be placed wherever desired. If two machines, similar in every respect, except that one is motor-driven and the other belted to a lineshaft, were to be operated side by side under similar conditions, the motor-driven machine would be found to produce more per day. The reason for this is that the speed of the motor-driven machine can be kept practically constant at its proper value at all times; whereas, with the belt-driven machine some variation in speed is bound to occur because of the slippage of the numerous belts between the machine and the driving power, and thus its average speed will be 2 or 3 per cent or even more below its proper speed.

The independence of motor-driven machines also helps to increase production by eliminating much of the time lost through the shutting down of departments, or the entire plant, when trouble occurs. Not only are the other machines unaffected when trouble occurs with a motor-driven machine, but since in most cases central-station power can be obtained for breakdown service, even trouble in the power house of the factory need not halt production.

The foregoing considerations apply to every machine in a rubber factory, but a special increase in the production of the calender can be obtained through the use of motor drive. When this machine is belt driven, only two speeds are available—a slow threading-in speed obtained by slipping the clutch, and a running speed. But for every grade and thickness of stock there is a very definite speed of the calender at which maximum production of the highest quality is obtained. If for a given grade of stock, the running speed of the calender is below this point, production is less than it should be; while if the running speed is too high, either the quality of the product suffers or the slow speed must be used which is ordinarily much too low for the most efficient results. When the calender is motor-driven, any desired speed range and any speeds within that range can be obtained. Each grade of stock can be run off at the most efficient speed (or very near it) and the full output of the calender obtained without increasing the cost of labor.

Though the reduction in expenses obtained through the use of motor drive is of small consequence when compared with the increase in production made possible, nevertheless it is of interest to note that an electrical drive system costs less to operate and maintain than a mechanical system. This is due to the fact that lineshafts must be given considerable attention in order to keep them in proper operating condition; the expense of belt renewals is high; and the

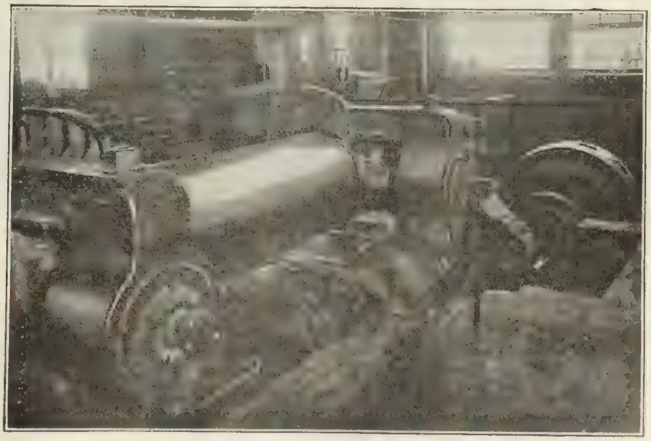


FIG. 2. MILL DRIVEN BY 200-HP. MOTOR

whole system consumes a considerable percentage of the power generated, especially when only part of the machines are in operation. Motors, on the other hand, especially where alternating-current machines are used, require little care; the power losses in the system are small; there is no loss at all for a machine that is shut down; and the depreciation charge is low.

A motor-driven factory is cleaner, lighter, better ventilated, and in every way a pleasanter place to work in than one using belts and lineshafting. Motor drive is much safer, for the majority of the dangerous belts and pulleys are eliminated and the drives that remain, (whether belt, gear or coupling) can be readily protected by inclosing with screens. Safety stops can be placed at any desired number of points around the mills and calenders, so that these machines can be stopped instantly in case of accident; thus reducing these hazards to a minimum.

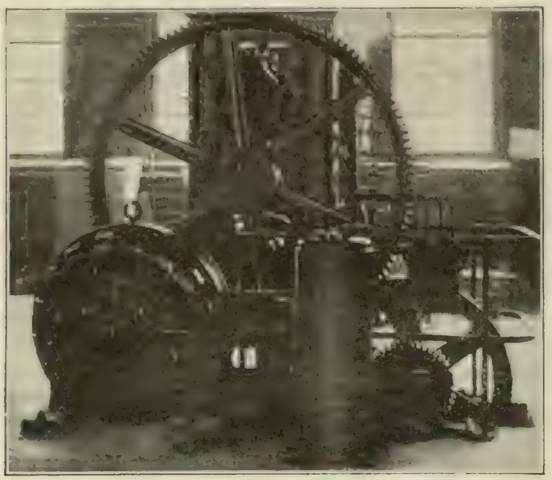


FIG. 3. CALENDER DRIVEN BY 75-HP. ALTERNATING-CURRENT MOTOR

For driving the machinery direct current is entirely satisfactory, and several plants are using it for all power purposes. But alternating current is in general preferred for the following reasons:

Almost all of the machinery, with the exception of the calender and some minor machines, are of the constant-speed type, and alternating-current motors are especially well adapted for this service.

Alternating-current motors, having no commutators, require somewhat less attention than direct-current motors, especially in places where there is more or less dust.

If central-station power is used, alternating-current is almost invariably supplied; and if the factory has its own power plant, it is always good practice to generate the same kind of current as the local central station, in order to use power from the latter for breakdown service.

If the plant is large and the main-power circuits are several thousand feet long, alternating current is necessary in order to transmit power without excessive losses.

On the other hand, direct current must be used for calenders, if they are to have a wide range of speed, and in consequence the great majority of rubber factories use alternating current for their main power and generate an auxiliary supply of direct current for the calenders and some other adjustable-speed machines. There are, however, a few factories using alternating current throughout.

MOTORS FOR MILLS, CRACKERS, AND WASHERS

From the standpoint of motor drive, crackers, washers, and mills, all have the same requirements. They are all ponderous machines, require large motors (from 100 to 600 hp. depending on the size of the rolls and length of the line), operate continuously at constant speed and may occasionally (as on cold mornings) require a considerable excess of power for starting up.

The motor that is almost invariably used for driving these machines is the wound-rotor induction type, which is admirably adapted to this service because it can be made in large, slow-speed sizes, suitable for direct-connection to the mill; can be started gradually under a heavy load without drawing excessive current from the line; and operates continuously at a uniform speed at good efficiency. It is started by connecting its primary circuit to the line by means of an oil switch or circuit breaker, and bringing it up gradually to full speed by cutting out resistance in the secondary circuit by means of a drum controller.

Squirrel-cage motors have been used for mill drive, but to a very limited extent because their high starting current is usually objectionable.

Synchronous motors, on the other hand, appear to be growing in favor for this service, to which they are well adapted because of their slow speeds, high efficiency and ability to improve the power factor—a point of special importance when power is purchased. The difficulty in starting this type of motor under load is obviated by the use of the magnetic clutch, hereinafter described.

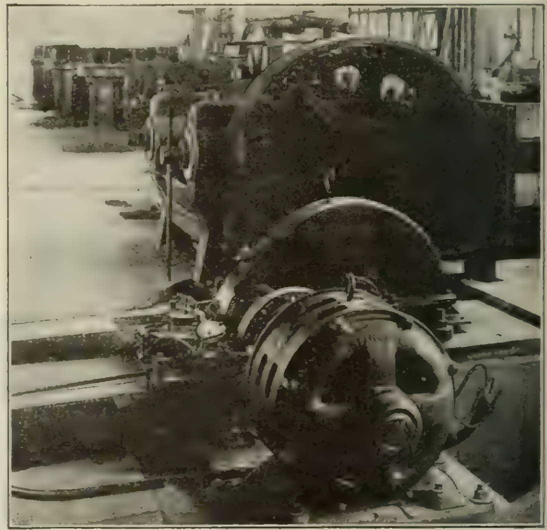


FIG. 4. CLUTCH AND BRAKE SHOWN BETWEEN MOTOR AND MILL

When direct-current motors are used for mill drive, they should be of the constant-speed compound-wound type and controlled by automatic controllers, since manually operated controllers are not recommended for direct-current machines of this size.

Most mill motors are operated on circuits of 220 or 440 volts, but in a few cases where high-voltage alternating current is supplied to the factory, the cost of the transformer installation has been reduced by operating these large machines directly from the high-voltage lines. In such instances the motors and controllers must be protected with screens, as in Fig. 1, in order to keep unauthorized persons away.

The use of a magnetic clutch between the motor and the mill line is almost invariable practice. When this clutch is energized, it provides a rigid connection between the motor and the rolls; but when the clutch current is cut off, the motor is instantly disconnected and a brake is applied to the rolls, stopping them immediately. Switches, opening this circuit, can be placed in any desired locations around the rolls and provide a high degree of safety. Direct current is needed to energize the clutch and, in alternating-current plants, is supplied by a motor-generator set. When sychronous motors are used for mill drive, they are brought up to speed with the clutch open.

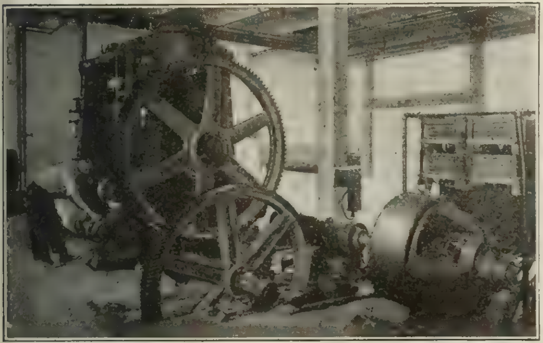


FIG. 5. DOUBLE-VOLTAGE 75-HP. DIRECT-CURRENT MOTOR DRIVING CALENDER

Motors for Calender Drive

The wound-rotor induction motor, similar to that used for mill drive, can be used for driving calenders, Fig. 3, but its speed varies with the load, which is undesirable, and it provides a speed range of only from normal speed to 20 per cent below normal (the slow threading-in speed being provided mechanically). Its use is therefore restricted to calenders requiring but small speed variation. Direct-current motors, however, provide a wide speed range, and these are ordinarily used for calender drive.

Two kinds of direct-current drive have been specially developed for calenders:

1. The single-voltage system, in which the motor operates at all times on a 230-volt circuit. This is mainly used for small calenders.
2. The double-voltage system, in which a three-wire circuit is employed and the motor is operated on 115 volts for low speeds and 230 volts for high speeds. The main reason for developing this system is that by using two voltages a given horsepower and speed range can be obtained with a smaller and less expensive motor. It is mainly used for the larger calenders.

From an operating standpoint the two systems are practically alike, as the method of control is the same in both cases. The speed range of both motors is 1 to 4 (for example, 250 to 1,000 r.p.m.), with a number of steps, including a very slow threading-in speed.

The controller in general use is of the semi-automatic type and consists of three main parts: A small drum controller, called the master controller; a set of four push buttons, mounted on the calender and marked respectively "start," "stop," "slow" and "fast"; and a panel carrying a set of automatic magnetic switches.

The speed of the calender is regulated by the position of the master-switch handle. When this is on the first notch, the motor operates at its low threading-in speed, with resistance in series with the armature. On the second notch the armature resistance is cut out and the motor operates with full field strength and at its lowest running speed. On the remaining notches resistance is cut into the motor field in successive steps, so that the motor speed is increased until maximum is reached. With the two-voltage motor, Fig. 5, the connections are made with the 115-volt circuit for the lower speeds and with the 230-volt circuit for the higher speeds.

Moving the master-switch handle does not, however, start the calender. The handle is first set for the speed desired, and then, on pressing the "start" button, the calender starts and comes up to that speed. On pressing the "slow" button, the calender slows down to the first running speed, and on pressing the "fast" button it comes up to the speed corresponding with the setting of the controller handle. Pressing the "stop" button stops the motor and applies dynamic braking, bringing the rolls promptly to rest.

Neither the push buttons nor the master controller make the actual connections with the motor. These devices control the action of the magnetic switches, which in turn open and close the proper circuits and cause the motor to operate in accordance with the wishes of the attendant. Safety switches that stop the motor and apply dynamic braking can be placed around the calender in any desired number of locations.

In alternating-current plants, direct current is usually obtained by means of rotary converters or motor-generator sets. The former are generally preferred because they are more compact and efficient and less expensive. Both kinds of apparatus can be supplied with either a two- or a three-wire direct-current supply, depending upon whether the calender motor is single or double voltage.

Motors for Other Machines

Practically all other machines in the rubber factory are of the constant-speed type, and as, in general, they require small powers, they are usually best driven by squirrel-cage motors.

The machine tools in the repair shop and the ventilating fans are, however, preferably driven by direct-current motors to provide satisfactory speed variation. But these machines are usually relatively unimportant, and it is common practice to operate the machine tools by squirrel-cage motors, obtaining speed variation by mechanical means, and the ventilating fans by wound-rotor motors, which provide a fair degree of speed variation, or by squirrel-cage motors if speed control is unnecessary.

The Making of Better Producer Gas

Points of Interest in the Operation of a Large Gas-Producer Plant. Kind of Coal To Use, Tar Separation and Gasification in the Producer, Making Possible 200-B.t.u. Gas

By A. Clark Liscom
Engineer, Producer Gas Department, Ford Motor Company

THE planning, construction and operation of a producer-gas plant with an hourly capacity of two to five million feet, is one of the later developments for the economic use of fuel. With proper planning and operation, as high as 78 per cent efficiency can be maintained and the gas, cooled and cleaned, can be distributed through miles of pipe lines of ordinary size.

Producer-gas engines have an original cost per horsepower exceeding that of the steam engine, but this is counterbalanced by their higher economy in operation. Using this type of engine in conjunction with furnaces makes an excellent combination. The engines produced today will have a thermal efficiency approaching 30 per cent, and this economy is greatly improved by utilizing the heat from the exhaust gases.

Necessity of Good Ventilation

In laying out a producer plant the gas building should have liberal lighting from the sides and roof and be well ventilated, so that the men will not be obliged to leave the job on account of their lungs just about the time their training has made them of value on the work.

The building should not be used as a support for lean-to construction, thus shutting out ventilation and light. It should have ample area around the four sides for light and air, and interior passages should be laid out to permit moving the largest parts of the machinery without taking down walls or columns. A well-studied exhaust air system will be necessary. Injection of air into the building to dilute the mixtures is not the thing. The foul and heated air should be drawn out of the building quickly.

Proper Unit Arrangement

With their primary condensers or cooling towers and low-pressure or dirty gas headers, the producers should be grouped into units to the capacity of the exhausters, and the latter, with their driving mechanism, should be in a separate room. They will be cleaner and the bright work will have a chance. This does not mean that the producer room need be dirty if proper provisions have been made for coal and ash handling. Each exhauster taking the product of several producers should be capable of delivering the gas to either furnace or power mains, or both, as needed. On light loads a unit could be shut down for adjustment or repairs without affecting the balance of the load.

The exhausters should have a normal rating of 200 cu.ft. displacement or better. If the gas is used for both power and heat, there will be a difference in the line pressures. That of the power line will be between 2 and 6 in. of water, and the furnace line between 10 and 30 in. of water. The latter pressure will depend upon the length of the mains and the type of furnace used. The selection of large exhausters eliminates a row of small machines, each of which requires almost as much fuel, space, oil and attention as the larger outfit. The gas exhausters should never be installed without bypasses. When pumping dirty gas, the ends of the impellers should be lubricated with crude oil through force-feed devices.

Gas Meters Desirable

Coal- and ash-handling equipment require careful study. The size of coal most economical to use varies with conditions, but if the tar is to be returned to the producer and gasified, the finer sizes of slack cannot be burned. Hence it is necessary that the coal delivery be flexible to meet these conditions. The coal should be weighed before going into the producers. One per cent saving of the year's coal supply will buy the most elaborate automatic equipment for this purpose. The operation of each machine is then under close observation, so that the weak spots may be eliminated. The ashes should be removed with as little dust and labor as possible and should be sampled to check the wasted combustible. Ash weights should be available.

It is not desirable to locate distributing mains on the exterior of buildings in latitudes where the temperature is much below freezing in winter, particularly if laterals are to be connected. Producer gas is laden with moisture and distillation products. The change in velocity, and consequently in pressure, at a change in pipe size, causes precipitation of solids that will stop the flow of gas. It has been known to do this in less than ten minutes in passing from a 24-in. into an 8-in. pipe. Installation of heating apparatus at such points is uneconomical and the apparatus is subject to trouble. Gas mains should always be graded and provided with drains and cleanouts. Meters are essential to give the total fuel in and the total product delivered. If various departments are supplied, it may be advantageous to meter them separately. Rubber gaskets are not for producer-gas lines or machinery. Shellacked paper or cardboard will hold better than any other combination.

Planning the Tar Piping

Long lines for tarry water or tar drains should be avoided if they cannot be provided with intermediate clean-outs. In distinctly tar work, tees with a plug should be used instead of elbows. There will be many times when it is desired to find what is behind the plug without tearing down the line. There is a certain amount of tar work which cannot be eliminated. The proximity of tar operations to those of the cleaner sort should be avoided in the planning.

If the cooling water is not more than ordinarily cheap, it should be gathered at a common point, preferably a settling basin where the tar and dirt are precipitated, then put over cooling apparatus and recirculated. The water cost is reduced to the cost of handling and the makeup loss from evaporation. Many types of pump are not adapted to the handling of tarry water. Preference should be given to pumps that are readily accessible for cleaning.

In a producer plant there are no smokestacks to spread soot and ash over the landscape and keep the smoke inspectors on the job, but there are times during the first and last parts of the stand-by periods when the escaping gas from the purge pipes is not much better; especially in the neighborhood of high buildings. As this gas is poisonous, the tops of the purge pipes should be provided with igniters and the gas burned.

The Need for a Laboratory

A well-equipped laboratory is a necessity. With such a laboratory it will be possible to know at all times the value of the fuel as fired, the quantity of wasted combustible in the ash and the character of the product from each unit. The samples for the regular record of the day's performance should be continuous over each shift. Snap samples for this work are valueless. Almost any gas man can put a machine in condition for a snap sample which will make a fine showing temporarily, but he may not be able to hold that condition for even one hour. One of the samples under such conditions ran 286 B.t.u. per cubic foot. The average for the eight-hour shift was 202. The laboratory will enable the raising of the hydrogen content of the gas to the limit, and will show when the return of tar has been properly handled to give the maximum quality of methane.

Stand-By Loss Is Small

The comparative ease with which good economy can be effected in the producer makes this method of generating heat value attractive. The loss of fuel during the stand-by period is particularly low. Producer gas is formed by slow combustion, which is not brought to completion in the producer, the final burning being done in the engines and furnaces. To obtain a high B.t.u. value uniformly, that does not necessitate juggling with the mixtures of air and gas at the engines and furnaces throughout the working period, pick the best fuel possible, stick to it, and keep the fuel uniform.

Use Good Coal Uniform In Size

The B.t.u. value and the ash content of the coal have much to do with the final cost of the gas. Compare two coals, one having a value of 14,400 B.t.u. and the other 11,000 B.t.u. per pound. If the delivered price of the first was $8 per ton, the price for the other should be $5.53, based on heat value. The high-heat-value coal will probably have 6 per cent ash, while the poorer qualities will have, say, 12 to 14 per cent. Taking the low figure, the additional ash is 6 per cent. If the plant uses 7,000 tons per month, this additional ash amounts to 420 tons at $8, or $3,360. If the gasification cost per ton is $3.50, add $1,470, and if the ash disposal costs 50c. per ton, add $210, giving a total of $5,040 for excess ash. It has used up room in the car en route and in the producers which could have been occupied by good fuel. Of the better coal a horsepower-hour would be produced from ¾ lb., and of the low grade the same amount of work will require almost a pound.

Another feature affecting economy is the size of the coal. Gas producers have a large grate area and a deep fuel bed. For anything like effective gasification, the draft throughout the bed must be uniform. Coal with large quantities of slack content cannot meet this requirement. At intervals the draft is greater where the coarser coal happens to lie. This is fatal to efficiency. The coal should be nearly uniform as to size so that the voids will have the same character. The deep fuel bed allows a higher velocity of the passing gases, which means a greater quantity of gas from the same floor space. The same time element of contact is maintained between saturated air and the incandescent carbon as with a thinner fuel bed and a lower gas velocity. In addition the deep fuel bed has a thermal flywheel effect that will be found useful on fluctuating loads.

Gasification of the Tar

When the tar is returned to the producers, slack coal is an obstacle of serious dimensions. In the later types of clean gas plants all cooling and drain waters are carried to a settling basin where the tar is precipitated with such solid matter as is washed from the gas. The tar is pumped back to the producers and sprayed over the fuel bed. A small quantity of steam assists in the distribution at this point. Standard duplex pumps with iron fittings are used to return the tar. If the fuel bed is composed of sizes above "pea," the tar will be uniformly distributed over each piece of coal without choking the voids, and as it settles to the distilling zone it is driven off in the form of methane. If the bed consists of considerable slack of fine size, the addition of the tar makes a pasty mass that will check the draft, and the result, due to the general disruption of the bed conditions, is poor gas.

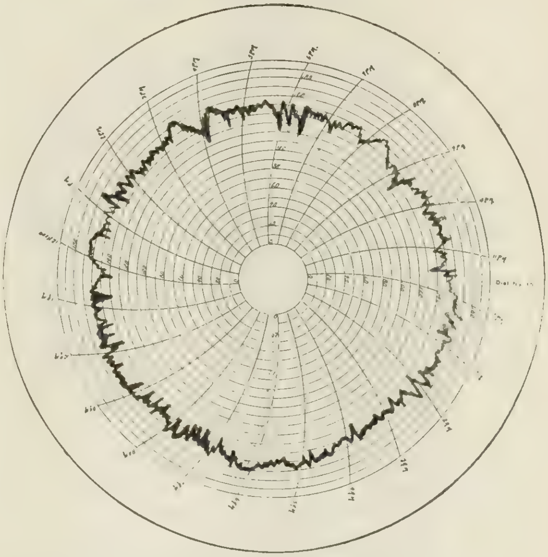


FIG. 1. TYPICAL CALORIMETER CHART

Poor coal, heavy load off at 12 p.m. and on at 6:30 a.m. Each quick drop entails much excess labor to get back to normal.

As nearly 10 per cent of the coal is tar, it is quite necessary that its heat value be utilized. Gas without tar return should, if conditions are good, analyze: CO_2, 5 per cent; CO, 25 per cent; H_2, 17.5 per cent; CH_4, 3.5 per cent; C_2H_4, 0.4 per cent, and N_2, 48.6 per cent. The B.t.u. value is 189 and the percentage of combustible, 46.4 per cent. With the same fuel conditions and the return of the tar, the analysis will show CO_2, 5 per cent; CO, 21.5 per cent; H_2, 17 per cent; CH_4, 5.5 per cent; C_2H_4, 0.5 per cent, and N_2, 47.5 per cent. The B.t.u value is 208 and the percentage of combustible, 47.5 per cent. This is conservative. If the conditions are maintained for several days, the CH_4 may go as high as 8 per cent. The samples, taken from continuous eight-hour sampling tanks, were chemically analyzed and computed and checked with a calorimeter. These results cannot be obtained from coal containing slack in any quantity. The place for slack is under boilers. Likewise the place for coking coal is in a coke oven, not a gas producer.

AVOID THE FINER SIZES OF COAL

If it is attempted to use the finer sizes, the thickness of the fuel bed must be cut down so that the mass will "breathe." About the time this condition is attained, little channels are blown through the fire bed. Oxygen, unchanged, comes through and, in contact with the hot gas, burns a proportional amount of the gas to CO_2, with a consequent reduction in quality. Then the vapor is filled with fine solid matter known as lampblack. The offtake temperatures rise from 800 to 1300 deg. or higher. The tops of the producers suffer from the heat as well as do the men. Larger quantities of water are necessary to cool the gas. The exhausters are putting out 160-B.t.u. gas instead of 200, and it costs just as much to pump a cubic foot of the leaner gas. Other costs increase in proportion. There is but one proper course in this case, and that is to reduce the velocity through the fuel bed, and this means less gas from the same installation.

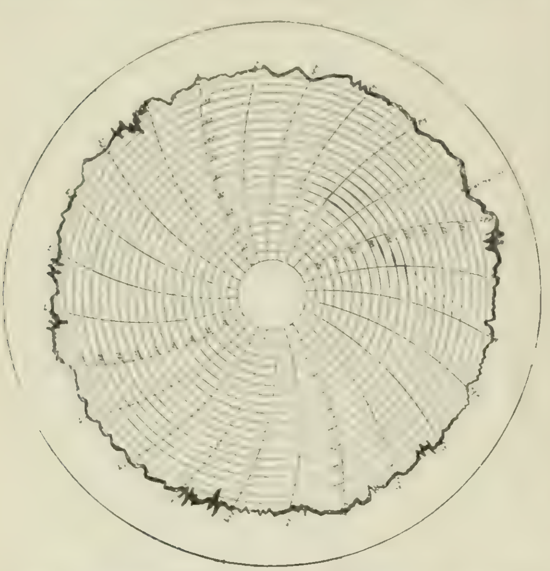


FIG. 2. CALORIMETER CHART WITH GOOD COAL AND CAREFUL OPERATION

The quick fluctuations, generally right after shift changes, are due to violent grate shaking.

A résumé of the fuel situation shows that the coal should have a high heat value, be uniform as to size, low in ash content and non-coking. It should have less than 1 per cent of sulphur, and the fusing point of the ash should be high. The most desirable size is re-screened nut, but this has little commercial value over a coal passed through a 4-in. screen and over a ¾-in. screen. The sulphur content should be low, as it destroys contact parts of the power apparatus under high heat and moisture. For furnace work a high sulphur content attacks metal, in some cases making the gas unusable and at all times a hardship for the furnace workers. Clinkers can be mastered usually by adding moisture to the air supplied under the grates of the producer.

REMOVING THE TAR FROM THE GAS

There has been much improvement in the cleaning of producer gas. The tar-laden gases were formerly passed through an incandescent coke bed. The smothering of the incandescent mass by the gas was to be overcome by the addition of air. The air did not stick to the coke at all times, but united with the incoming gas and burned it. The electric ionizer was another stage in the development of gas cleaners. A two years' fight with this under the writer's supervision resulted in getting the solid matter down to 0.08 gram per cubic foot. This was productive of a dirty mess in the engines and the furnace line valves. City gas had to be admitted around the electric insulators. The temperature of the gas had to be juggled with changes of fuel. The outfit finally went to the scrap heap with its predecessors. Down-draft machines have been successful to a certain extent in small plants, but not where the operation has a gap of but eight hours per week for clean-up and often not even that.

A later claimant for honors in this line is the spun-glass screen. This is not in effect a mechanical screen, for the tar is agglomerated and precipitated after passing through the screen. When the fuel is poor and the operation is defective, lampblack is held up on the pressure side of the screen and the pressure necessary to force the gas through the cleaners rises rapidly until it is a hardship to handle the output. With experience the operating end of the trouble soon disappears. As low as 0.0025 gram of solid matter per cubic foot of gas is fast becoming past history, as much of the time this low figure has been improved.

TWO HUNDRED B.T.U. GAS

Reference to the various authorities now available shows that 160 B.t.u. is the best average quoted for a cubic foot of producer gas. The reason for this seems to be that the rough and ready methods of the old dirty, hot gas plants have left their impression on the industry. In larger plants, where more intensive study is made of the work, this figure is low. With the larger types of machines fed with two to three tons of good coal per hour, the offtake temperatures will not go much above 800 deg., the cooling-water requirements will be nominal, and the machines will last several years without internal repairs. Some machines have been run for eighteen months without letting the fires go out, even when the coal has not been kept to the specifications given previously in this article. When good conditions obtain, there is almost absolute control of the balancing of the gas values. The proper proportion of CO, H_2 and CH_4 can be maintained. It has been found that for some engines a hydrogen content of more than 18 per cent produces preignition, while for furnace work all that can be made adds to the value of the gas. The latter is especially pertinent for small flames.

In the table are given analyses of random eight-hour samples taken when good operating conditions were maintained. All are from machines using 1¾ to 3 tons per hour. The samples were chemically analyzed and computed and checked with the calorimeter. The tar was being returned in all cases.

ANALYSES OF RANDOM EIGHT-HOUR SAMPLES

CO_2	CO	H_2	CH_4	N_2	Comb.	Inert	B.t.u.
3.9	27.1	16.6	5.5	46.9	49.2	50.8	209
8.3	21.3	20.3	5.2	44.9	46.8	53.2	198
7.5	22.1	19.7	5.2	25.5	47.0	53.0	199
3.9	26.9	17.5	4.6	47.1	49.0	51.0	202
7.5	21.7	17.6	6.1	47.1	45.4	54.6	200
3.8	26.9	16.0	5.5	47.8	48.4	51.6	206
5.4	25.0	16.3	5.6	47.7	46.9	53.1	202
4.0	25.9	17.7	5.6	46.8	49.2	50.8	210
9.5	19.5	21.4	6.6	43.0	47.5	52.5	211

In the tabulation the C_2H_4 is grouped with CH_4. Excess steam produced high H_2 and CO_2 and lower CO, but the total is supported by extra H_2 and CH_4, so that the final heat value of 200 B.t.u. is not much affected. In 1918 a freak eight-hour sample for which no tangible clue has ever seemed logical, ran as follows: CO_2, 15 per cent; CO, 14.9 per cent; H_2, 33.6 per cent; CH_4, 9.3 per cent; N_2, 27.2 per cent; combustible, 57.8 per cent; inerts, 42.2 per cent; B.t.u., 266. No sample since has approached this heat value nearer than 227 B.t.u.

With the conditions previously enumerated, the production of 200-B.t.u. producer gas can be considered standard, and the cost of the gas delivered in the mains at the furnaces and engines should not exceed $3.50 to $3.75 per ton of coal, supplying, say, 110,000 cu.ft. Another year will see the general adoption of ammonia recovery in large plants, and this will help to reduce the cost for fuel. It is feasible to use clean 200-B.t.u. gas for city distribution, since gas lighting is now a negligible quantity, and also for various industrial purposes, including heat treating, drop forging, tempering, bath work, enameling, soldering, etc.

Electric Welding Machines—Factors Influencing Their Operation

By L. W. WEBB
Master Electrician, United States Navy Yard, Norfolk, Virginia

Various types of welding machines have characteristics common to all. A machine should not be chosen from the standpoint of power input to power delivered at the arc alone—amount of work produced should be one of the deciding factors. Variable reactance should be used in all welding circuits. A curve is given showing the amount of reactance required in a welding circuit for different values of current.

ALL THE different types of constant-potential and constant-current welding machines, described in the Aug. 10 and 17 issues, possess features common to each but each one has some individual characteristic peculiar to itself and which, the manufacturer claims, possesses certain advantages over the others. Some of these machines have been designed to be of the slowspeed, three- or four-bearing, continuous-duty type with rugged frames and commutators, which would insure long life and reliability; while others have been designed for high speed, of the two-bearing type with a rating for normal load of one hour, and are as small and compact as possible, which makes them lighter and more easily portable than some of the others.

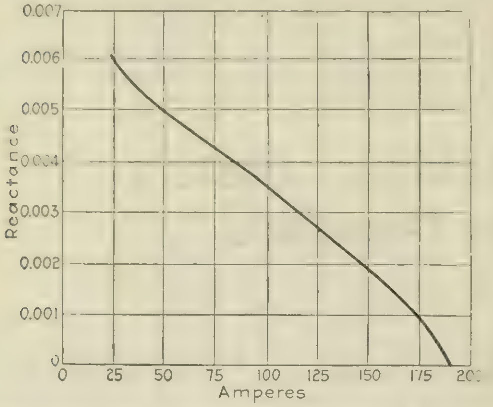
Both of these types possess advantages and disadvantages, depending more upon local conditions as to their use than any real merits or demerits in the individual machines themselves. Some of them have motors that show small percentages of drop in speed from no load to full load, which is a desirable feature and assists greatly in making the welding operation more stable at the instant of striking the arc. Other types allow greater drop in speed between no load and full load and depend upon supplying reactance of higher value to care for this drop in speed at the instant the arc is struck.

The efficiency of the various machines ranges from about 50 to 65 per cent. The over-all efficiency depends somewhat upon the manner in which it is calculated and whether the machines are designed on a continuous-duty cycle or on one-hour rating. These efficiency assumptions are made strictly from the input and output standpoint and do not consider any losses in the external circuit, which, in some of the machines supplying reactance having high values, amounts to considerable.

The fact that one machine is more efficient than another from the standpoint of power input to power delivered to the arc, however, is not of the greatest material advantage after due consideration is given to the fact that the pay of the operator is usually many times that of the cost of power and the value of the work produced is much more than both combined. The machine that is capable of producing 5 to 10 per cent more work than another machine, even though it had an efficiency of 20 per cent less, might, from the standpoint of cost of work produced be much more economical to use. One of the determining factors in deciding upon the general adaptibility of any type of machine should be work produced rather than efficiency from the power-consumption standpoint.

It is desirable at all times to have machines that are efficient but require very little maintenance; that are reliable in operation and simple to operate; that can be depended upon at all times not to break down or heat up excessively under abnormal conditions of rush jobs, etc; and that are easy for ordinary operators to use. Machines having these characteristics would in most instances be preferable to others that might be far more efficient and that could be purchased at less cost than these.

For this reason in general it is usually just as efficient to do welding with machines of the 60-volt constant-potential type as with those of the so-called constant-current type, as experience shows that with these higher voltages the operator can, in the course of a day's work, usually produce more work than with the other type of machine. This is especially true where several operators are grouped in close proximity and can be supplied from multiple-operator type constant-potential 60-volt machines, and in such a case not only is the maintenance of the whole equipment lessened, but the time saved in starting and stopping welding operations amounts to considerable. Where machines have to be portable, most of those of the constant-potential type on the market are necessarily of higher rating than those of the constant-current types, and are therefore much heavier; but one machine in particular is an exception to this, and this one is very compact and weighs less than most of the constant-current types of motor-generators. As the efficiency of this machine is very much higher than that of many of the constant-current types, its over-all welding efficiency is not very much lower when compared from power input to power delivered to the arc standpoint. This type of machine will produce as much or more work in the course of a day than some of the so-called constant-current types.



REACTANCE AND CURRENT FOR SUITABLE WELDING CONDITIONS

EFFICIENCY NOT GOVERNING FACTOR

Therefore, while in the descriptions of the individual machines in the previous articles, mention was made of the fact that some showed a higher over-all efficiency than others, and also the fact that the constant-current type of machine is more efficient than the constant-potential type from the standpoint of power input to power delivered to the arc, and while the manufacturers themselves lay great stress on these efficiency values, they alone should not be considered from an economical standpoint of cost of total work produced.

In each of the descriptions of the machines it was noted that certain reactances—usually connected in the external circuit, some of them partly variable but usually of the fixed type—were furnished with each machine and the amount of reactance on the individual machine varied considerably.

As can be clearly recognized, each type of machine has common to itself certain definite machine reactance due to its series field windings, etc. This would seem to indicate that external reactances provided with them were of such values that the sum of the two reactances would make a certain definite total reactance in each welding circuit, for the best conditions of arc stability and ease on the operator. However, most of the manufacturers have neglected this to a certain degree, possibly due to the rush in getting out designs or standardizing their sets. Some manufacturers supply reactance of high values so that any operator, even though inexperienced, can maintain an arc and do welding with the machine without any special instructions; other manufacturers have provided only the amount of reactance that should be required by an experienced operator holding the proper arc length, and which, if the arc were drawn out too long, would cause it to blow out. The latter point is an excellent one from the standpoint of preventing poor welding due to an inexperienced operator holding too long an arc. It keeps him strictly on the job at all times and makes him maintain the proper arc length and prevents him from becoming careless. Experienced operators, however, do not have this trouble, as they are not likely to get careless and allow the arc to be drawn out too long.

The correct amount of reactance is such that when the arc is lengthened out beyond a point where poor welds would be made, self-regulation of the machine should be such that the arc is immediately blown out. Also, it can be easily seen that for best results this reactance must vary with the current used and the nature of the weld. A variable type of reactance for best welding should be provided with each machine, rather than the fixed type, as is at present furnished by most of the manufacturers. Even though this adds materially to the cost of the machine, it is justified by the better results that should be obtained in the welding itself.

TESTS MADE TO DETERMINE REACTANCE REQUIRED

To obtain a general idea of how the reactance required varies with different current values used, a storage battery delivering about 600 amperes at 60 volts for one hour, continuous rating, was connected through a non-inductive resistance and a variable reactance to a welding circuit. By varying the reactance to get suitable welding conditions for currents from 60 to 200 amperes, the curve plotted in the figure with currents as abscissas and reactance as ordinates was obtained.

All wiring was run in duplex wire with straight leads to eliminate all circuit reactance, consequently the variable reactance would then be total in each case. It was noticed that from 60 to 100 amperes the reactance required was easy to ascertain, and from 125 to 150 amperes more difficult; from 150 to 200 amperes no perceptible difference could be noticed with all reactance cut out. This was particularly noticeable and indicates that the lower currents do not have arc stability and require stiffening much more than the higher currents. These results were obtained by close observation and using the most experienced operator available. He was not allowed to know when the reactances were varied or whether higher or lower values added. Three or four checks were made before the final value was determined upon. It is believed that much more accurate results could be obtained by the use of an oscillograph, but as no apparatus was available it was done in the manner described. Also, as the voltage was reduced from 60, more reactance was required, and the more stable the voltage the less the reactance. Therefore machines that are slow to regulate should have higher reactances than those which regulate quickly. Also, the more stable the circuit voltage and the machine speed, the easier it is to weld with less reactance. In every case, however, the reactance should be variable for different currents used within the range of the machine.

Francis Winthrop Dean

Since Leaving College Two-Score Years Ago, Mr. Dean Has Given Much Time and Thought to Improving the Design of Boilers, Steam Engines, Pumping Machinery, etc. Many Important Modifications in Construction and Operation Are the Results of His Efforts.

DURING the world conflict in 1917 the United States was faced with the tremendous task of quickly transporting overseas to the scene of the struggle millions of men and vast quantities of food, clothing and ammunition. The task was seemingly impossible, and even the Germans ridiculed the idea of a nation three thousand miles away being an effective opponent. There were not nearly enough ships to transport troops and supplies in the quantity needed. The United States Shipping Board Emergency Fleet Corporation was formed to consider ways and means of facilitating the construction of the much-needed ships. Not the least important part of this task was the design of an efficient boiler for use in wooden vessels. F. W. Dean, who for a decade had been interested in improving the design and construction of boilers and who had done much good work in this direction, was selected to take direct charge of a series of tests to determine on a standardized boiler for use in the wooden ships which the United States Shipping Board was planning to construct in great numbers. Both coal and oil were used in the tests. A number of modifications in the design of boilers were suggested by Mr. Dean, which were adopted as standard. This work did not end with the war, but formed the basis of further investigation and improvement.

The outstanding characteristics of Mr. Dean are painstaking care and conscientiousness in his work. The performance of these boilers furnishes ample proof of the ability of the man who designed them.

His work, however, was not confined to boiler tests. A number of experiments with steam engines were conducted, and at present he is testing out an experimental uniflow engine with the object in view of obtaining data on the performance under varying conditions of this type of engine.

Mr. Dean was born in Taunton, Mass., in 1852. After completing his primary education at that place, he entered the Lawrence Scientific School where he studied civil engineering. In 1874 he became an instructor of civil engineering in the Lawrence Scientific School. He resigned in 1882 and entered the office of E. D. Leavitt, Cambridge, Mass., as an assistant. Later, he became a draftsman, inspector of machinery and chief draftsman, which position he held from 1886 to 1889. Mr. Leavitt, his employer, had the reputation of being one of the most conscientious and expert engineers on the design of mining machinery and pumping engines in the country. At all times he sacrificed economy for perfection of construction. Mr. Dean received valuable experience here and became so appreciative of the engineering ability of his employer that he wrote a review of his work. In 1889 he opened an office in Boston as the head of the firm of Dean & Main, engineers and architects. While a member of this firm he had as clients a number of large manufacturers, including the American Woolen Co., the Lowney Chocolate Co. and the Walter Baker & Co., Ltd., of Dorchester, Mass., and Canada.

He also designed the power plant of the Massachusetts General Hospital at Boston.

Mr. Dean's interests at this time were varied, and much research work was done by him on the design of boilers, pumping machinery, utilization of pulverized fuel, compound engines, etc.

In connection with his pumping-machinery tests in 1894, he prepared the design for a new suction system for the City of Taunton. During the same year he was retained as expert for the Louisville Water Co., Louisville, Ky. With Dexter Brackett, expert for the I. P. Morris Co., of Philadelphia, the builders of a new pumping engine at Louisville, a contract trial of six days' duration was held. The engine ran 144 hours and 10 minutes without a stop, the longest test run then on record, and established itself as the most economical compound engine that had been tested up to that time. A short time later he conducted an experiment with a compound engine working with high-pressure steam with the idea of establishing the economy of performance of an engine of this character.

For several years prior to 1915 Mr. Dean had been impressed with the value of corrugated furnaces for vertical boilers. A great deal of experimental work on the design of fire-tube boilers and steam drums has been done by him, embracing every phase of construction, and in a paper presented at the annual meeting of the American Society of Mechanical Engineers in 1915, he brought out very clearly the need for care in detail of construction and pointed out various remediable faults of boilers. He also suggested changes which would eliminate many of the prevalent faults.

No matter how efficient the boiler or engine may be, maximum performance cannot be obtained unless the best fuel is used. Mr. Dean is now turning to pulverized coal as the ideal fuel. He is firm in his belief that this method of burning coal when carried out on a scientific basis will give the best results.

Mr. Dean, while modest and unassuming, has never hesitated to give the benefit of his wide experience to fellow engineers.

The following papers presented to the American Society of Mechanical Engineers indicate subjects which have been in direct line with his professional work and in which he has specialized: "Distribution of Steam in the Strong Locomotive"; "Some Experiments with the Throttling Calorimeter"; "Trials of a Recent Compound Engine with a Cylinder Ratio of 7 to 1"; "Trial of the Leavitt Pumping Engine at Louisville, Ky."; "Report of Committee on Standard Method of Conducting Duty Trials of Pumping Engines"; "Power Plant of the Massachusetts General Hospital, Boston, Mass."; "Forcing Capacity of Fire-Tube Boilers"; "Comparative Tests of Steam Boilers with Different Kinds of Coal"; "Calorific Power of Weathered Coals"; "Burning Anthracite Culm"; "Best Form of Longitudinal Joint for Boilers."

He is a member of the American Society of Mechanical Engineers (vice president, 1895-7), Boston Society of Civil Engineers (vice president, 1907-9), N. E. Water Works Association, Engineers' Club, New York; Harvard Union, Cambridge, and Exchange, Boston.

Mr. Dean is an ardent lover of music and manages occasionally to steal away from the cares of business to attend concerts and recitals.

"Type A" Power-Plant Oil Filter

On oil filter that should interest power-plant engineers is manufactured by the Richardson-Phenix Co., Milwaukee. This filter operates on the so-called dry principle of filtration, in which the oil is not passed through water. It is designed to accomplish purification both by precipitation and by filtration through closely woven cloth. By the former process the oil is brought practically to rest, and entrained water and heavy particles of foreign matter are allowed to settle out. The incoming dirty water is heated to lower its viscosity and reduce its ability to retain water and foreign particles in suspension. The oil then takes a long path, flowing at low velocity over shallow trays where precipitation takes place, and finally through the filtering medium. The oil is stored in a clean-oil compartment ready for re-use. When necessary, it is passed over cooling coils after being filtered.

Referring to Fig. 1, the dirty oil enters the filter through the removable strainer box *A*, where large particles of foreign matter, such as waste, etc., are removed. It then passes to the heating tray *B*, where its viscosity is so reduced that it becomes extremely thin and is unable to retain the water and solid matter in suspension. The heating tray is so arranged that the oil flows over the heating coil *C* in a thin stream.

After passing over the heating tray, the oil flows through compartment *D* and down through the funnel *E*. Passing down through the conductor *F*, it is spread out by the baffle *G*. Under the action of the greater head that can build up in the conductor *F*, the oil is forced to take a zigzag course upward, passing under the trays, *H*, *I*, *J* and *K*, as shown by the lines of flow, and out through *R* to the filtering compartment.

As the oil passes over the tray at a very low velocity ($\frac{7}{10}$ ft. per minute at the normal capacity of the filter) the heavy particles of dirt and water settle to the bottom of these trays; and as the water, in settling, takes a course at a right angle to the direction of the flow of the oil, the movement of the latter offers no resistance to the precipitation process.

The separated water collects in the bottom of the trays and is bypassed directly to the bottom of the precipitation compartment by means of the funnels *L*, *M*, *N*, and *O*, and does not come in contact with the oil where it might be picked up again. The water in the bottom of the precipitating compartment is automatically ejected by the adjustable water-overflow tube *P*. The column of water in the pipe balances the column in the precipitation compartment, which is made up largely of oil and partly of water. As oil is lighter

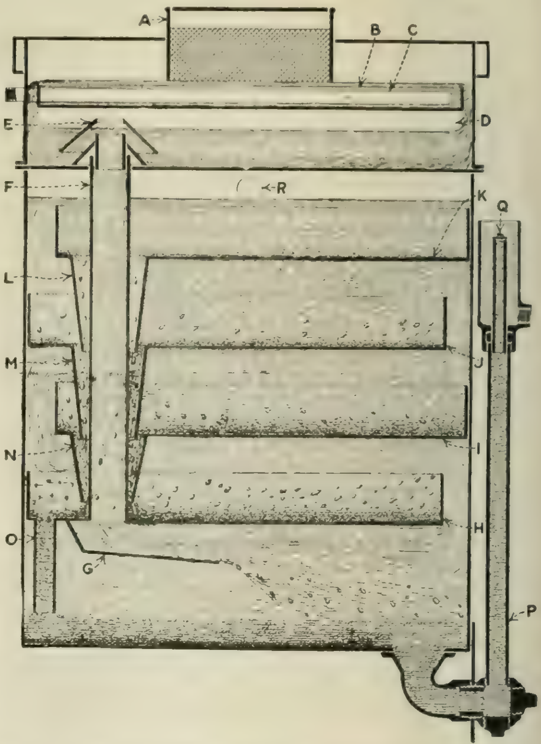


FIG. 1. SECTION THROUGH PRECIPITATION COMPARTMENT AND AUTOMATIC WATER EJECTOR

than water, the top of the tube *Q* is a little lower than the overflow level of oil in the precipitating compartment, the overflow is always water sealed and can be so adjusted that oil will not pass out through it.

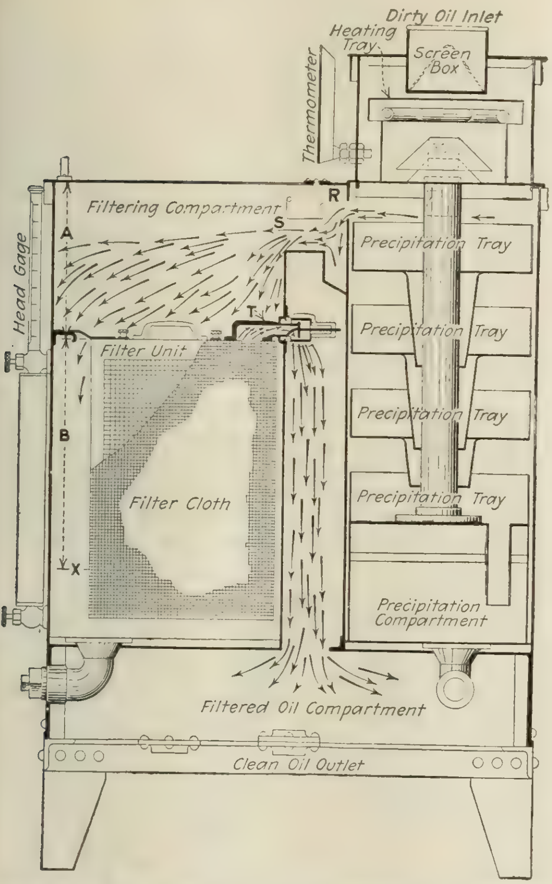


FIG. 2. SECTION THROUGH FILTER, SHOWING FILTERING COMPARTMENT

The level in the top tray is maintained constant by a skimmer, *R*, Fig. 2. The oil then flows through the pipe *S* into the filtering compartment, which contains nine non-collapsible filtering units, passing from the outside to the inside and then out through the nozzle *T*.

The clean oil occupies all the space in the bottom of the filter under the precipitation and filtration compartments and also the space alongside the filtering compartment, which is about one-half the width of the filter. The clean oil is piped off through a fitting in the center of the bottom of the filter.

Simple Rules for Operating Hand-Fired Boilers When Using Low B.t.u. Coal

By W. A. Darter

The thickness of the fuel bed should depend upon the nature of the fuel, whether lumpy or slack, hard or soft, also upon the draft, whether weak or strong. If the draft is strong, a thick fuel bed can be carried, because the air can be forced through the fuel. If a thick bed of slack coal is carried, air cannot easily pass through it, hence a thin fire or fuel bed is necessary.

With a given load on a boiler a given amount of coal has to be burned, and this amount of coal will require a given thickness of fuel bed and therefore a given draft.

To get the best results from the fuel, it is necessary to keep the grates free from ashes and clinkers, because they keep the air from entering the fuel bed, and without air the coal cannot burn.

With very slack coal keep the fuel bed about three inches thick. The more lumpy the coal the thicker the fuel bed can be kept. With forced draft and thin fuel beds air holes will form and give an excess of air. Thick fuel beds have a tendency to form clinkers and give trouble. Keep the fuel bed level and all the holes filled up.

STOKING AND FIRING

It is better to systematically stoke the furnace at short intervals than to fire it at long intervals. The intervals depend upon the load the boiler is carrying. If lightly loaded, the intervals can be longer. While firing, do not keep the furnace doors open any longer than necessary, because cold air rushes in and chills the boiler.

Only a part of the furnace should be fired at one time, because if coal is thrown over the entire grate surface there is an interval in which the steam pressure will drop and then rise. This change in pressure is not desirable and is wasteful of fuel.

The grates should be shaken just enough to get rid of the ashes, but not enough to shake coal through into the ashpit. The fires should not be stoked any more than it is necessary, because stoking causes clinkers—the melting of ashes together.

All coal burned should be weighed and the water metered, in order to figure the evaporation. Watch the draft gages to see that the boiler does not have too much draft for the load. With the damper set at the right position, the draft gages will show when the fire has holes in it or when the fire is choked.

BLOWING DOWN BOILERS

The interval at which boilers are to be blown down depends on the nature of the water that is used. Very hard water containing vegetable matter will require more blowing down than water that is free from such matter. With good water, blow down the boilers about one inch every twenty-four hours; with poor feed water, blow down from two to three inches every eight hours. The water column should be blown down on every shift to make sure that the water level in the boilers shows true. Don't open or close blowdown valves with a jerk, but open them wide.

The soot on the tubes should be blown out at least every shift, when the boiler is carrying full load, and the blowing should be done with high steam pressure.

CONTROL OF THE DRAFT

The draft can be controlled in two ways—by operating the damper and by closing the ashpit doors. When too much draft is used for the thickness of fuel bed or the coal used, then an excess of air is used, which is the greatest enemy to proper combustion of coal. The better way is to control the draft by the damper and not by the ashpit doors. Controlling the draft by the ashpit doors causes a greater suction on the entire boiler setting, and all cracks and porous bricks will admit more cold air, thereby reducing the efficiency of the boiler.

The damper should be kept as nearly closed as possible and still keep up the required steam pressure. The required position of the damper for every load should be tested out and marked.

The less draft with which a boiler can be operated without giving out smoke, the better will be the efficiency. The CO_2 machine should not, ordinarily record over 12 per cent. Excess air will reduce the percentage of CO_2. The greater the amount of damper opening, the greater the amount of heat that will go up the chimney.

When using dumping grates, clean one section at a time and try to clean the fire when the steam pressure is normal or above normal and when plenty of water is in the boiler.

To clean one section, push the fire to the back end of the section to be cleaned, dump the front half of the grate and pull out all the large clinkers. Then pull all the fire to the front of the section and dump the back half of the section, and rake out all the clinkers. Then distribute the fire evenly over the section and cover with coal.

After the steam has reached normal, clean the other section and so on until the entire grate is cleaned. To clean stationary grates, push the good fire from one side toward the center of the boiler and rake out the ashes and clinkers. Then distribute the fire evenly over the clean section and cover with coal. After the steam is again normal, clean the other side and so on until the entire grate has been cleaned. Never clean the whole grate at one time because the boiler will become chilled and there is always danger of the steam pressure dropping. When a boiler is running heavily loaded, the fires should be cleaned about every three hours.

To remove ashes by hand with the least heat, always throw sufficient water on them to kill the live fire. If more water than this is used, it makes the ashes water-soaked and hence heavier to handle.

Live ashes should not be dumped near wooden structures or any material that is likely to catch fire. Before removing ashes from the ashpit the fire should be thoroughly cleaned and all clinkers pulled.

BANKING FIRES—METHOD NO. 1

Push the fire back to the bridge wall and cover it with green coal and then with some ashes if needed. Close the furnace tight.

When the boiler is needed, spread the fire evenly over the grate and add coal. When a boiler remains idle only a part of a day, it is best to bank the fire, because the walls and boiler retain their heat and a great amount of contraction and expansion is avoided.

BANKING FIRES—METHOD NO. 2

To bank a fire flat, cover the entire fuel-bed surface with green coal and close the furnace tight. To start the boiler up, open the draft and, after shaking the grates, add more coal. Sometimes fires are banked at the front of the grates, in which case the boiler can be fired up much quicker.

To bank a 150-hp. boiler 24 hours will take about 1,000 lb. of coal when method No. 1 is used. To bank the same boiler 24 hours by method No. 2 will take about 1,400 lb. The second method will keep the boiler furnace heated up more evenly, and flat banking is not satisfactory when volatile coals are used.

CONTROLLING THE STEAM PRESSURE

With every given load there should be a given position for the damper. The greater the load the greater will the draft have to be. When there is no load on the boiler, the dampers should be closed tight, and the front of the boiler closed.

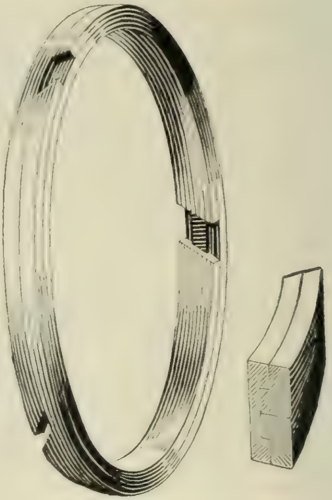
Set the damper at the proper position and fire up the boiler. Keep the furnace doors closed as much as possible, because the cold air cools the furnace gases and heat is lost. When the steam pressure begins to approach the blowoff point, the ashpit door should be closed in order to keep the air from entering the fuel bed and burning the coal when the heat is not needed.

If the steam pressure still rises and the water level of the boiler is below normal, pump feed water a little faster into the boiler in order that it may absorb part of the heat.

When the ashpit doors have to be closed too often, it is a sign that the damper is open too wide.

Zelnicker "Ever-Tyte" Piston Ring

A simple form of multi-piece piston-ring—three rings locked together with a right-angle interlock—known as the "Ever-Tyte," is manufactured by the Ever-Tight Piston Ring Co., 1620 Kingston Ave., St. Louis, Mo. The inner, or keeper, ring is the width of the groove of the piston and is grooved on the outside surface to take the flanges of the two outside rings, which fill up the groove on the keeper ring. The outside rings are held in place by a dowel pin so that the joints are staggered, thus reducing the amount of gas leakage. The construction of the ring forms a right-angle interlock which closes the points of contact between the members and seals all gaps and compression, thus preventing waste of power. This ring is designed for use in internal-combustion engines, ammonia compressors and in steam engines.



EVER-TYTE PISTON RING

EDITORIALS

Need of an Hydraulic Laboratory

THE American people are apparently to embark upon an extensive campaign of water-power development. The passage by Congress of the water-power bill, the increasing price and precarious supply of coal, the possibilities of electrical transmission, the growing possibility of great interconnected systems to which they may be tributary, the growing demand for power through the electrification of railways to which many as yet undeveloped water powers within reasonable distance of which the roads pass could be contributory, all favor an early and intensive movement in this direction.

The observer who looks back upon the developments of the next thirty years in the light of the knowledge of 1950 will doubtless see many errors and failures; much that could have been better done, much waste and loss that could have been avoided. How many of these mistakes may be shunned, how much more effectively may we spend our money and our effort in developing our water power resources if it is gone about in a systematic and intelligent fashion?

In the past twenty years the attained efficiency of the water turbine has been increased from about eighty to ninety-odd per cent. This leaves little to be accomplished in this direction, but this is only one of the factors. Recent developments have made it possible to operate turbines efficiently at high speeds under low heads. This means the use of lighter and less expensive wheels and generators and a reduction in the installation cost per horsepower or kilowatt. One of the most grievous difficulties about the operation of a waterpower is the loss of head due to back water. At the very time that the greatest amount of energy is coming down the river, in a state of flood, the available fall is so reduced by the backing up of the water below the falls, the incapacity of the channel to carry away the increased flow, that the plant is unable to convert as much of this energy as in times of moderate flow. To install and maintain units enough to meet the maximum demand under the lesser head and to lie idle most of the time is costly. Efforts are being made to provide for utilizing, with the units installed to meet the requirements under ordinary conditions, enough of the energy of the surplus water to make up the deficiency due to the loss of head; to get, by the use of a greater quantity of water under a lesser head, as much power as with the lesser amount under the greater head, for which the turbines were designed, and this with the same machines. A lowering of the efficiency is not material at a time when water is so plenty as to be a nuisance. These and other possible improvements will make profitable the development of powers that might otherwise be unavailable, or the development to better advantage of others more advantageously situated.

Are we going into this development feeling our way with our eyes shut and commit blunders, or are we going to systematically and scientifically study the subject and let our heads save our hands—and money?

What is needed is a national hydraulic laboratory equipped for the scientific study of the flow of water and its conversion into power. Clemens Herschel in a paper presented at the last meeting of the American Society of Mechanical Engineers urges the establishment of such a laboratory and presents a weir the idea of which had lain latent in his brain for twenty years for lack of an opportunity to try it out.

The effective development of its water powers is of moment enough to the nation to warrant the establishment and operation of such a laboratory by the Government. At least it might follow the example of the British Government and contribute toward the establishment and support of such a laboratory a dollar for every dollar furnished by private enterprise. The power companies, the companies interested in the development of hydraulic machinery and those who would profit less directly in the accelerated and perfected development of our water powers could well afford to provide one-half the cost. The Engineering Foundation or the Engineering Committee of the Research Bureau could appropriately serve as the collectors and conservators of the fund. Perhaps it would be a proper activity for the new Federated American Engineering Societies to try its lance upon.

Roof Condensation

MANY power plants in the northern section of this country and in Canada, where temperatures below zero are common in winter, have trouble with so-called "sweating" of the engine room roof. This is particularly troublesome and annoying where there is installed electrical equipment that must be kept dry. In some cases tar-paper covered structures must be erected over motors, generators and switchboards to protect them from these drips.

The cause of this roof condensation is due to variations in the humidity of the air in the engine room. The air around the engines or turbines is heated and its absolute capacity to carry moisture is thereby increased. It tends to saturate itself with any moisture available such as that escaping from steam leaks at valve stems, piston-rod packing, glands or other places. This heated, highly humidified air rises to the roof. In contact with the cold roof it loses much of its heat by conduction and radiation and its temperature drops. The dew point for the amount of moisture present is soon reached and moisture is deposited on all the exposed cold surfaces of the roof, particularly on the metal beams because of their greater heat conductivity. The moisture collects in drops and falls down on machinery and equipment. The air having now become much cooler descends to the floor level, where it is again heated and humidified and the process is repeated.

The trouble can be lessened by making the roof of special heat-insulating construction with dead air spaces, layers of building paper and a wood sheeting. This, however, generally is very expensive. Another method is to build the roof of gypsum blocks, but these are also expensive. Neither of these methods prevents condensation on the steel roof members. Still another plan is to provide heating coils under the roof. These generally will prevent condensation but are rather extravagant in the use of steam.

A plan developed by one of the large engineering-construction companies bids fair to provide the most satisfactory cure for this trouble. The cooling air from the turbo-generators can be regulated so that the discharge is sufficiently hotter than the room to be used for heating the building. This air is normally carried by a duct to the forced-draft stoker-fan inlet, but may be directed toward the roof of the engine room by a damper in this duct which opens directly upward in the operating room. The temperature and also the absolute humidity of the air entering the generator are kept low by an air washer which is furnished with cold water from the condenser supply. Hence when this air leaves the turbo-generator it is hot, but with very low relative humidity. It rises directly to the roof absorbing any moisture with which it comes in contact. The turbo-generator draws air through the air-washer from the operating room so that the circulation of air in this room is very rapid. The warm air does not stay long enough in contact with the roof to cool down near its dew point, so that no roof condensation occurs. When the air is cooled during its passage through the cold air-washer sprays, the moisture that has been picked up is effectively removed. This system presents no operating difficulties and appears to be a most satisfactory solution of the problem of roof condensation, as well as providing good ventilation for the operating room. It would be interesting to know how others have attempted to overcome this trouble and with what success they have met.

Ultimately Worth While

THE effect of the railroad rate increases upon coal prices is variously estimated. That an immediate increase in coal prices will result in most districts seems inevitable. The exact magnitude of the increase, however, will depend more upon the temper of the coal man than upon the Interstate Commerce Commission decision itself, it appears. The ultimate effect is, however, less obvious though apparently no less certainly favorable to the coal user.

By limiting coal priorities to New England and the Northwest, with the exception of assigned cars for public utility coal, the Commission in a sense established itself as a fuel administration, fixing the price of coal for utilities and these favored districts. It might as well have said that the buyer will hereafter determine coal prices instead of the seller, for if coal may not move in other directions until given quantities go here, the purchaser in these particular districts can in a large measure determine the maximum price which he is willing to pay and thereby limit the prices charged.

The freight rate order, however, has an entirely different effect. As stated above it means an immediate increase in coal delivery cost and, therefore, probably in coal prices as well. However, it means improved facilities and equipment of the railways, eventually and probably very soon. The ability to move coal should thereby be greatly increased and the benefit of the improved transportation should then eliminate the opportunity for famine prices of fuel, assuming, of course, that the car shortage is, as has been claimed, the greatest factor in the present coal situation. Another season with favorable income and opportunity for accomplishment of deferred maintenance should, it seems, eliminate the extravagant coal prices with which the fuel user has had to contend during the current year.

Why Not Co-operate?

THE country has at last been brought to a stern realization of the necessity for conservation of fuel, both coal and oil. Consequently, engineers are everywhere looking to greater use of water power, and the recently enacted Water-Power Bill is expected to stimulate such development.

There are many sites which can best be developed under private initiative with the safeguards provided in the Water-Power Bill. There are other sites so situated as to make it difficult to attract private capital, and in these cases the Government should take the initiative. Great Falls on the Potomac comes within this latter class. Special provision was made in the Water-Power Bill for its investigation. Yet, at the first hearing on this project a few days ago in Washington, the local electric company interposed strong objections. It appears that the company has acquired certain rights or options, but admits that it has no plans for development and, moreover, no intention of developing the falls. However, it was intimated that the company would be willing to relinquish them to the Government at a substantial profit. Meantime, the company is paying high prices for coal, is doing its share to exhaust the supply, and presumably its customers are helping to pay the interest on these non-productive options.

Such an attitude is economically unsound. Why not encourage the Government to develop the site and through some equitable agreement sell in bulk to the local company, which, in turn, would distribute as at the present time? The existing steam plant of the company would provide the required reserve for periods of low water or peak load. The plan is being worked to advantage on the Pacific coast and would seem just as feasible in the East. It is high time that such problems were viewed broadly and in a spirit of co-operation rather than competition.

May Cut off Natural Gas

FIVE public-service commissions will meet on September tenth to decide important policies with respect to industrial natural-gas supplies. These commissions are considering joint action looking to rules that will cut off natural gas from those who use it for boiler firing, brick making, ceramic manufacture, glass production and similar large-scale industrial uses. The states involved are Pennsylvania, West Virginia, Ohio, Maryland and New York.

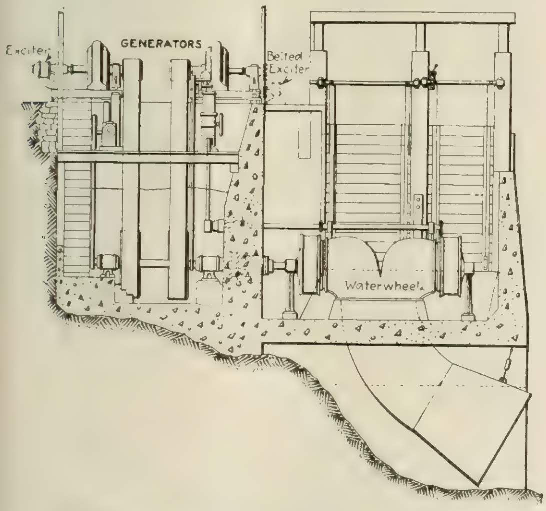
Users of natural gas for boiler firing, unless they have very special demands which can demonstrate the right of priority, will doubtless find it necessary to look to other fuels during the coming winter, and if the program proposed is adopted by these commissions, these users probably will never be supplied with natural gas for boiler firing again, even at low-load seasons. This policy seems to be essential in order that appropriate resting of wells may be accomplished during light-load seasons, thereby increasing the available rate of production for domestic users during peak-load periods.

CORRESPONDENCE

Operating Alternators in Parallel Belted From the Same Shaft

My attention has just been attracted by an article in your July 13 issue of *Power* entitled "Operating Alternators in Parallel Belted from the Same Shaft." In February, 1916, the San Joaquin Light and Power Corporation completed and put into operation a hydro-electric plant on the Merced River at Merced Falls. It was considered a rather unique installation at the time, inasmuch as two separate alternators were to be belted to a single waterwheel and operated in parallel.

The figure shows the general arrangement of the power house with two 225-kw. 600-r.p.m. 3-phase, 2,300-volt generators belted to the one waterwheel. One of the units has a direct-connected exciter, while the other is belted to its exciter. The exciters are not arranged for parallel operation. Each generator has its main oil switch on the main bus. The total output from the bus feeds through an oil switch to a single bank of transformers, where it is stepped up to distribution voltage.



GENERAL ARRANGEMENT OF WATERWHEEL AND GENERATORS

The operation of the plant is much more simple than might be supposed. If it is desired to shut the plant down the load is reduced to zero and the transformer switch is then opened. The generator switches and field switches are left closed and the excitation gradually dies out as the generators slow down. Getting the units back on the line is quite as simple. None of the switches having been opened, the waterwheel is started and the units are brought up to speed, the excitation building up and holding the generators in step. When the point of synchronism is reached the transformer switch is closed, connecting the plant on the system. While essentially a block-load plant, the waterwheel is connected with a Woodward oil pressure governor which controls the speed should the plant at any time be running separate from the system carrying the local distribution.

There is a slight surging or exchange of current between the generators due to belt slippage, but it is not serious as the voltage is not affected. No trouble has been experienced in the division of load by the generators or their holding in step. In fact the operation has been very satisfactory. As the present belts are badly worn it is proposed in the near future to couple the generators together mechanically and drive them with one new belt, which will result in a trifle better efficiency and eliminate the surging. This was tried out recently and demonstrated to be perfectly feasible.

R. C. DENNY, Operating Engineer.
Fresno, Cal. San Joaquin Light & Power Co.

Back in 1908 I operated a plant where two 2-phase 2,200-volt 60-cycle alternators were connected in parallel from the same driving shaft, and I do not recall any particular operating difficulties. The machines were the same size, 200-kva., with voltage controlled by a Terrill regulator, and each machine had its own exciter.

In 1899 a plant consisting of three 3-phase 440-volt compensated winding alternators was installed to operate from the same driving shaft. A fourth machine was added later. This plant operated without any serious difficulty for twenty years. In this case also the machines were all the same size and make. With two machines of different capacities the story might be different. However, so many queer stunts have been pulled off with alternating-current machinery that I would hesitate to say that it could not be done.

Paterson, N. J. W. H. MOORE.

We have been operating in Derby three belted machines from the same shaft for the last fifteen years and have had no trouble in the operation of them. The installation consists of four waterwheels belted through two belts to a common line shaft, this line shaft operating two 200-kw. 2,300-volt 600-r.p.m. machines; also one 450-kw. 360-r.p.m. machine. All three machines are placed approximately 25 ft. from the main line shaft. We found some difficulty at first in making the machines take their proper amount of load. All machines are furnished with paper pulleys, consequently by turning down the pulleys to a slight extent we were able to get the machines to operate with a proper division of load. There is absolutely no trouble in bringing the machines in parallel operation. The incoming machine having no load, of course always runs somewhat faster than the machine carrying the load. The usual division of load between these three machines has been about 450 kw. on the larger machine and 150 kw. on one of the smaller machines and 75 to 100 on the second smaller machine. This takes in the full capacity of our waterwheels. We are also able to make a very material change in the amount of load on the smaller machines by a very slight adjustment of the tension of their belts.

M. M. Eckhardt, Supt. Elec. Dept.,
Derby, Conn. Derby Gas Company.

In the July 13 issue of *Power* I note Mathew King desires to operate a 75-kw. and 120-kw. alternator in synchronism from a common shaft and that the editor states this is highly impractical. I operated a plant for two years which consisted of three 120-amp. monocyclic alternators driven from a common jackshaft by belts.

Two of these machines were synchronized in the usual way and operated on the day load. The third machine was synchronized in with the other two for the evening lighting load. While two of the machines operated together and took their share of the load, yet we were never able to get the third machine to take its share. The belt on the third machine would chirp continually, indicating a continual slip.

All of these machines operated at the same speed, had the same size pulleys and same width of belt. All machines had friction clutches, which also allowed for some slippage. The plant was installed in 1893 and operated night and day until 1907, at which time two 3-phase 200-kw. machines, each driven by its own engine, were installed.

These old monocyclic alternators were installed before the modern oil switches were used. Hence we had only open 3-pole knife switches. One peculiar thing which we did not understand in those days was, No. 1 or No. 2 alternator could be disconnected from No. 3, but No. 3 could never be taken away from Nos. 1 or 2, because it could not be made to drop its load, but the load could be reduced on the other two by cutting down the exciter voltage. When the load was heavy the only way we could separate the alternators was by slowing down until it was safe to open the switch. We were always troubled with cross currents. This was apparent from a continual swinging or darting of the ammeter needle.

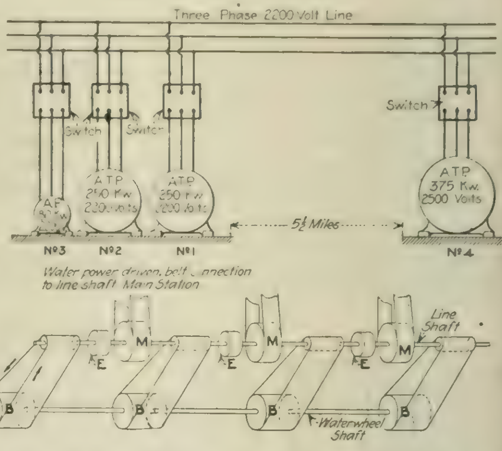
These alternators had a great many peculiar characteristics which I will not attempt to narrate here, but I would advise Mr. King to get one alternator large enough to carry the load or else divide the load between the two machines and not attempt to operate them in synchronism. Waldo Weaver.

Canton, Ohio.

In answer to Mather King's letter in the July 13 issue, would say that we have two 100-kva. 2,300-volt 900-r.p.m. alternators belted from the same shaft and have never been able to run them in parallel satisfactorily. We changed the pulleys and turned them down several times but the only way the machines would operate together was by slackening the belt on the high unit and letting it slip. It was impossible to get them the same speed. We finally divided the load and ran the machines separately. Bernard G. Brown.

Attawaugan, Conn.

In the figure is shown the general arrangement of shafting in a water-power plant in New Hampshire where three alternators driven from the same shaft are operated in parallel. The belts marked *B* run from the waterwheel shaft to the main line shaft. Those marked *M* are belts to the three generators, and *E*, *E*, *E* are driving pulleys to three 15-kw. exciters. Nos. 1, 2 and 3 represent the electrical end of the station driven by water power and No. 4 is an engine-driven unit, located 5½ miles away, for auxiliary service. These machines may be connected in parallel or operated independently. The two 250-kw. machines were installed when the station was first built in 1894.



BELT, SHAFTING AND ELECTRICAL LAYOUT

When the water power and steam stations are used at the same time we always let the waterwheels take all the load they can and allow the engine to govern and take care of the peaks, since this gives us the best economy in operation. R. A. Cultra.

Cambridge, Mass.

We have had considerable experience in days gone by in operating alternators in parallel off the same jack shaft. There has been quite a number of plants operated in this way for years without any serious difficulty. In putting these generators into service it is, of course, necessary to get pulleys of exactly the same size. In a number of cases this has been done by using wooden pulleys or by lagging iron pulleys and making final adjustment to size by sandpapering the pulleys with sandpaper fastened on a block.

In measuring the diameter of the pulleys a steel tape should be used and the circumferences made as nearly the same as is possible before starting to synchronize. It may take two or three trials, under operating conditions, to get the pulleys to the proper diameter so the machines will run without cross currents. The machines may have to be thrown in a little out of step in synchronizing unless one wants to go to the trouble of slacking off the belt on the incoming machine. Machines once in parallel will stay together and the load can be adjusted by belt tension.

N. L. Rea, Const. Eng.,
Schenectady, N. Y. General Electric Co.

The power equipment in our plant consists of one 150- and one 175-hp. Corliss engine—connected to a lineshaft by means of belts running on clutch pulleys. To this lineshaft are belted two 120-kw. 440-volt 3-phase 60-cycle generators which were installed over 20 years ago. These machines, while they are identically the same, were never operated in parallel until about a year ago, after some of the armature coils burned out on one of the units. After replacing the coils it was decided to parallel the machines. As soon as this was done I noted the load shift to the repaired generator. A rumbling noise started and a moment later one of the coils burned out. Since then the machines have been run separately. Of late the load has been too heavy for one generator and we divided it into two separate systems.

Joseph Villiger.
Dixon, Ill.

In taking charge of a plant that had two alternators operating in parallel from the same lineshaft, I was told that when I got around to it I might investigate why one machine took more load than the other. Thinking that one machine had a tendency to run faster than the other, I sprinkled a little water on the belt of the machine taking the heaviest load, the temporary slipping of the belt caused the load to be shifted to the other machine. After this I turned the pulleys down several times in an endeavor to obtain the proper speeds to divide the load properly, but found it impossible except for short periods. Finally we belted each machine to its own prime mover and had no further trouble.

I am of the opinion that it is not practical to run two machines from the same lineshaft if you want each generator to carry its share of the load. I might add that although it was almost impossible to tell which machine was running the faster, using a stop watch and counter, the slight difference in speeds gave a load of 220 kw. on one machine against 90 kw. on the other.

Pawtucket, R. I. Richard Dilworth.

Referring to the article in *Power* for July 13, 1920, in regard to "Operating Alternators in Parallel Belted from the Same Shaft," in one of the hydro-electric plants of this company we operated for five years two 200-kw. 600-r.p.m. 60-cycle alternators belted to pulleys on the same waterwheel shaft. Only one alternator was used during the day, but both were run in parallel every night. The armature windings of the two generators are quite different, one having form-wound coils in open slots, the other having semi-closed slots.

The same alternators are still in use, but owing to changes and reconstruction in the plant, they are now driven from separate waterwheels. As a matter of fact we found it much easier to synchronize the generators when belted to the same shaft than when driven from different waterwheels as at present.

The point is that all belts slip more or less, making it easy by a slight adjustment of belt tension on one or the other of the alternators to bring the two into synchronism. After throwing the generators in parallel, in order to divide the load properly it is only necessary to loosen the belt slightly on the alternator tending to take more than its share of the load or to tighten the belt on the other machine.

At the start it is evidently necessary to see that the pulley diameters are correct; that is, such that the two alternators tend to run at almost exactly the same speed.

Aspen, Col. C. E. Doolittle, Mgr.
Roaring Fork Electric Light & Power Co.

[Other discussion letters have been submitted to date on Mr. King's problem. G. E. Lyons, Woodhaven, N. Y., expressed the opinion that it is impracticable to operate the two alternators in parallel when belted to the same lineshaft. A. C. Barker, Oxford Electric Co., Mechanic Falls, Me., states that his company has, in one of their plants, been successfully operating two alternators in parallel belted to the same shaft. T. H. Dion, Draper Corp., Hopedale, Mass., reports operating two alternators in parallel for 20 years which are belted to the same lineshaft. J. H. Bender, superintendent Municipal Light & Water Department, Clayton, N. M., says he has for 2½ years operated fairly successfully two alternators in parallel arranged according to Mr. King's proposed scheme. These machines are now driven by separate engines; however, this is not on account of any difficulty encountered in the operation of the machines, but to additions being made to the plant. L. S. Henley, National Park, N. J., reports installing two 80-kw. 2-phase alternators which were made to operate successfully in parallel when driven from the same lineshaft. Mr. Henley also tells of another installation where successful operation of two alternators in parallel, of different makes, was obtained with the lineshaft driven by a waterwheel and steam engine jointly. G. E. Shaw, Central Falls Mazda Lamp Division, General Electric Co., Central Falls, R. I., explains how he has made two 150-kw. alternators operate in parallel when driven from the same lineshaft, and these machines operate in parallel with a 460-kw. waterwheel-driven alternator. Division of load between the machines is taken care of by changing the tension of the belts. It is regretted that space limitation will not allow publishing in full all the discussion letters submitted.—Editor.]

Cement-Lined Stoker Coal Chutes

About a year ago Joseph Davis, superintendent of construction for the Illuminating Company of Cleveland, Ohio, installed some automatic stokers. From previous experience he had found that the taper chutes connecting the storage hopper and the stoker hoppers had a tendency to wear in a short time, and as an experiment he lined them with mortar made of one part cement and two parts sand. The mortar was 1¼ in. thick and reinforced with common poultry wire. The chutes being on a steep angle, it was necessary to place the material rather dry in order to hold.

Recently, one of these chutes was removed and an examination showed that the mortar had not cracked, nor did it show any signs of wear, although it had been in use for at least a year.

The company is planning to adopt this method on all of its automatic stokers, using a cement gun for placing the mortar on future work. J. H. Williams.
Cleveland, Ohio.

Determining Weight of Ammonia in Circulation

Mr. Gavett's methods of calculating the weight of ammonia in circulation in a refrigerating plant, as described in *Power* for June 29 are interesting.

In the first method (pressure-volume), it seems that the whole calculation hinges on the reading of the temperature of the ammonia gas at the end of compression (point *D*, Fig. 1; Fig. 3 in Mr. Gavett's article). So far as I know, no method has yet been commercially developed that will give one a reading of this vital temperature. Without it, the whole of Mr. Gavett's analysis falls down. Fig. 3 shows an approximate pressure-volume diagram.

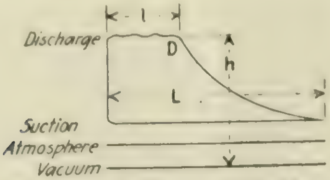


FIG. 1. MR. GAVETT'S DIAGRAM

The ordinary mercury test thermometer in an oil well will not give accurate readings of temperature of a superheated gas, according to the Belgian authority. M. Armand Duchesne (in *Revue de Mecanique*, March 31, 1912). He found that in measuring the temperature of superheated steam the mercury oil-bath thermometer is unreliable. He found that there was a difference between the temperature as indicated by the hyper-thermometer and that indicated by the mercury thermometer in an oil bath as high as 85 deg. C. (153 deg. F.) at low pressure (17,084 kg. per sq.m., or 24.2 lb. per sq.in.) falling to 43 deg. C. (78 deg. F.) at the pressure of 66,930 kg. per sq.m., or 95 lb. per sq.in. In general he believes that in many cases where the temperature has been measured by the mercury thermometer in an oil bath, the temperature of superheat is much higher than the measurement would indicate. Where a hyperthermometer cannot be used, an ordinary mercury thermometer placed direct in the steam will show the temperature sufficiently correct for most practical purposes.

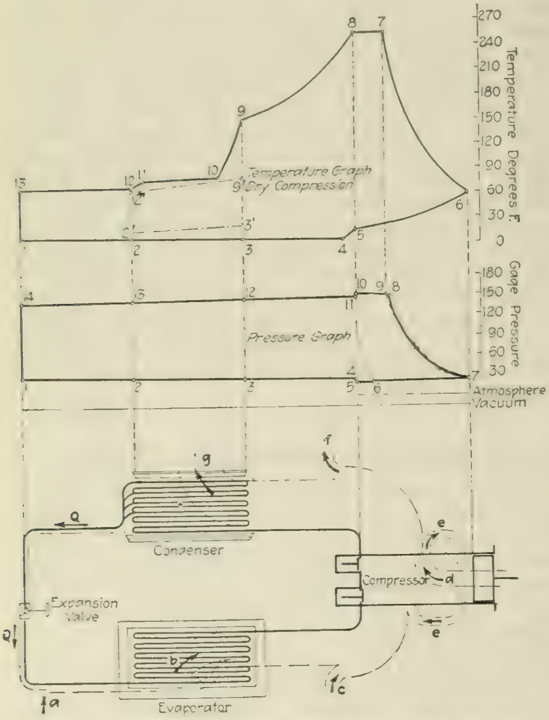


FIG. 2. TEMPERATURES AND PRESSURES IN THE AMMONIA REFRIGERATING CYCLE

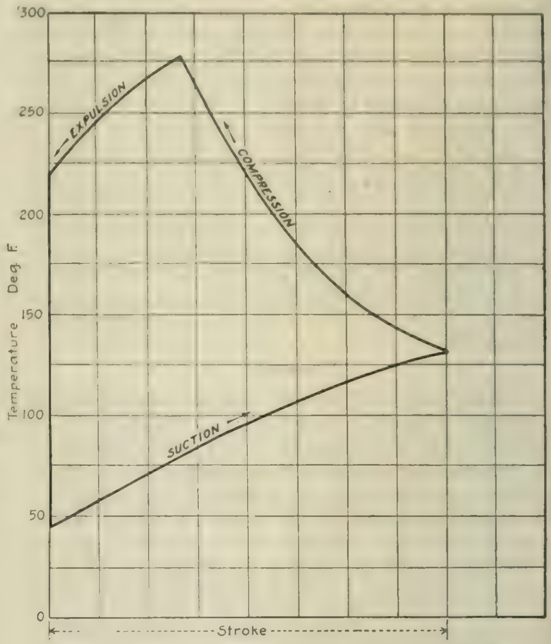


FIG. 3. APPROXIMATE TEMPERATURE-VOLUME DIAGRAM

TEMPERATURE OF SATURATED AMMONIA

(For use with accompanying Mollier Diagram.)

Pressure, Lb. per Sq.In.	Temperature, Deg. F.	Pressure, Lb. per Sq.In.	Temperature, Deg. F.
5	—62	50	22
6	—57	60	30
7	—52	70	38
8	—48	80	45
9	—44	90	51
10	—40	100	56
11	—37	120	66
12	—34	140	74
13	—31	160	82
15	—26	180	89
17	—22	200	96
19	—18	240	107
21	—14	280	118
23	—10	320	127
25	— 7	360	135
30	— 0	400	143
35	6	450	152
40	12	500	160
45	17	550	168
50	22	600	175
60	30	...	.
70	38	...	
80	45	.	

Not only will the discharged temperature as read by an ordinary test thermometer in an oil well in the discharge pipe be incorrect as indicated above, but also the temperature of the discharge if correctly known is *not* the temperature at the end of compression, namely at point *D* of Mr. Gavett's diagram. The following quotation is from a paper by J. H. H. Voss, read at the December meeting of the American Society of Refrigerating Engineers entitled "Heat Balance of the Ammonia Compression System." Referring to his Fig. 7 (here Fig. 2), Mr. Voss says:

"From point 6 to point 7 the temperature rises rapidly during the compression of gas. During the expulsion period there is a drop in temperature, which is noteworthy because the compressor is cooled by it. Unfortunately, no observations as to the extent of this drop are available, and it seems difficult to calculate it accurately. Investigation of this point seems desirable."

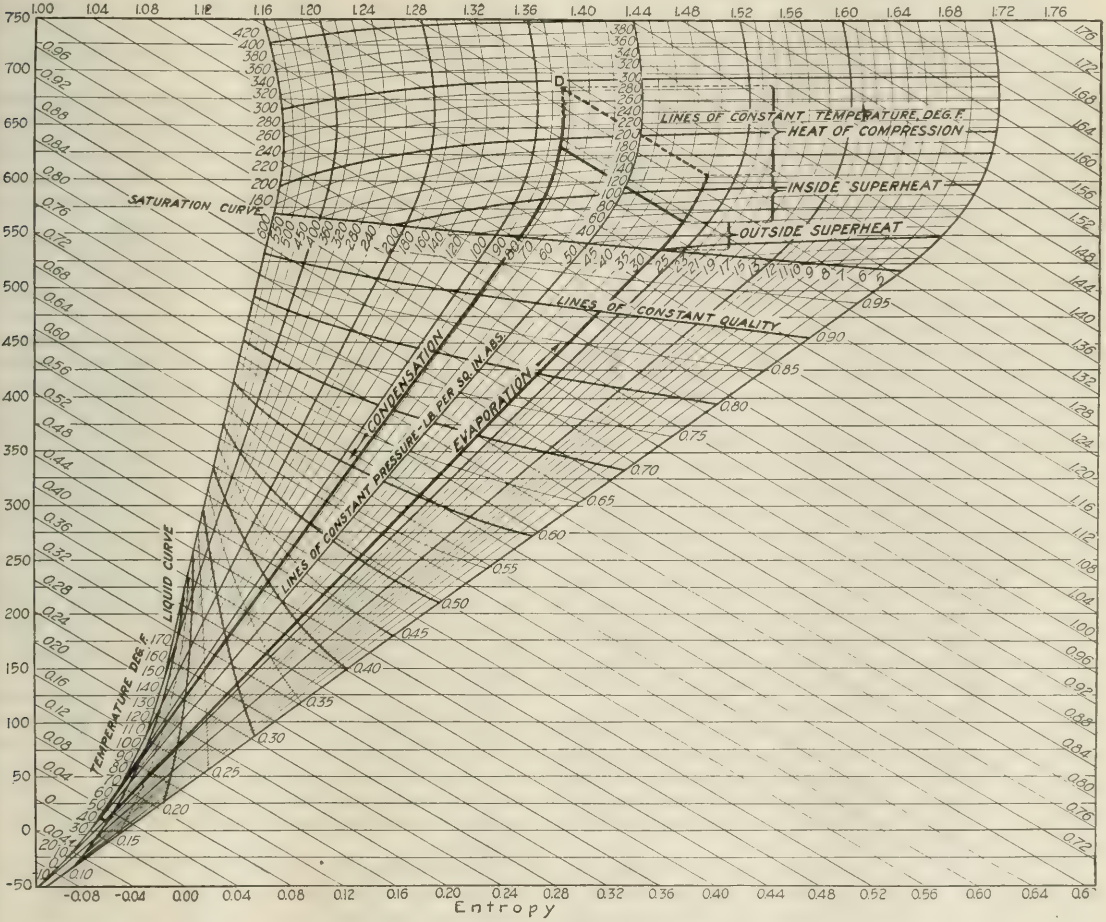


FIG. 4. THE MOLLIER DIAGRAM FOR AMMONIA

(By the Late W. E. Mosher, University of Illinois Bulletin.)

A further examination of Mr. Gavett's data indicates the danger of calculating refrigeration by this method.

The suction gas pressure was 29.2 lb. abs. with a temperature entering compressor of 46.5 deg. F. Assuming that there was no further heating of the gas during the suction stroke, then during adiabatic compression (to point *D*) to discharge pressure of 82.7 lb. abs., the gas temperature would be increased to about 180 deg. F. Mr. Gavett's reading was only 138.5 deg. F.

As a matter of fact, there is heating of the gas during suction stroke. An empirical formula for the amount of the "inside superheat," i.e., temperature rise within the cylinder during the suction stroke, was advanced in 1910 or 1911 by Charles Jonnson of New York. He claimed that this rise in temperature was in inverse proportion to the cylinder diameter, or

$$\text{Inside superheat} = \frac{669 \text{ deg } F}{D} \text{ (inches)}$$

irrespective of speed, type, etc. Whether or not we agree with Mr. Jonnson in detail, his formula gives a first approximation. A Mollier diagram (Fig. 4) is here shown to assist the reader.

For the case in point, namely, an 8-in. diameter cylinder, the inside superheat by the above formula would be 83.5 deg. F. Adding 83.5 deg. F. to the suction gas temperature of 46.5, gives a temperature at end of suction stroke of 130 deg. F. With adiabatic compression from 29.2 lb. abs. to 82.7 lb. abs., the temperature at the end of compression (point *D*, Fig. 1) would rise to about 280 deg. F. I do not put forward 280 deg. F. as the accurate temperature, for it is based on an assumption (Jonnson's); but it is much nearer correct than 138.5 deg. F.

In conclusion, I would make the suggestion that those with the scientific equipment available, solve this problem once for all by use of hyperthermometers.

New York City. G. H. CRAWFORD.

Should These Conditions Continue?

During the last few months I have visited twenty-one power plants, to ascertain for my own information the existing conditions. These plants range from one hundred to six hundred boiler horsepower. Out of the twenty-one plants four had furnaces equipped with draft gages, which were the only instruments provided for the economical use of fuel. A few of these plants were modern in every respect as to the building and the power equipment, but in the majority there is a waste of 20 to 30 per cent of the fuel. The engineers or firemen did not take the interest they should in the economical use of the fuel, and the management was too busy with production to look into the matter

In one plant in particular there are two hand-fired horizontal return-tubular boilers that are used for heating and drying purposes. I visited this plant on the first of June and the two boilers were in use. In passing through the plant, I noticed that the radiators were warm, while the windows were open. The manager told me that they intended to put in another boiler to take care of the heating of a new addition to the plant. The two boilers that they have at present will take care of all the heating and process work they require. The fireman does not know what a draft gage is or what the chimney damper is used for. He was firing the furnaces with the ashpit doors closed and the chimney damper wide open. Who should be blamed for this waste of fuel and poor management?

On presenting my card to a manager of a six hundred horsepower plant, he looked me over as though I were a bandit, and before I could say anything regarding my errand, informed me that he had had all the expert advice that he cared for. After explaining to him that I was not trying to impose upon him to take any advice or to retain my services, he told me of a man that had come to him, claiming to be a combustion engineer, and that he could save him 25 per cent of his fuel. After hanging around the plant for seven days and charging a fee of $10 per day, the conditions were the same as before he started to save the 25 per cent, besides the loss of a good fireman.

In another case the management of a plant was complained of because of the smoke issuing from the chimney. The expert that was called in on this occasion gave the intelligent advice to install a mechanical soot blower to keep the tubes cleaned, which would do away with the smoke.

There should be something done to enlighten the operators and management of the small plants to reduce this waste of fuel to a minimum. The small plant has to pay the same high price for fuel as the larger ones, and as long as this waste goes on the mines must produce an extra amount to supply the demand, which has a tendency to keep the prices up.

There should be some means whereby men that follow the business of expert adviser for power plants should be compelled to undergo examination to prove their ability to give such advise. These examinations should be held by a board of experts of long standing in this business. If the board finds the applicant capable, he should be awarded a certificate of merit, which should be registered with some responsible official in the vicinity where he is to ply his business, thereby assuring the management of power plants against incompetent persons. C. J. MILLER.

North Tonawanda, N. Y.

Day Versus Night Repair Work

In every power plant there is a certain amount of small repair work that is usually left for the operating crews to clean up; that is, the routine repair work that is not large enough to take up the regular repair crew's time. This condition has created an intense argument between the day and the night crews in a large plant, where it is customary to leave a goodly portion of routine repairs for the night crew. About three-fourths of the night crew work a steady night turn, not a change turn. The man in charge at night works week about. The men working a regular night shift come on at 5:30 p.m. and are relieved at 7 a.m. For these extra one hundred hours per month they get an average of $10 per month more than their respective reliefs on the day turn.

The man who has charge of this station never worked a night trick. He doesn't understand the various conditions that rob a night man of his valid share of rest. He doesn't know anything about the long, hard hours on a night watch, after midnight, for a man who has to keep awake to watch monotonous operation.

Therefore this superintendent thinks nothing of leaving a cylinder head to be slugged up or a set of piston-rings to be fitted to a new piston, by the night operating crew. Another one of his pet hobbies is to leave a lot of pipe work to be done on the night turn. Another is to complete the cleaning and repairs on a boiler that has been down for probably a week and have the night crew cut it in during the night, and cooling off some other boiler for repairs. Regarding the last-named practice, there should be a law against the criminal practice of manipulating high-pressure boilers on the night turns in any power plant.

The recent explosion at East Chicago is ample reason for calling it criminal practice. There is no possible excuse for the insane contention harbored by far too many bosses, that the night crew in their plants must be kept busy. And there is still less excuse for any superintendent or foreman who has boilers cut in or out during a night watch.

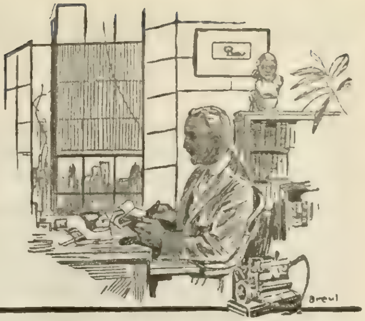
Why impose on the night men around a plant? They do a good deal of work that the day crew takes as a matter of course, but at the same time, if the crew should be reversed, it would, in nine cases out of ten, turn the organization almost inside out. This is meant to apply to large plants where the operation is complicated.

We are not looking for a feather-bed because we work nights; we do not expect something for nothing. We fellows merely want fair play. We feel that we have done our bit when we have operated our equipment to the best of our ability and are making station records consistent with good operation in our respective plant. And on account of the long hard hours it is not just to expect us to do a lot of extra repair work as well as take care of our operation. While we believe in consistent effort (hard work never hurt anyone), we also believe that there is a limit to a night man's endurance; we believe there is a limit to his physical worth, who puts in thirteen hours on a night watch.

Operating engineers do not want to be misconstrued in this matter; they are not looking for a well-oiled volume of sympathy, but they feel that they have just grounds for an earnest appeal for more considerate treatment of the fellows who have to work nights.

Chicago, Ill. J. J. JAHOBART.

INQUIRIES OF GENERAL INTEREST



Beading Tube Ends of Fire Tube Boilers—How is the holding power of tubes of fire tube boilers affected by beading-over the ends? R. A.

The operation of beading over the tube ends has a tendency to drive the expanded tube from the hole in the tube sheet and thus impair the tightness of the joint and excessive beading produces granulation and reduction of strength of the material. But when the operation of beading is carefully performed on good tube material, the holding powers of beaded and flared tubes are about the same, with the advantage of greater durability of beaded tube ends over those that are simply flared in resisting the burning action of the fire.

Condenser Pressure Not Ascertainable from Temperature—Why cannot condenser pressure be known by simply obtaining the temperature and ascertaining the corresponding pressure from tables of the properties of steam? W. A.

The absolute pressure within a condenser is made up of the pressure due to the steam or water vapor present and the pressure due to the gases present, generally called air as the greater part of such gases usually consists of air. The total condenser pressure cannot be obtained from steam tables because the temperature is that corresponding to the pressure of only the saturated steam that is present, which would be something less than the total pressure, depending on the amount of "air" contained in the mixture.

Specific Gravity Corresponding to Baumé Degrees—What are the specific gravity values corresponding to gravities of petroleum oils quoted in Baumé degrees? L. P.

The corresponding values of the Baumé scale and specific gravity within limits most used in connection with petroleum are as follows:

Baumé Deg.	Spec. Grav.	Baumé Deg.	Spec. Grav.
20	0.9333	34	0.8536
22	0.9210	36	0.8433
24	0 9090	38	0.8333
26	0.8974	40	0.8235
28	0.8860	42	0.8139
30	0.8750	44	0.8045
32	0.8641	46	0.7954

Heat Energy Realized per Pound of Coal—What per cent of the heat energy in the fuel is realized by an engine in a plant where the coal used contains 12,000 B.t.u. per pound, the evaporative economy of the boilers is 7 lb. of water per pound of dry coal, the economy of the engine is 32 lb. of water per i.hp., and the mechanical efficiency of the engine 88 per cent? R. H. D.

With evaporation of 7 lb. of water per pound of coal, the fuel consumption would be $32 \div 7 = 4.57$ lb. of coal per i.hp.-hr. and for 88 per cent mechanical efficiency, the energy realized would be $\frac{33,000 \times 60}{4.57} \times 0.80 = 346,608$ ft. lb. or $346,608 \div 778 = 445.5$ B.t.u. per pound of the coal; and for coal containing 12,000 B.t.u. per pound, the per cent of heat energy realized would be $445.5 \times 100 \div 12,000 = 3.7$ per cent.

Permissible Back Pressure for Heating Feed Water—To what extent is it economical to increase the back pressure of a non-condensing engine for raising the temperature of boiler-feed water delivered by an exhaust-steam feed-water heater? A. R. D.

Within moderate limits, the total steam consumption of an engine increases substantially in direct proportion to the increase of the load, or increase of mean effective pressure, and each additional pound of average back pressure increases the total steam required for a given load the same as though the load had been increased to require as much additional mean effective pressure as the added back pressure. Under average conditions, where an exhaust-steam feed-water heater is employed only for heating water for generation of steam supplied to a non-condensing engine, for one pound of additional back pressure on the engine there will be obtained an increase of about 3 degrees additional temperature of feed water, depending on the efficiency of the exhaust-steam feed-water heater, and for each degree of feed water there will be a saving of about $\frac{1}{10}$ of one per cent of heat required for generation of the steam used by the engine. Under these conditions, the limit of advantage is reached when the cost per degree increase of the feed water is $\frac{1}{3}$ lb. per sq.in. of additional back pressure, and when for each degree rise of feed-water temperature the increase of back pressure amounts to $\frac{1}{30}$ of one per cent of the mean effective pressure.

Connecting Water Column of R. T. Boiler—How should a water column be connected to a return-tubular boiler? R. M. P.

The pipes connecting the water column to the boiler should be not less than 1 in., with the steam connection taken from the top of the shell, or the upper part of the head, and the water connection should be of brass pipe taken from a point not less than 6 in. below the center of the shell and provided with plugged cross fittings at angles to facilitate cleaning. The water column, or water connection, should be provided with a drain cock or drain valve with suitable connection not less than $\frac{3}{4}$ in. to the ash pit or other safe point of waste. Both the water and steam connections should be provided with a shutoff consisting of either outside screw and yoke type gate valve or stop cock with permanent lever and such valves or cocks should be locked or sealed open and located as close as practicable to the boiler. The water column should be provided with water glass stop and drainage fittings set at such height that the lowest visible part of the glass gage will be not less than 4 in. above the upper row of tubes, and unless there are two water columns located on the same horizontal line and not less than 2 ft. apart, the water column should be provided with at least three gage cocks located within the range of the visible length of the water glass, unless the boiler is otherwise provided with the same number of gage cocks located at similar levels.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Some Features of Modern Hydro-Electric Practice*

BY H. M. TURNER

THE modern water-power station was not developed until after the middle of the last century, and in the last twenty years it has reached its present state of, one might almost say, perfection.

The modern turbine is distinct from other types of wheels—the old waterwheels and the modern impulse wheel, which operates in the same manner as the paddle wheel on a steamer, a jet of water at high velocity turning the veins on a wheel with which it comes in contact—in that the turbine wheel is always full of water, the buckets of the wheel are completely filled, and the passage from the headrace above to the tail water below is practically completely a solid column of water, the power being obtained from the reaction of the water against the bucket of the waterwheel. In the modern waterwheel the water enters all the way around the wheel and discharges inward and downward. In the impulse wheel, which is used only for very high heads, it is a jet which impinges on veins on the edge of a wheel and then falls dead into the pool below, in the air. The head over which the water falls is usually divided into two portions—the head acting on the wheel direct in the form of pressure, and a head acting in the form of the suction of a column of water after it leaves the wheel in the draft tubes.

To those "Power" readers who are not familiar with water-power plant practice, this hydro-electric abstract will be of interest.

The early types of wheels had small, short draft tubes, but the modern wheel is set well above the tail water and has a column of water, perhaps 18 or 20 ft., pulling down on the wheel. This long draft tube has a distinct advantage. The head or power in water can exist as pressure head or as what is called velocity head; that is, water moving at high speed has a power in it due to its velocity corresponding to a certain definite height or pressure of still water. The water in the turbine leaves the runner at high speed. It may be 15 or 20 ft. per sec. or higher. This represents considerable energy in the water which, if it were allowed to discharge at that rate, would be wasted. The draft tube provides a means of gaining back that velocity head, that power in the speed of the water. By gradually enlarging the draft tube so that the water is "stilled down" we can bring the velocity at the outlet of the draft tube to perhaps four or five feet per second and discharging at that low speed little head is lost. That is one of the improvements of the modern waterwheel.

The other improvements in recent years have given high speeds and greater efficiency. The development of electrical generators direct-connected to waterwheels has required the waterwheel designer to get the speed up as high as he can to reduce the generator cost of the unit. Waterwheels have now reached a stage where an efficiency above 90 per cent can be reached, sometimes as high as 91 or 92 per cent at the point of speed and gate opening which is most efficient. That is usually something less than full gate, that is, something less than the widest opening of the wheel gates. The efficiency then usually drops off as the gates are opened wider, until the usual waterwheel will have an efficiency of somewhere above 80 per cent at its point of greatest power, or full gate. On the other side—that is, on the part load side—going down from the highest point of efficiency, the efficiency is maintained pretty well up to half-load or half-power; it may be above 75 per cent, and from that point on it rapidly declines. That gives us a curve that at the best point of efficiency reaches 90 per cent, and at any point between three-quarters and full load it will be above 80 per cent. Formerly, with small units, the open flume was frequently used. That was suitable for small units. In that form of setting, which was a good one, the velocity of the water has to be kept low to get the best efficiency and to eliminate eddies. The next step was the closed flume, where the water is introduced to the wheel in a closed, usually a metal, casing.

To be efficiently used, the course of the water must be free from abrupt turns. Abrupt enlargements or contractions are not permitted as they cause eddies.

The modern low-head unit uses a large vertical runner with a so-called scroll case, or spiral case, where the water is brought down to the wheel and then carried in a spiral passage of gradually decreasing section around the rim of the wheel, so that the velocity change is kept at a nearly constant rate. That installation has another advantage, in that the gate rigging, the arms that operate the gates around the waterwheel, can be taken out into the open, where it can be inspected, whereas with the older form of horizontal waterwheel units in a case, if they were a pair of wheels particularly, the gate rigging on one wheel would have to be submerged. The higher-head units are often made horizontal. Developments in the gates and gate mechanism have helped produce the high efficiency obtained today.

The other chief development in recent years has been in the size of units as well as in their efficiency. The Keokuk development was one of the early installations of large single units set in concrete cases, which practice is now being followed. This type gives the efficiency of the vertical setting, with good water passages, and the spiral case gets rid of any bearing under water, the bearing being carried either on top of or immediately below the generator, between the waterwheel and the generator itself.

Drainage area is as essential a part as is head itself. The character of the drainage area is important, too. The amount of natural storage and its elevation count materially in the yield had from the drainage area. The dry periods of summer and the flow conditions of spring represent a tremendous contrast. The water-power plant has seasonable variations in flow and yearly variations in flow, good years and bad years, dry years and wet years. The average water-power plant does not use more than one-third to one-half of the water that flows down the river, so irregular are the streams in their discharges. On the Connecticut, for instance, the greatest flood amounts to 20 cu.ft. per second, while the minimum in the dry period will not be more than 0.3 cu.ft. per sec.

Both those conditions of river flow, both the low-water period in summer and the very high flood conditions in the spring, limit the output of the water-power plant. The waterwheel will not take more than so much water. In the flood season the river rises below the wheel, and the head is cut down because of the rise of water in the river. At the time we have the greatest amount of raw material (water), the amount of power available is cut down. This is something that should be corrected and storage seems the only practicable way to do it.

Pondage near the power plant to provide for the daily fluctuation in load is important. In modern water-power development great attention is paid to the pond and its regulation. In the older plants the dams were built solid across the stream without provisions for waste or sluice gates for maintaining flash boards on the dam. To prevent these flash boards being washed out by every rise of water, sluice gates or waste gates are provided to take the water under or around the dam, so that the boards may be maintained in place.

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*From a paper by the author before the New England Load Dispatchers' Club.

Elaborate provisions have been made in some cases for andling the flash boards. There is a plant out in Spokane, Vashington, which has a flash board consisting of three olling lift dams. The flash board is 19 ft. high and perates with large rollers which roll up on a geared track, o that they can be handled as a large movable dam. Durng flood seasons they are elevated and the flood passes nder them. During the seasons of dry water they are owered, thus the plant gains the benefit of that 19 ft.

We are very much more bothered with questions of ice, vhich are likely to interfere with any structure of that ort across the top of the dam itself. Heavy ice pretty early requires an even, clean spillway during high water n order to get rid of it, and any obstructions in the shape f piers are usually unwise; but we get around it by means f putting on temporary flash boards and providing these ates, and perhaps methods of handling the flash boards vhen there is water flowing over them so as to keep them n as long as possible and as much of the year as possible.

Another factor of importance is that of relief, or you night call it the safety valve, necessary in case of a udden shutdown. The long or short column of water in he penstock has a large amount of energy. In case of a hort-circuit the wicker gates are closed by the turbine overnor. The energy in the moving column of water must e dissipated in some way. Some relief must be provided, nd is usually had by means of a tank which takes the urges of the water. At Turners Falls, at the Cabot staion, there is a large forebay pond immediately at the head f the power station which serves the same purpose. Not nly in case of a sudden shutdown, but also in case of a udden load coming on the wheel, relief of that sort is ecessary. A sudden load coming on tends to draw down he canal. In cases of a long pipe line it has been known o draw the water out of the pipe line. High-head plants sually have elaborate surge tanks provided to take care f the fluctuations in head due to sudden changes in the elocity of the water leading to the wheel.

There is a limit to the overload capacity on the waterower plant which is not true to the same extent of the team turbine. Once the waterwheel gates are open wide, o more power can be had from the wheel—no momentary verload is permissible as it will slow down the wheel. It s advisable to run the waterwheel with its gates only art way open. With such opening not only is best fficiency had but it also gives reserve capacity in the ase of a sudden draft.

Hearing on Great Falls Power Project

Advantages to be obtained from the development of power t Great Falls, on the Potomac, were painted in roseate olors at a hearing before the Federal Power Commission ug. 24. Representatives of the civic bodies in the Disrict of Columbia and witnesses from nearby points in aryland and Virginia urged the development of the project. epresentatives of the Potomac Electric Power Co. apeared in opposition to the project.

S. R. Bowen, vice-president of the Potomac Electric Power o., explained that his company had secured the power ights at Great Falls, with the expectation of developing t, but examinations by its engineers led to the conclusion hat the project could not be developed as a commercial roposition under existing conditions. He admitted that he company at this time has no plans for utilizing this vater power. Any hydro-electric plant that might be stablished would have to be duplicated by a steam plant o take care of needs during periods of low water. When ecretary Payne asked if the company would be willing to ispose of its rights at the Falls Mr. Bowen replied that t would do so for adequate compensation. This led Judge ayne to ask if it would become suddenly very valuable if he Government should think of taking over the rights. Mr. owen replied frankly in the affirmative.

R. Walton Moore, the representative in Congress of the irginia district which adjoins the District of Columbia, ointed out how manufacturing could be stimulated within a radius of 200 miles around the Falls if the maximum amount of power were developed.

The Engineer Commissioner of the District of Columbia, Col. Charles W. Kutz, urged the development of the power project, even if no reduction in the existing rates results. Such a development would carry with it a reduction of the smoke evil in the capital and would permit a diversion of considerable quantities of coal for other purposes. He suggested that the large steam plant of the Potomac Electric Power Co. should be utilized in connection with the development and could either be purchased by the Government or operated under an agreement with the company.

W. B. McCaleb, representing the Pennsylvania Railroad Co., stated that his company is not interested in electrification at this time because of financial considerations. While he admitted that his company is interested in cheap power at any point on its lines, his position is that the transition from steam to electricity requires a greater capital outlay than would be justified in Washington and its vicinity. The representative of the Washington Terminal Co., which is owned jointly by the Pennsylvania and the Baltimore & Ohio Railroads, testified that no serious thought has been given to the electrification of the terminal.

Col. Lafe Pence protested against the construction of any dam which would prevent the use of the right-of-way of the Chesapeake & Ohio Canal for a railway outlet. By filling in this canal, a right-of-way for the Western Maryland, Norfolk & Western and the Cumberland Valley Railroads would be provided, forming the best grade from the coal fields to tidewater.

The matter of securing an additional water supply for the District of Columbia also was considered at the hearing. All witnesses favored the development of the water supply for the District as a separate project from the power development.

The hearing was presided over by the Secretary of War, who is chairman of the Federal Power Commission. Secretaries Payne and Meredith and Executive Secretary O. C. Merrill were in attendance.

Agreement Between Bureau of Mines and Coal Exchange

Much importance is attached to the co-operative agreement which has been entered into by the Bureau of Mines and the Sewalls Point Coal Exchange. The agreement provides for an analysis of the coal shipped to tidewater pools with the idea of improving the grading and classification. The negotiations for the Bureau of Mines were conducted by O. P. Hood. The agreement is signed by the Secretary of the Interior; F. G. Cottrell, Director of the Bureau of Mines; G. H. Caperton, president and S. T. Snead, secretary of the Sewalls Point Coal Exchange, Inc. The text of the agreement in part is as follows:

> The United States Bureau of Mines and the Sewalls Point Coal Exchange, Inc., Norfolk, Va., desiring to conduct investigations concerning preparation of coal with a view to increasing efficiency agree that all works shall be directed by the Bureau of Mines according to a program as mutually agreed upon between the Bureau and the Exchange.
>
> In the district to be investigated, the Bureau agrees to complete a list of mine samples and analyses and to obtain at the mine tipple, point of delivery or other place as agreed upon, representative samples of the commercial coal as shipped by the several mines.
>
> The Bureau agrees to make, at its Pittsburgh laboratory, proximate analyses and B.t.u. determinations of all samples which are acceptable to the Bureau, and ultimate analyses and fusing temperature of ash determinations of such samples as may be mutually agreed upon.

The report of the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, on domestic exports from the United States of refrigerating machinery during June shows that machinery valued at $245,045 was exported. Japan leads in imports valued at $130,252; Cuba is second with imports valued at $38,571, and Brazil is third with imports valued at 28,222.

To Prosecute Coal Profiteers

In a letter to all district attorneys, the Attorney-General again has called attention to the necessity for taking rigorous action against those who unduly enhance the price of coal. The letter reads:

In connection with previous instructions to investigate and institute prosecutions in cases where unreasonably high prices have been exacted in the sale of bituminous coal, you are instructed to investigate cases where the price to the consumer has been enhanced through repeated resales by dealers successively buying and selling the same coal, and to institute prosecutions against such dealers, where the facts warrant, for engaging in an "unfair or deceptive or wasteful practice or device" or a "conspiracy, combination, agreement, or arrangement" to enhance the price of coal by such practice or device, in violation of Section 4 of the Lever Act, as amended by the Act of Oct. 22, 1919.

Production of crude oil in the United States this yea plus imports will exceed 500,000,000 bbl., according to prediction by the Geological Survey. The prediction is base upon the record of production for the first half of th present year which shows an output of 214,086,000 bbl. a compared with 178,355,000 bbl. during the same period i 1919. The total output for June is given at 37,219,000 bbl as compared with 36,931,000 bbl. in May. The daily average production during June—1,240,633 bbl.—was the greatest on record.

The Division of Power Resources of the United State Geological Survey has given out statistics of electric power production for the first four months of 1920. Th average daily production of electricity in kilowatt-hours wa as follows: January, 124,700,000; February, 119,700,000 March, 120,800,000; April, 119,700,000. These figures ar based on returns received from about 2,800 power plants o 100 kw. capacity or more, engaged in public service.

Personals

James A. Noxon, formerly with Du Pont Engineering Co., Janesville, Wis., is now superintendent, Rock Cut Stone Co., Syracuse, N. Y.

Charles T. Porter, formerly with the Naval Aircraft Factory, Philadelphia, Pa., is now associated with the Huff, Daland & Co., Ogdensburg, N. Y.

Charles Estes Wood, formerly teacher in metallurgy, University of Cincinnati, is now designer and draftsman with the Lunkenheimer Co., of Cincinnati.

Louis A. Delaney, formerly mechanical engineer with F. X. Hooper Co., Glenarm, Md., is now manager of the American Sheet Metal Corporation, of Philadelphia, Pa.

Harry de Lapotterie has resigned his position with the Townsend Company, of New Brighton, Pa., to become industrial engineer of the Falls Rivet Company, of Kent, Ohio.

William D. Cecil has severed his connection as resident material inspector with the Baltimore & Ohio Railroad and is now connected with the Magnus Metal Co., of St. Louis, Mo.

H. Boyd Brydon, mechanical engineer of the Byllesby Engineering and Management Corp., has been appointed a member of the Prime Movers Committee of the National Electric Light Association.

Norris M. Perris, formerly engineer with the Aluminum Castings Co., Cleveland, Ohio, is now industrial engineer of the Industrial Management Council of the Rochester (N. Y.) Chamber of Commerce,

William C. Briggs, formerly sales engineer and New York City manager of the Shepard Electric Crane and Hoist Co., has become vice president in charge of manufacturing of the Franklin Moore Co., Winsted, Conn.

Henry C. Berrian, formerly engineer of the engine scientific department, Federal Shipbuilding Co., Kearney, N. J., is now in the engineering department of the Newport News Shipbuilding and Dry Dock Co., Newport News, Va.

Herbert H. Van Winkle has resigned his position as chief engineer with The Vogt Brothers Manufacturing Co. of Louisville, and is now associated with The John H. McGowan Co., of Cincinnati, Ohio, in the capacity of chief engineer.

Karl R. Kennison has resigned as plant engineer of the Emergency Fleet Corporation in charge of shipyard and drydock construction in New Orleans, La., Mobile, Ala., and Pensacola, Fla., and has opened an office as a power-plant engineer at 18 Tremont St., Boston.

J. Jacques Stunzi, plant study engineer of the engineering department of the E. I. du Pont de Nemours & Co., has resigned his position and accepted an offer as consulting engineer of the Lancaster Steel Products Corporation, a subsidiary of the General Motors Corporation.

Stephen E. Preble, for many years associated with the I. W. Jones Co., Milton, N. H., has been elected vice president and general manager of the Industrial Planning Corp., Buffalo, N. Y., which specializes in hydro-electric development and the design of pulp, paper and fiber mills.

Society Affairs

The Illuminating Engineering Society's convention, which was to have been held in Cleveland Sept. 27-30, will be held in that city Oct. 7-10.

The American Institute of Electrical Engineers at a recent meeting of the Board of Directors adopted a resolution to become a charter member of the Federated American Engineering Societies.

Long Branch Association, N. A. S. E., No. 17, of New Jersey, was organized by State Deputy John Reddy on Saturday, August 14. There were 66 names signed to the charter and National President John J. Callahan installed the new officers.

Engineering Societies throughout the United States have received invitations to become charter members of the Federated American Engineering Societies, and also to appoint delegates to attend the first meeting of the American Engineering Council, which will be held this fall at a date to be selected later.

The American Chemical Society will hold its fall meeting with the Chicago Section, September 6 to 10 inclusive. Hotel headquarters will be made at the Congress Hotel. The entertainment committee have arranged a banquet, smoker and excursions. A number of interesting papers and addresses are on the schedule.

The Society of Naval Architects and Marine Engineers, 29 West 39th St., New York City, will hold its twenty-eighth annual meeting, Nov. 11-12, in the Engineering Societies Building. A committee has been appointed to arrange for an excursion to points of interest in the vicinity of New York City on Saturday, Nov. 13. Members will be entertained at a banquet on Friday evening.

The New England Water Works Association will hold its thirty-ninth annual convention at Holyoke, Mass., Sept. 7-10. Headquarters will be at the Hotel Monotuck. A number of interesting papers will be read, including "Experience with an Exploded Pressure Boiler and Check Valve on Service Pipes," by Edward J. Looney, Supt. Water Works, Belmont, Mass., and "Comparative Cost of Pumping by Steam and Hydraulic Power at Manchester, N H.," by James H. Mendell, Supt. Manchester Water Works. Auto trips, theater parties, golf, etc., have been arranged by the entertainment committee for the amusement of the delegates.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention at the Hotel Pennsylvania, New York City, Sept. 20-24. The convention will open with transaction of routine business, after which the following papers will be read at the various sessions: "Practical Education of Steel Mill Electricians," W. A. Cornwell; "Relations of Standardization in Electrical Equipment to Safety," Walter Greenwood; "Power Transmission for Industrial Plants," D. M. Petty; "Underground Transmission," A. L. Freret; "Some Considerations in the Determination of Auxiliary Drives," Gordon Fox; "Repor of Electrical Development Committee fo 1920," E. S. Jeffries; "The Reversing Ele tric Mill Considered from the Standpoint o Tonnage," K. A. Pauly; "Centralize Turbine Generating Stations for Ste Mills," T. E. Keating; "Current Limit Reactance," R. H. Keil; "Report of Electri Furnace Committee for 1920," E. T. Moore and "Standardization Committee Report, W. T. Snyder. The entertainment committee have arranged several excursions an a banquet for the benefit of the visitor and members.

Miscellaneous News

The West Penn Power Co. has complete installation of one of the two 25,000-kva units at the $6,000,000 central station a Springdale. The second unit should b operating by Sept. 1.

If the Supreme Court of the Unite States upholds the decision of the Circui Court of Appeals at Asherville in the Lamberts Run case, Rush Butler, counsel fo the National Coal Association, declares tha it will mean an abrupt end for the practic of assigning cars in the coal trade.

In an Effort to Curtail Speculation i coal, a special report has been made to th president of the National Coal Associatio recommending that operators be require to satisfy some competent authority tha they can give immediate disposition of th shipment before cars are furnished.

Since the Signing of the Water Powe Bill by President Wilson applications fo more than 500,000 hp. in water power hav been filed with the Forestry Service of th Department of Agriculture Increased fue costs and transportation difficulties ar probably the reasons for this unusua demand.

Hydro-electric development in Arkansa to cost in the neighborhood of $300,000,0 is being planned. Two dams, fifty and sixt feet high respectively, with a total generating capacity of 16,500 kw. are to be erected Transmission lines 130 miles in length ar expected to deliver the 22,000 hp. curren for light and power.

The Eastern Wisconsin Railway an Light Co. is to build a large power plan in Fond du Lac soon, according to a announcement by the Kelsey-Brower Co of Grand Rapids, Mich. A bond issue o $1,200,000 is to finance the plant and als improve the company's property at Sheboygan and Oshkosh.

Under the New Railroad Rates the tidewater rate on smokeless coal will be $2.8 This is an increase of 100 per cent sinc March, 1917. In making application fo increased rates, public utilities in Washington, D. C., estimate that the new freight rates will add 90 cents per ton t the cost of their coal.

The Pacific Gas and Electric Co. wil supply the city of Stockton, Cal., with hydro-electric power according to an announcement made by Irving Martin, railroa commissioner. At a hearing which too place recently in Stockton, it was decide that the Pacific company should extend its mains to supply the city.

The Central Illinois Public Service Co. has "hooked up" the last link in a high-power transmission line which is now 1,355 miles long and joins the four states of Illinois, Kentucky, Indiana and Iowa. This single line crosses thirty-one counties. It starts at the hydro-electric development at Keokuk and ends at Louisville, Ky.

Mining Companies of Grass Valley, Cal. are urged by the railroad commission to economize as much as possible in the use of electricity. It is said that a serious shortage will result if this is ignored. No rationing plan has been suggested and it is hoped this may be avoided by the voluntary action of the companies already in force with some of the larger concerns.

John A. Britton, general manager of the Pacific Gas and Electric Co., San Francisco, Cal., has notified the city engineer's office that an increase of 15 per cent will be paid by the corporation for the power it buys from the Hetch Hetchy project. The increase recently allowed by the railroad commission will net the city about $8,000 a month extra.

The Interstate Commerce Commission has announced that coal mines will continue to have priority of use of open-top cars for a period of ninety days from June 21, the date of the original order. The effort of representatives of public utilities companies to have the assigned car feature of the order made to apply to coal for storage, as well as to that for daily needs, was unsuccessful.

The Work of the Federal Water Power Commission, which will have charge of all development under the recently enacted water power act, has been divided into seven departments: Engineering accounting, statistical, regulatory, licensing, legal and operation. The engineering department will be in charge of Lieut.-Col. William Kelly, who has been detailed by the Army Department as the engineer officer of the Commission. A general investigation of the electric power industry, power sites, costs, and development will be conducted by this department. A report covering the results of the investigation will be made to Congress.

Eastland, Texas, Oil Wells are to be pumped and drilled by electric power in central west Texas fields when the power plant of the Oil Fields Electric Co. is finished. The first unit is already in operation. Transmission lines are being constructed to all parts of the petroleum producing region, and within a short time electric power will be used for pumping several hundred wells and drilling many others.

Business Items

The Detroit Valve and Fittings and Detroit Brass Work, manufacturers of iron and brass goods, announce that the name of the firm has been changed to Detroit Brass and Malleable Works.

The Pennsylvania Pump and Compressor Co., of Easton, Pa., announce the opening of additional sales offices in the following cities: Buffalo, N. Y., J. B. Laird, manager; Cleveland, Ohio, L. J. Wakefield, manager; St. Louis, Mo., Corby Supply Co.; Minneapolis, Minn., L. E. Pollard Co., and Omaha, Neb., L. E. Pollard Co.

The Uehling Instrument Co., 71 Broadway, New York City, manufacturer of fuel-economy equipment, announces that it is now represented in the New England States by the Smith Engineering and Supply Co., 89 State St., Boston, manufacturers' agents and engineers specializing in power-plant equipment. S. W. Smith, president of the latter company, was until recently associated with the Uehling Instrument Co. with headquarters in the New York Office.

Dr. E. Vernon Hill announces the formation of a new company in Chicago known as the E. V. Hill Co., Aërologists, with offices at 117 North Dearborn St. "Aërology" is a new term for ventilation, but has a broader meaning, since it includes the physical, chemical and bacteriological phases of ventilation work as well as the mechanical side. For the last eight years Dr. Hill has been engaged in organizing and conducting the Ventilation Division of the Chicago Health Department. During this period he found it necessary to design new instruments and methods for test work, and he now proposes to place some of these instruments on the market for the benefit of engineers engaged in this line of work.

Trade Catalogs

Charles T. Main, designing, consulting and supervising engineer for water-power projects, Boston, has published a 32-page booklet entitled "Hydro-Electric Developments," the purpose of which is to show the work of the organization of Charles T. Main in the design and supervision of water-power structures and hydro-electric systems. Photographic reproductions of work accomplished are shown, together with brief descriptions of plants or special features connected with the same. The frontispiece contains a discussion of the water-power situation. This is followed by an index of the plants where work was done.

Uehling Instrument Co., 71 Broadway, New York City, has issued Bulletin No. 111, describing Style U Uehling CO_2 Equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front CO_2 indicator, which guides the fireman, while the CO_2 recorder, installed in the chief engineer's or superintendent's office, makes a continuous record showing all changes in boiler adjustments.

New Construction

PROPOSED WORK

Mass., Boston—The Supt. of Lighthouses will receive bids until September 7 for furnishing independent beam air pump.

Mass., Longmeadow—Carl Withe is in the market for a ¼ hp., 220 volt, 60 cycle, 2 phase, 1,800 r.p.m., pulley 4¼ diam., 1½ in. face motor.

Conn., Bridgeport—Fletcher, Thompson, Inc., Engrs., East Main St., will soon award the contract for a power plant addition for the Bridgeport Brass Co., East Main St. About $14,000.

Conn., Hartford—The Bd. Educ. will receive bids until September 7 for a 3 story, 90 x 160 ft. high school on Maple Ave. including steam heating system. About $750,000. Whiton & McMahon, 36 Pearl St., Archts.

Conn., Middletown—Buck & Sheldon, Inc., Engrs., 60 Prospect St., Hartford, will soon award the contract for a 1 story, 30 x 40 ft. boiler house for the Goodyear Rubber Co., 114 Church St. About $30,000.

Conn., New Britain—The Bd. Educ. will soon award contract for a 3 story, 60 x 240 ft. school including steam heating system on Tremont St. About $350,000. D. K. Perry, 27 West Main St., Archt.

Conn., New Haven—The Yale University plans to build a 2 story chemical laboratory including steam heating system. About $250,000. Delano & Aldrich, 126 East 38th St., New York City, Archts. and Engrs.

Conn., Windsor Locks—The Conn. River Co., c/o C. H. Tenney & Co., 201 Devonshire St., Boston, Mass., plans to build a dam, 30 ft. high and 2,000 ft. long, for power purposes.

N. Y., Brooklyn—Maurice E. Connolly, Pres. of the Borough of Brooklyn, Queens Subway Bldg., 68 Hunterspoint Ave., Long Island City, will receive bids until September 3 for furnishing and erecting one high pressure stationary boiler setting, etc., in the Far Rockaway disposal plant.

N. Y., Buffalo—The State Hospital Comn., Capitol, Albany, will receive bids until September 29 for additions to central heating plant and for coal and ash handling equipment at the Buffalo State Hospital, here.

N. Y., Great Neck, L. I.—W. S. Bessell, Archt. and Engr., 56 West 45th St., New York City, will receive bids until September 10 for a 2 story school including steam heating system for Bd. Educ. About $400,000. Noted August 24.

N. Y., New York—The Union Sulphur Co., 17 Battery Pl., is having plans prepared for a 14 story, 30 x 89 ft. office building including a steam heating system on Rector and West Sts. About $400,000. Henry Otis Chapman, 334 5th Ave., Archt. and Engr.

N. Y., Ossining—Chas. D. Rattigan, Supt. of State Prisons, Capitol, Albany, will receive bids until September 15 for addition to power house at Sing Sing Prison.

N. Y., Schenectady—F. F. Proctor, 1564 B'way., New York City, is having plans prepared for a theater building, including steam heating system. About $400,000. J. M. Merron, 1564 B'way, New York City, Archt. and Engr.

N. J., Glassboro—F. H. Bent, Archt., 142 West State St., Trenton, will soon award the contract for a 3 story, 125 x 301 ft. state normal school and a 1 story, 41 x 48 ft. boiler plant. About $700,000.

N. J., Newark—J. H. & W. C. Ely, Archts., Firemen's Trust Bldg., will soon award contract for a 16 story, 100 x 200 ft. office building at Broad and Clinton Sts. including a steam heating system for the Merchants' Natl. Bank, 770 Broad St.

N. J., West Orange—The Bd. Educ. plans to build a school including steam heating system. About $450,000. Guilbert & Betelle, 2 Lombardi St., Newark, Archts.

N. J., West New York (Weehawken P. O.)—The Bd. Educ. received bids for heating and ventilating systems for the new Public School No. 1, from Edward Beck at $60,968.

Pa., Blossburg—The Blossburg Hospital will soon award the contract for a 1 story, 35 x 50 ft. power plant and laundry. About $10,000. G. S. Idell, 1705 Chestnut St., Philadelphia, Engr. and Archt.

Pa., New Castle—The Lehigh Portland Cement Co., 718 Hamilton St., Allentown, had plans prepared for a 3 story, 44 x 140 ft. new waste heat installation power house here.

Md., Frederick—The City Council, City Hall, plans to install one 125 kw. generator, at municipal plant, in connection with the change from arc and incandescent lighting systems to all incandescent. C. L. Reeder, Park Ave. and Saratoga St., Baltimore, Consult. Engr.

Md., Mount Airy—The Hagerstown & Frederick Ry. Co., Hagerstown, plans to construct a 1 story, 25 x 75 ft. substation, etc., here. M. A. Pooler, Genl. Mgr.

Md., Salisbury—The Shoreman's Hotel Corp. will soon award the contract for a 5 story, 71 x 149 ft. hotel including heating system. About $250,000. T. W. Pietsch, American Bldg., Baltimore, Archt.; J. Posey, 11 East Pleasant St., Baltimore, Engr.

Va., Richmond—The Amer. Tobacco Co., 24th and Cary Sts., is in the market for boilers for curing tobacco.

W. Va., Shinnston—The Paquet Glass Co. is in the market for 60 or 80 hp. steam engines and an air compressor. P. J. Paquet, Pres.

Tenn., Clarksville—The Kentucky Pub. Serv. Co. is in the market for boilers, engines, turbines, steam machinery and electrical equipment to be installed in the new electric power plant to be located at 11th St. and the L. N. tracks. Noted June 29.

Ky., Henderson—The City is in the market for a new boiler for the municipal power plant. L. P. Hite, Supt.

O., Cleveland—The City, c/o Dir. Pub. Safety, City Hall, plans to build a 3 story hospital on Scranton Rd. including steam heating system. About $3,500,000. J. H. MacDowell, City Hall, Archt.; Dr. S. S. Goldwater, 1 East 100th St., New York, N. Y., Consult. Archt.

O., Cleveland—The Supervising Archt., Treasury Dept., Washington, D. C., [illegible] new boiler and [illegible] in the Marine Hospital here, [illegible] Co., Chicago, Ill. [illegible] Supply Co., Cleveland, O. [illegible] Wheeler Co., Cleveland, O. $11,[illegible].

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ., c/o F. K. Bryan, received low bids for power plant on Lee Rd. as follows: general contract, Philip [illegible], Hippodrome Bldg., Cleveland, $41,[illegible]; piping, Warden & Lees, 7140 Prospect Ave., $18,[illegible]; chimney, Alphonse Custodis Chimney Co., 95 Nassau St., New York, N. Y., $[illegible]; coal and ash handling machinery, The Link Belt Co., Rockfeller Bldg., Cleveland, $18,430.

O., Toledo—H. J. Ricker, 343 Spitzer Bldg., is in the market for five 50 hp., 220 volt, 60 cycle, 3 phase motors and an electrically driven centrifugal pump.

Ind., Bedford—The Bedford Steel & Constr. Co., Engrs., are preparing plans for a canning factory to include conveying systems, conveyors, motors, etc. Owner's name withheld.

Ind., Indianapolis—The American Hominy Co., 1100-15 Fletcher Savings & Trust Bldg., plans to build a 4 story addition to its boiler and power house and install new boilers, generators and other equipment in same. Total estimated cost, $90,000.

Ind., Indianapolis—The Westinghouse Lamp Co., Watsessing Ave., Bloomfield, N. J., will soon award the contract for a 4 story, 100 x 200 ft. factory on La Salle St. here, including steam heating system. About $2,000,000.

Mich., Detroit—The Temple Beth El, 580 Woodward Ave., plans to build a 2 story, 153 x 200 ft. temple, including steam heating and ventilating systems. About $1,000,000. Albert Kahn, Marquette Bldg., Arch. and Engr.

Mich., Grand Rapids—The city is having plans prepared for an additional waterworks system including a pump house and 2 pumps having a daily capacity of 8,000,000 gal., etc. C. A. Paige, City Hall, Engr.

Mich., Saginaw—The Amer. Safety Navigation Co., c/o Managing Secy., Bd. of Commerce, is having tentative plans prepared for first unit of plant to consist of a 1 story factory and 6 story office building. Plans include a steam heating plant and power equipment. Total estimated cost, $10,000,000.

Ill., Chicago—A. Finkel & Sons Co., 1326 Cortland St., plans to construct a 1 story, 32 x 98 ft. heat treating plant. About $20,000. E. M. Newman, 80 West Washington St., Archt.

Wis., Grafton—The Jungers Stove Range Co. plans to install a steam heating system and several electric motors for power in its proposed stove factory on Main St.

Iowa, Manchester—The City, c/o T. Wilson, Clk., is having survey made of pumping station with view to electrifying equipment. A survey of the municipal power plant may be made later. W. E. Skinner, 15 South 5th Street, Minneapolis, Minn., Engr.

N. D., Fargo—The Union Light, Heat & Power Co. plans to repair electric and gas plant here. M. L. Hibbard, Genl. Mgr.

Mo., Butler—The City voted $65,000 bonds to build an electric power plant. J. F. Smith, clk.

Mo., St. Louis—The Little Sisters of the Poor are having plans prepared for addition to institution building and enlargement of present heating plant. About $250,000. Lee & Rush, Syndicate Trust Bldg., Archt.

Mo., St. Louis—Widmann, Walsh & Pankem, Archts., Wainwright Bldg., will receive bids until September 15 for a 4 story, 144 x 250 ft. office building including steam heating system on Olive St. for the Lowenstein Bros. Real Estate Co., Wainwright Bldg. About $750,000.

Mo., St. Louis—The Sisters of Charity, 3539 Pine Blvd., are having plans prepared for a hospital on Pine St. including a power house for heating system. About $2,000,000. Lee & Rush, Syndicate Trust Bldg., Archts.

Tex., Austin—The Bd. Educ., c/o A. W. Blanton, Secy., will soon award the contract for administration and dormitory buildings and heating plant. Ross & Read, 208 Bankers' Trust Bldg., Waco, Archts.

Tex., Cleburne—The Cleburne Waterworks plans to install a 150 hp. motor and a compressor with a daily capacity of 1,250,000 gal. W. S. Hockaday, Supt.

Tex., Clifton—The Planters Gin Co. plans to install one 130 hp. oil engine. F. T. Graffenreid, Pres.

Tex., Dallas—The Texas Hosiery Mills, 1407-09 South Ervay St., plans to build a hosiery factory and is in the market for electrically driven knitting machinery for same. James C. Dobson, Mgr.

Okla., Lawton—V. V. Long & Co., Consult. Engrs., 1300 Colcord Bldg., Oklahoma City, has prepared report for new sewage disposal plant and sewage pumping station here. About $200,000.

Okla., Stigler—V. V. Long & Co., Consult. Engrs., 1300 Colcord Bldg., Oklahoma City, have prepared report for extensions to waterworks here, including pumping station. About $35,000.

Col., Denver—The Denver Gas & Electric Light Co. plans to build a 50 x 59 ft. boiler room and install one 750 hp. boiler in same. About $39,000.

Utah, Salt Lake City—The Bonneville Irrigation Dist. has voted to issue $600,000 in bonds for the construction of an irrigation pumping system including a power house. Two 500 hp. and two 900 hp. motors are to be installed in the pumping station.

Cal., Los Angeles—A. R. Erlanger, 214 West 42nd St., New York, N. Y., plans to build a theater, including steam heating ing system. About $500,000. T. R. Anderson, 214 West 42nd St., New York City, Archt. and Engr.

Cal., San Francisco—A. R. Erlanger, 214 West 42nd St., New York, N. Y., plans to build a theater here, including steam heating system. About $500,000. T. R. Anderson, 214 West 42nd St., New York City, Archt. and Engr.

CONTRACTS AWARDED

Mass., Holyoke—The Lyman Mills, 71 Front St., has awarded the contract for altering the power plant to the Casper Ranger Constr. Co., 20 Bond St., at $20,000.

R. I., Pawtucket—The What Cheer Chemical Co., Grotto Ave., has awarded the contract for a 3 story, 40 x 62 ft. boiler house addition to J. F. Cole, 81 Niagara St., Providence, at $50,000.

Conn., Montville—Robert Gair & Co., 50 Washington St., Brooklyn, N. Y., has awarded the contract for a 2 story, 200 x 500 ft. manufacturing building and a 1 story 50 x 50 ft. power plant to the Austin Co., 217 B'way, New York City, at $600,000. Noted June 29.

N. Y., New York—The John J. Buckley Syndicate, 233 B'way, has awarded the contract for an 8 story printing crafts building including a steam heating system on 9th Ave. between 33d and 34th Sts. to the John O. Devlin Constr. Co., 233 B'way. About $3,500,000.

N. J., Union Hill—The Consumers' Hygienic Ice Co. has awarded the contract for an addition to its ice and refrigeration plant to the Selbach-Meyer Co., $29,000.

Pa., Easton—The Y. M. C. A., 9 Centre Sq., has awarded the contract for a 4 story, 105 x 125 ft. Y. M. C. A. building including a steam heating system to Wark & Co., 1239 South Broad St., Philadelphia, at $400,000. Noted March 30.

O., Columbus—The Columbus Ry., Power & Light Co., 102 North Ohio St., has awarded the contract for a 3 story, 25 x 46 ft. substation on East Rice St. to E. J. Spencer, Huntington Bank Bldg., at $25,000.

Ill., Chicago—The United States Industrial Alcohol Co., Inc., 27 William St., New York, N. Y., has awarded the contract for a warehouse on 37th St. and Western Ave., here, including steam heating system, to George A. Fuller Co., 175 5th Ave., New York City. Estimated cost, $500,000.

Wis., Sheboygan—The Jenkins Machine Co., c/o A. H. Studeman, 315 North 8th St., has awarded the contract for a 2 story, 150 x 200 ft. machine shop to Verhulst Bros., 1615 Erie Ave., and is in the market for motors.

Wis., Sheboygan—The St. Nicholas Hospital Assn. has awarded the contract for furnishing boilers and all material and installing same in power house at the institution to Chas. Honold, 821 Penn Ave. Noted August 17.

Minn., Minneapolis—The Flour State Baking Co., E. C. Foley, Secy., 12th and Minnehaha Aves., has awarded the contract for a heating system to be installed in the new 4 story, 60 x 150 ft. bakery plant at 500 East 37th St. to J. J. Egan, c/o owner. Total estimated cost, $250,000.

Mo., St. Louis—The Boyd Clothing Co., 7th and Olive Sts., has awarded the contract for a 6 story, 88 x 150 ft. mercantile building, including steam heating system. About $400,000. T. P. Barnett Co., Arcade Bldg., Archts. and Engrs.

NEED COMPETENT MEN?

SEE THE
SEARCHLIGHT SECTION

Pages 85 to 99

Pages 85 to 99

POWER

lume 52 New York, September 7, 1920 Number 10

Participate in the Activities *of* Your Society

FIFTY years ago the artisan went about his daily task with little regard to what his fellow worker did; the merchant paid scant attention to others in the trade, save to regard them as competitors, and the professional man dealt with his problems as an individual, jealously guarding the knowledge gained by his experience.

While this practice lasted, progress was limited to the capacity of the individual. Today all is changed. We are living in an age of collective effort. Nowhere is this more apparent than in the engineering field, as exemplified by the various engineering associations.

There are two classes of such associations—those that cater largely to the social side, and those whose principal object is to uplift the individual and render a service to society. Benefits from membership in the former are likely to be transient and confined to an extended acquaintanceship. Membership in the latter, however, offers opportunities limited only by the effort which the individual puts into the society.

The initiative in most societies is borne by a comparatively small group while the majority hold aloof, sometimes through indifference, but more often through modesty which restrains the member from offering his services unless called upon. This lack of active participation frequently fosters discontent and sometimes envy of those who rise to positions of distinction in the councils of the society. But let it be remembered that this rise to distinction is seldom through preferment or any unusual qualifications, but rather because the member is always ready to give the best there is in him to the cause.

This is an opportunity that is open to every member if he will attend the meetings, join in the discussions or the presentation of papers, do committee work and mix with the members generally.

The most valuable privilege that membership in the vocational or professional society offers is the opportunity for service. The influence of any society is measured by the activities of its members, and in turn, the greater the influence of the society the greater will be the value of membership in it to the individual.

The New Lakeside Pulverized-Coal Plant, Milwaukee

Largest Power Station in the World Burning Pulverized Coal—Ultimate Capacity To Be 200,000 Kilowatts—Initial Installation of 40,000 Kilowatts Now Going in—Features Are Long, Low, Bungalow Type of Building, Special Coal-Handling and Preparation Equipment, Burners of the Horizontal and Vertical Types and a 500-Kilowatt Turbo-Generator to Supply Current for Station Auxiliaries, Which Will Exhaust to the Feed-Water Heaters and by Thermostatic Regulation Maintain the Temperature of the Feed Water—Machine and Blacksmith Shops Will Be Provided at the Plant

THE Milwaukee Electric Railway and Light Co. has started the construction of what will be the largest central power station in the world utilizing pulverized coal for steam generation. The ultimate installed capacity will be 200,000 kw. The design is such that the plant can be constructed in units. The first will contain equipment sufficient for producing 40,000 kw.; the second and third units, 80,000 kw. each. In conjunction with the present system the plant will supply current for the street railways, street- and house-lighting circuits and power demands of the many industries of Milwaukee and surrounding towns.

With its site one mile south of Milwaukee, directly on the shore of Lake Michigan, the new Lakeside power plant will have an ideal location for several reasons. The water from the lake will be used for condensing purposes and also for boiler feed. Its qualities are such that no purifying treatment will be necessary. Eventually, piers will be built out into the lake at which colliers can be unloaded by a mechanical conveying and storage system that will deliver coal directly through the crushing plant on the shore. For the present coal will be transported by railroad cars and unloaded by means of a car dumper.

First Unit Will Meet Present Needs

Construction now under way embraces the rail connections, cold-storage yards, coal-handling and crushing plants, a breakwater for impounding cooling water and the cooling-water intake and discharge tunnels, each of a capacity sufficient for a total output of 200,000 kw. Present needs will be met when the first unit of the station is completed. As the demand for current increases the other units will be installed, and it will be necessary only to add to the boiler room, turbine room, coal-pulverizing plant and switchhouse equipments, and to the respective buildings for housing them.

In the main building of the plant are the boiler room, turbine room and switchhouse arranged in the order named. The coal-pulverizing plant is in a separate building about fifty feet back of the boiler room. Between these two buildings are two concrete chimneys, each of which serves four boilers. On one side of the main building opposite the turbine room is a connecting building in which will be located the operating engineers' offices, a blacksmith shop, a pipe shop and a machine shop. All these shops will be equipped fully for repairing worn and broken parts of the power station apparatus. The work will be done by the operating men with the idea of educating them in the construction and care of the machinery they are running The remaining building is the crusher plant, which i on the shore of the lake about 400 ft. distant from the pulverizing plant. The illustration on the opposite page shows the layout.

Coal Handling a Feature

In this station the coal-handling and preparation equipment differs widely from that of plants using stokers or hand firing. It is best described by following the course of the coal from the storage yards to the boiler furnaces. The coal is received in gondola cars these are shunted onto a system of parallel tracks between which the coal is piled by three locomotive cranes equipped with 2-yd. clamshell buckets. The coal stored in this manner is for emergency use only. For every-day consumption coal trains are passed through a revolving car dumper, one car at a time, at a maximum rate of about twenty cars per hour. This dumper is located on a bluff running along the lake, and coal passes by gravity through the crushing-plant machinery in the following order: After being fed from the hoppers under the dumper, it is carried by a 48-in. belt conveyor to a rotary grizzly. The head pulley of the conveyor is highly magnetized and carries tramp iron to its under side, thus separating it from the coal The grizzly screens out coal 2 in. and over and discharges it into a two-roll crusher which reduces it to 2 in. and under. The crushed coal, together with that passed through the grizzly, is fed through a hammer mill, which reduces it to ½ in. in size, and onto a 36-in. belt conveyor which leads to the pulverizing plant.

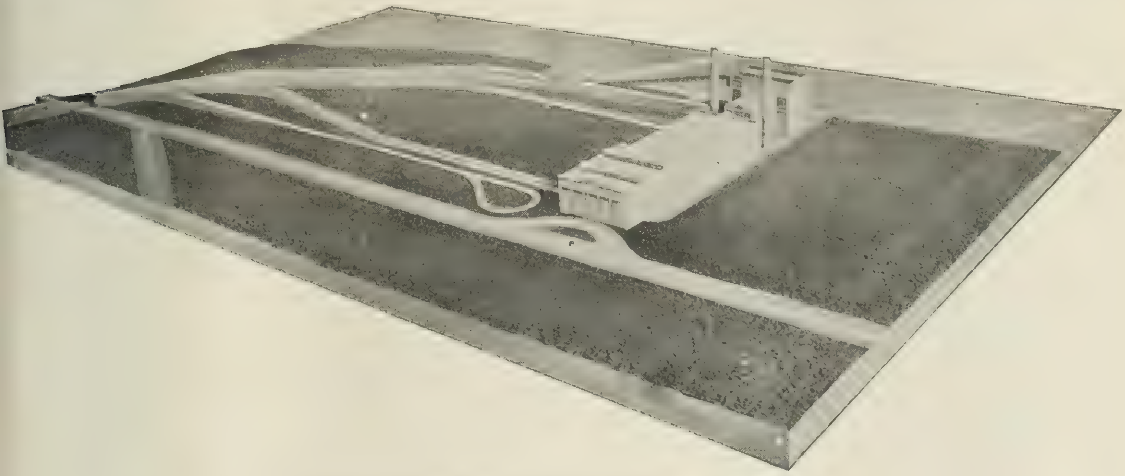
The crusher plant, when operating as described, will handle 150 tons per hour. When fine coal is received it is bypassed directly to the belt conveyor under the hammer mill, and 250 tons per hour can be handled. The crusher building is designed to accommodate two grizzlies, crushers and hammer mills, and when these are installed it will be necessary only to double the speed of the conveyor to double the capacity of the layout as a whole.

The belt conveyor leading to the pulverizing building is 36 in. wide and in its length of 385 ft. rises 91 ft. It discharges onto a reversible cross-belt conveyor of the same width, which distributes the crushed coal to three parallel conveyors equipped with automatic trippers which pass over the green-coal storage bins in the pulverizing building and maintain an even supply in them. There are seven of these bins, having a combined capacity of 3,500 tons. Under the bins run three 12-in. screw conveyors arranged to discharge through automatic scales into three indirect-fired rotary driers 5 ft. 6 in. in diameter and 42 ft. long. These driers reduce the moisture in the coal to about 1 per cent by means of hot gases from individual furnaces fired with pulverized coal. After being exhausted from the drier, the gas is blown through collectors 14 ft. in diameter, which recover any coal dust it carries away in passing through the agitated coal. The hot, dried coal is next transported to the mill feed bins by means of parallel arrangements of 16-in. screw conveyors and continuous-bucket elevators, each set having a capacity of 60 tons per hour, which is also the combined capacity of the three driers. The idea is to provide spare capacity in case of breakdown.

There are eight mill feed bins, each holding 25 tons and placed over its respective mill. Fuller-Lehigh ball pulverizing mills utilizing the air separation system will be used, and they will have a total hourly capacity of 48 tons. With the air-separation method no screens are needed; an exhauster driven by the mill shaft draws a current of air over the bull ring in the mill, and the velocity of this air is such that it picks up only those particles that have been ground to the necessary fineness. The dust thus formed is forced through a collector which separates the coal, and the air is conducted back to the mill to be drawn through again, thus making a continuous circuit. From the collectors the pulverized coal is conveyed to a 50-ton storage bin supplying a pneumatic conveying system which transports it to four sets of bins over the firing aisle in the boiler room. One set of bins will hold 150 tons of coal.

Six of the boiler furnaces will each be fired by three duplex burners (Combustion Engineering Co. type) set vertically through the top of a dutch oven. About 15 per cent of the necessary air is blown in with the coal dust, and the rest is admitted through a number of openings in the front wall of the furnace. These openings are fitted with top-hung doors used for regulating the air supply. The remaining two boiler furnaces each have four Fuller burner nozzles. These are of the horizontal type and are placed in the front furnace wall. Air for combustion is admitted partly with the fuel and partly induced through an annular space around the nozzle. The idea of installing two different schemes for burning is to compare them under actual operating conditions, with the view to adopt the better type in case of future additions that may be made to the station.

When operating either of these burning systems the flame temperature never will be allowed to rise high enough to slag the ash content of the coal, hence this will be deposited partly on the hearth and partly carried away with the flue gases in the form of dust. What amount collects in the furnace will be removed through cleanout doors in the boiler-room basement and fed by hand into the pipe line of a vacuum conveying system, which will carry it to a conveniently located ash hopper.


MODEL OF LAKESIDE POWER PLANT AND GROUNDS

In the station the main power equipment will be two 20,000-kw. turbo-generators, each equipped with a 35,000-sq.ft. three-pass surface condenser. Steam at 265 lb. pressure and 200 deg. F. superheat will be supplied from eight water-tube boilers, each rated at 1,306 hp., but to be operated at 250 per cent of rating. An economizer having 7,503 sq.ft. of heating surface will be installed in the rear of each boiler and also an individual exhaust fan for assisting the natural draft in drawing the gases through it. Dust removed from the economizer tubes will fall into hoppers from which it will be carried away by connections to the vacuum ash system.

In a gallery between the boiler and turbine rooms the principal auxiliaries will be located. An elevated hotwell tank will supply feed water to two Hoppes open heaters, from which the water will flow through a V-notch meter on the floor below. Under the meter will be placed four boiler-feed pumps, two motor-driven and two turbine-driven. It is estimated that the feed-water temperature leaving the pumps will be 120 deg. F. and under a pressure of 325 lb. gage. In addition there will be one 500-g.p.m. centrifugal motor-driven makeup pump and two 500-g.p.m. motor-driven centrifugal house service pumps.

A unique feature of the plant will be a 500-kw. turbo-generator which will supply current at 480 volts for station use. The turbine end of this machine will be equipped with a diaphragm operated governor controlled by a thermostatic device located in the feed-water heaters. The purpose of such an arrangement is to regulate the temperatures of the feed water by varying the amount of the exhaust steam passing into the heaters from this turbine. The electrical load on the generator side will be balanced with a transformer connected to the main station busses. With the aid of this unit the main turbo-generators can be started under a vacuum in cases of complete isolation from an outside source of power, as the electrical auxiliaries of the condenser can be operated with current supplied from it.

The main condenser auxiliaries will comprise a motor-driven centrifugal condensate pump discharging through a heater to the elevated hotwell tank, two 24-in., 18,000-g.p.m. circulating water pumps, one motor-driven and one turbine-driven, and a steam-jet air pump for emergency use. The main generators will be cooled with washed air taken from inside the turbine room and discharged into the boiler room, thus utilizing the heat lost in one department to warm the air going into the boiler furnaces.

As a whole the plant will be modern in every respect. The best materials will be used throughout, and every precaution has been taken in the design to insure efficient and easy operation. At every point necessary, recording or indicating instruments will be installed so that each piece of apparatus will be run at its best efficiency.

The design is the conception of John Anderson, chief engineer of power plants for the Milwaukee Electric Railway and Light Co., who has already demonstrated the many advantages of pulverized fuel in the Oneida Street Plant, which has been operating successfully for the last three years. The plans were prepared and the construction work will be carried on by the engineering staff of the company.

New Type of Transformer Bushing and Housing

A new type of bushing and housing for outdoor transformers of moderate voltage has been developed. This bushing, which has been approved by the Inspection Department of the Associated Factory of Mutual Fire Insurance Companies, should make it possible to dispense with transformer houses. Transformer houses are specified, in some localities, by insurance companies, their construction being determined by the requirements of insurance companies and safety-first considerations.

GENERAL ARRANGEMENT OF CONNECTIONS

The scheme provides that all circuits, as shown in Fig. 1, generally above 600 volts, be brought to the housing in inclosed cables. This cable is above ground, in a metal duct that is securely fastened to the transformer cover, all exposed parts being at ground potential and waterproof. The waterproof feature is essential, from the underwriter's standpoint, in making it safe for firemen to play streams on burning buildings near the transformers. Since the circuits to the transformer will generally consist of waterproof lead-covered cable, provision is made in the outboard portion of the housing for inclosing a standard end bell, corresponding to the circuit voltage.

The installation shown in Fig. 1 is that of three self-cooled oil-insulated transformers, with corrugated tanks and radiators for cooling the oil, located outside of an industrial building. The general method employed in bringing the conduits and conductors into the transformer, so as to make a clean and neat installation, is clearly indicated.

The lower portion of the bushings are similar to the standard General Electric Co.'s high-voltage bushing; the upper portion is shown in Fig. 2. Ample clearance is provided in the housing. The transformers receive standard high-potential test with housings in position and without any taping or other insulation on the bushings. As regards voltage the use of these transformers is limited only by the voltage limits of the underground cable.

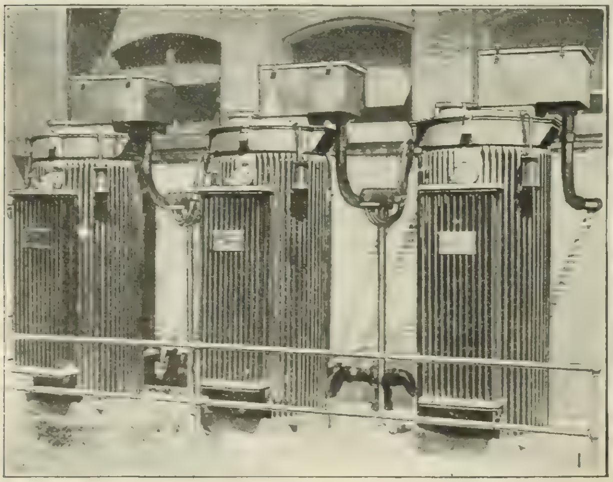


FIG. 1 OUTDOOR TRANSFORMER INSTALLATION

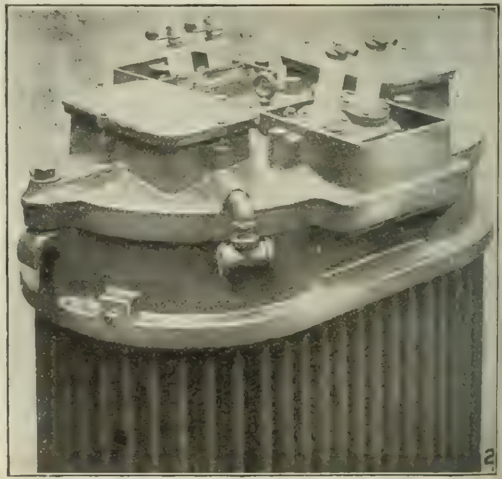


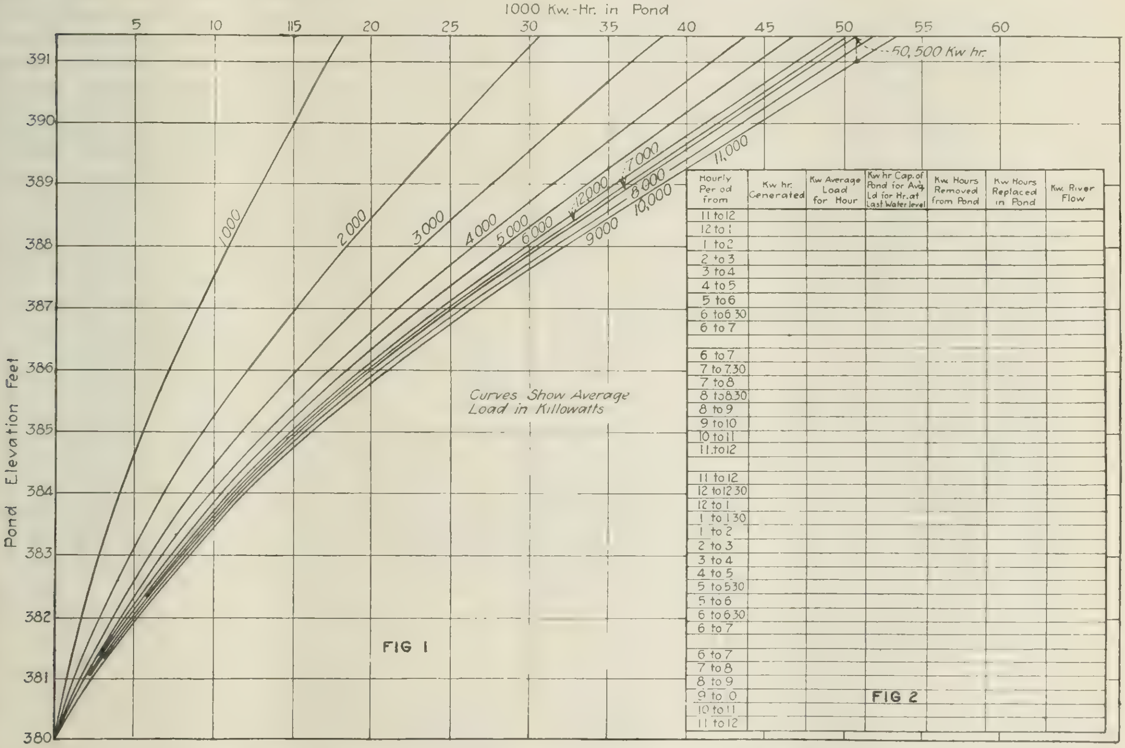
FIG. 2. BUSHINGS IN TOP OF TRANSFORMER

Measuring River Flow for Hydro-Electric Plant Operation

Problem of Calculating River Flow—River Flow Charts Used in the Operation of One Installation—Methods of Checking Capacity of Ponds—In Calculating Capacity of Pond, Hydraulic Gradient Must Be Considered

By R. D. DE WOLF
Chief Operating Engineer, Rochester Gas and Electric Corporation

In the combined operation of steam-driven and hydraulically driven generating plants very substantial economies can be effected by the proper distribution of load between two generating stations or between several steam and hydraulic stations, especially in cases where the river flow for the hydraulic stations is variable. The problem of measuring this river flow in some easy, practical manner, so as to give the load dispatchers a fairly accurate basis to divide their load on, is fundamental.



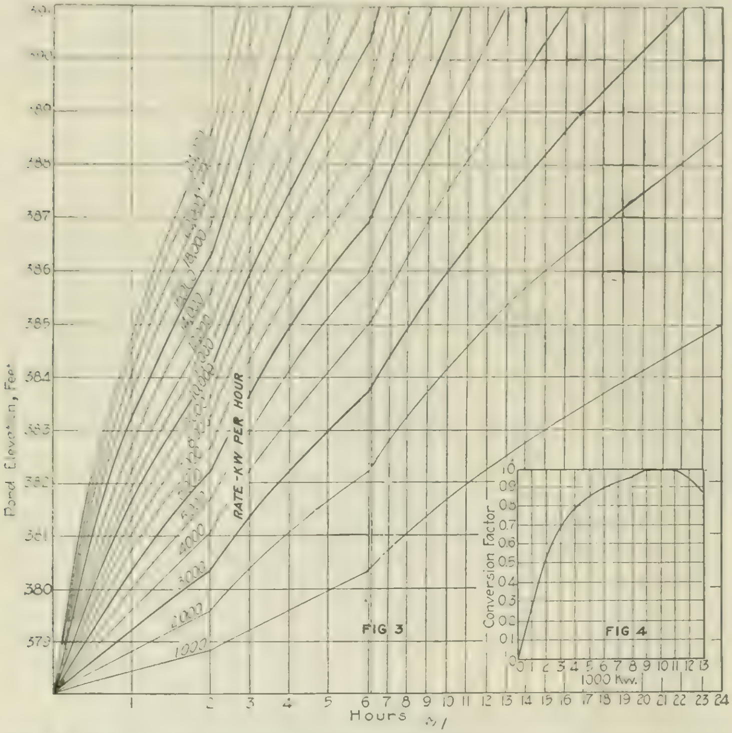
Hourly Period from	Kw hr. Generated	Kw Average Load for Hour	Kw hr Cap. of Pond for Avg. Ld for Hr. at Last Water level	Kw. Hours Removed from Pond	Kw Hours Replaced in Pond	Kw. River Flow
11 to 12						
12 to 1						
1 to 2						
2 to 3						
3 to 4						
4 to 5						
5 to 6						
6 to 6 30						
6 to 7						
6 to 7						
7 to 7.30						
7 to 8						
8 to 8 30						
8 to 9						
9 to 10						
10 to 11						
11 to 12						
11 to 12						
12 to 12 30						
12 to 1						
1 to 1 30						
1 to 2						
2 to 3						
3 to 4						
4 to 5						
5 to 5 30						
5 to 6						
6 to 6 30						
6 to 7						
6 to 7						
7 to 8						
8 to 9						
9 to 0						
10 to 11						
11 to 12						

FIGS. 1 AND 2. CHARTS FOR ESTIMATING POND CAPACITY AND RIVER FLOW

The most accurate method, of course, would be through the installation of a weir in the river by means of which the actual quantity of water flowing could be measured. This is not only expensive, however, but in many cases practically out of the question, and consequently some other method has to be devised.

In almost every case any hydro-electric generating plant has some storage capacity above the dam, and the pondage is used to a greater or less extent, depending upon whether the river flow is sufficient to provide all the power required all the time or not. If the river flow is not sufficient to supply the maximum amount of power required, then during the peak-load period on the plant the waterwheels will be using the total river flow and in addition will be drawing a certain amount of water from the pond. During the summer of 1919 the writer devised for use on the power system of the Rochester Gas and Electric Corp., Rochester, N. Y., a method of measuring the river flow, making use of the foregoing characteristic.

A determination was first made of the capacity of the pond in cubic feet so that the volume of water contained in the pond for any elevation was known. Knowing the amount of water contained in the pond, the head on the wheels, and the turbine and generator efficiency for a given load, it is evident that the number of kilowatt-hours that can be generated at that load if all the water in the pond were passed through the wheels can be calculated. Assuming that the hydro-electric plant would be supplied only with water from the pond and that no additional water was entering, the curves shown in Fig. 1 were plotted. In these curves, instead of using cubic-feet pond capacity, the capacity is expressed in thousands of kilowatt-hours. At an elevation of 391 ft., for instance, the capacity of the pond when the water is used at maximum efficiency is 50,500 kw.-hr. In the case of the two 12,000-kw. generators used for the particular installation for which these curves were calculated, the maximum efficiency is at 10,000 kw. with very little change in efficiency for any load between 9,000 and 11,000 kw. on the unit. If the load on the unit is above or below this amount, the efficiency at which the water is used is decreased; consequently, when a given amount of water is passed through the wheels, a smaller number of kilowatt-hours will be generated, due to the decreased efficiency in the use of the water. Therefore curves for other loads than the 9,000- to 11,000-kw. loads were calculated and plotted on the chart. For example, with a load of 5,000 kw., the kilowatt-hours in the pond at an elevation of 391 ft. amount to only 44,500, a loss of 6,000 kw.-hr. due to the decreased efficiency at which the wheels are operated.



FIGS. 3 AND 4. CHARTS FOR CALCULATING PERIOD THAT A GIVEN LOAD CAN BE CARRIED WITH POND AT A GIVEN LEVEL

The load dispatchers are provided with a form for entering the necessary data to calculate the river flow as shown in Fig. 2. This shows for each hour: The total kilowatt-hours generated for the hour, average load for one machine for the hour, the kw.-hr. capacity of the pond for the average load at the end of the hour, the kw.-hr. removed from the pond, the kw.-hr. replaced in the pond and the kw. river flow.

To illustrate the use of the method, let us assume the following data:

At 9 a.m. the pond elevation is 390 ft. and at 10 a.m. the elevation is 390 ft. and the total generation by two generators for the hour has been 20,000 kilowatt-hours, equivalent to an average load of 10,000 kw. on each generator.

Referring to the chart we get the following information:

Pond capacity at 9 a.m., at a load of 10,000 kw.	50,500 kw.-hr.
Pond capacity at 10 a.m., at a load of 10,000 kw.	44,500
Kilowatt-hours removed from the pond during the hour	6,000
Total kw.-hr. generated during the hour	20,000
Less kw.-hr. removed from pond	6,000
Difference equals river flow	14,000

By making this calculation every hour continuous check can be kept on the river flow.

In the left-hand column of Fig. 2, the half-hour periods are put in during the time when the system load is changing rapidly. During this period half-hour readings are taken, but the kilowatt river flow estimated from these readings is not used except as a very rough check on the river conditions. We have found from experience that, with the conditions existing in the pond, half-hour period readings do not seem to be long enough to iron out various inconsistencies and give reliable data. We have therefore made it a practice in estimating the kilowatt river flow to use only hourly periods. The hourly tabulation is arranged in the various vertical groups so as to give space for totalizing each group and figuring average results for each group. Our load conditions are such that we have found it convenient to divide the day into four periods—from midnight to 7 a.m.; 7 a.m. to noon; noon to 7 p.m., and 7 p.m. to midnight. For convenience the readings from 11 p.m. to midnight, from 6 a.m. to 7 a.m., from 11 a.m. to noon, and from 6 p.m. to 7 p.m. are repeated. These repetitions are not necessary, but our operators have found it convenient to handle it in this way. In figuring the river flow for each group this overlapping of one hour gives a more reliable average figure. The various vertical groups contain a different number of units, depending upon how many half-hour periods happen to fall in a given group.

One factor entering into this, which tends to make the results more or less deceptive, is the effect of the hydraulic gradient of the pond itself, in those cases where the point at which the pond level is measured is at the dam or at the intake. If we start out with the surface of the pond absolutely level from the intake back upstream to the upper limits of the pond and then use water at a rate greater than that at which it is flowing into the pond, it is evident that the level at the intake will fall a larger amount than the level farther up the pond, owing to the hydraulic gradient, or difference in head required to make the water run downstream. The more rapid the rate at which the pond level is falling, the greater will be the difference in the pond elevation at the intake and at the upstream end, especially in those cases where the pond is shallow and uncovs considerable ground area as the level falls. As the ɛvation at the intake is the lowest in the pond, it is wer than the true average level for the entire pond. ne figure for the number of kilowatt-hours taken out the pond will therefore be greater than is actually the se, if it is based upon the elevation of the lowest point ther than the average elevation. The effect of this is give a river flow lower than the true flow. This error, wever, is not one that need cause the operators to rry for fear the water will give out before they ex- ct it to, as it is on the safe side and means there is tually somewhat more water available than the fig- es indicate. In those cases where the pond elevation n be measured at a point that gives a figure that is ore nearly the average pond elevation, this error will practically eliminated.

In constructing the curves shown in Fig. 1, it is not solutely essential to have a survey of the pond, as ese curves can be constructed by a series of approxi- itions from the operating data only. Assuming that ly very rough information is available in regard to pond capacity, a set of curves could be plotted based on this rough estimate. In the course of operation ere will be periods when the amount of power being nerated by the plant will be only a relatively small ount greater than the river flow, so that the rate of l of the pond will be slow, thus minimizing the effect hydraulic gradient. These operating results will e certain river-flow figures. Taking the average these figures over a period of, say, three hours, a de- rmination can then be made along the general lines licated in the following calculation:

rage flow, in kw., for a period of three hours	15,000
d capacity, in kw.-hr., from given curves at end of this time. . . .	50,000
owatt-hours generated during next period of five hours	100,000
acity, in kw.-hr., from given curves, at end of the five hour period. .	20,000
-hr. generated by river flow of 15,000 kw. for five hours.	75,000
-hr. actually supplied by pond.	25,000
-hr. apparently supplied by pond as shown by curve.	30,000
or in pond capacity in kw.-hr.	5,000

By choosing a period during which it is fairly certain t the river flow is constant over the assumed period five hours, as given, this method can be used to de- mine the inaccuracy in the assumed chart, and after h determination a corrected chart can be made. This rected chart can be again checked in the same way l a third chart made which will be more nearly correct n the second.

The results secured by the foregoing method can be cked by still another scheme. During periods of ration when the pond is drawn down low during the vy-load period of the day and allowed to fill up dur- the light-load period, if we start at a time when the d is full and take hourly readings during the period en the pond is being emptied and filled, it is evident t at the end of the filling period the river flow will e been sufficient to generate the total kilowatt-hours nerated from the start. The average river flow will n be the total kilowatt-hours generated, divided by total time. For any hour a comparison can be de between the kilowatt-hours removed from the pond determined by subtracting the average river flow m the total kilowatt-hours actually generated for t hour, and the kilowatt-hours removed from the d as determined from the chart by the method out- ed in the foregoing.

Even in cases where an accurate survey of the pond available, the methods outlined can be used to check pond from time to time to determine the amount t it has silted up.

In order to assist the load dispatcher in estimating the number of hours that he will be able to carry a given load with a pond at any given level, the chart shown in Fig. 3 was drawn up. The curves on this chart represent the rate at which the pondage is being depleted. For example, if the pond elevation was 387 ft. and the load carried by the station such that 6,000 kw.-hr. were being taken out of the pond every hour, these curves show that this load could be carried for about six hours, at the end of which time the pondage would be all used up. These curves are based upon an assumed operation of the wheels at their highest point of efficiency. In case the wheels are not operated at this point but at a less economical load, use is made of the conversion factors shown in Fig. 4. In the case cited, for instance, if the load being carried by each machine was only 7,000-kw., then the length of time that the pondage would last would be only 93 per cent of six hours, or 5 hours and 34 minutes.

The load dispatcher can also make use of an estimating sheet on which he can put down the estimated load, river elevation, etc., for each hour for an entire day's operation, checking up the results actually gotten at the end of each hour and changing his estimate if conditions are such as to make this advisable. With an estimating sheet of this kind he can cover any period and any variation in load.

This system has been in use for a number of months, and on the whole the results have been found very satisfactory. Irregularities in the pond capacity have been found and corrections made from time to time to overcome these errors. A great deal has been learned about hydraulic gradient and its effect on the load conditions, and from experience the dispatcher makes allowance for the effect of this factor.

A Large Semi-Diesel Engine

Certain industries, especially rice irrigation and cotton ginning, have fairly large power requirements for a few months each year. During the remainder of the year the power plant is idle. Even though the fuel economy of the Diesel engine is much better than that of any other prime mover the interest charge per operating day is large in such plants. The surface-ignition or semi-Diesel oil engine, while using more oil per horsepower, is frequently the most advisable type to install, since the interest charge is lower; in addition, the surface-ignition engine operator need not be as high-grade as the Diesel engineer.

Heretofore most of the semi-Diesel manufacturers have confined the engine cylinders to a maximum of about 17 inches. It has been quite generally felt by the designer that this diameter was the largest that could be employed in a two-cycle engine without recourse to some form of piston cooling. Piston cooling, while customary with two-cycle Diesels, has not in the past met with favor in the semi-Diesel field. It is undoubtedly true that a so-called dry type semi-Diesel or surface-ignition oil engine would require piston cooling if manufactured in large cylinder sizes. With the wet type engine, or an engine using water injection into the working cylinder, it is claimed by several builders that the water thus introduced keeps the temperature of the piston head low enough to avoid danger of fracture or cylinder scoring regardless of the diameter of the cylinder.

With the experience of many years of oil engine construction to guide them the Power Manufacturing Co. of Marion, Ohio, has for some time been building the Primm surface-ignition engine in single-cylinder units with a cylinder diameter of 22 inches. This single-cylinder unit develops 150 hp. at 200 r.p.m.

To meet the demand for a 250- to 300-hp. engine for gin and irrigation plants, this company has designed a two-cylinder engine having cylinders 22 inches in diameter by 24 inch stroke. Fig. 1 is a view of the pump side of the engine, while Fig. 2 is a cross-section showing the moving parts. The frame is a one-piece casting containing housing for three shaft bearings. At the head end the frame has two cavities to receive the cylinders. It will be seen that the front or crank ends of the cylinders act as the compressors for the scavenging air. The air is admitted through a poppet valve mounted on the side of the frame. As the piston uncovers the exhaust pipe, the scavenging air rushes into the cylinder through the upper ports and completes the scavenging process.

INJECTION WATER UNDER CONTROL

The injection water is fed into the air transfer ports and is picked up by the air entering the cylinder. The velocity of the air serves to break up the water into a fine mist. This water vapor passes across the piston head and removes a great amount of the heat absorbed during the early part of the power stroke. The amount of water injection is controlled by the governor, while a special form of check valve prevents the entrance of the water into the air passage save during the period of exhaust and air scavenging. This timed injection of water removes a great deal of the objection that is so frequently raised by engineers to the wet type of engine. Doubtless if the water is allowed to drip onto the piston the lubricating oil will be washed off. Regulation of the timing places the water in the cylinder at the proper time to be most effective.

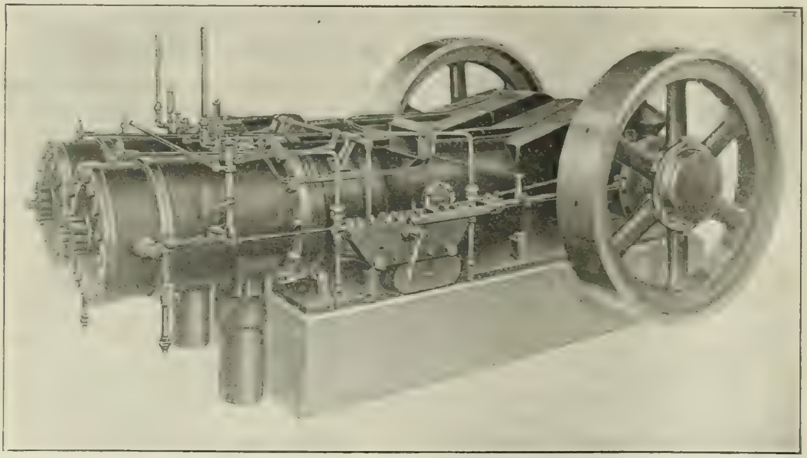


FIG. 1. PRIMM SEMI-DIESEL ENGINE

The governor is of the centrifugal flyball type and is driven by a bevel gear mounted on the crankshaft. The governor sleeve is connected to a rocker arm on the fuel pump, as appears in Fig. 3. This rocker has a dog which fits into a notch cut into the fuel pump plunger. The plunger is driven by a push rod from the shaft eccentric. The dog limits the travel of the pump plunger on its suction stroke. At an increase of speed the governor shifts the pump rocker. The dog then engages the pump plunger earlier in the suction stroke and the amount of fuel entering the pump is thereby reduced.

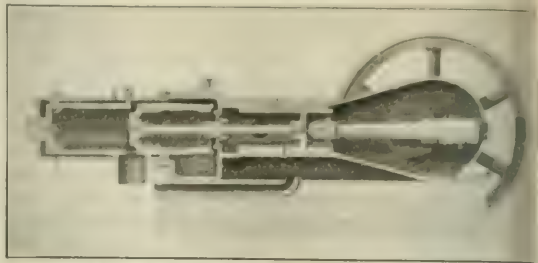


FIG. 2. CROSS-SECTION OF PRIMM OIL ENGINE

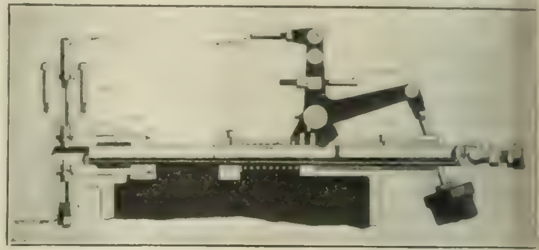


FIG. 3. FUEL PUMP OF PRIMM ENGINE

On the twin cylinder engines, the pump is double acting, allowing the use of a single eccentric and push rod.

The atomizer or spray nozzle is the Primm standard design and enters the cylinder at the top. The oil, as it enters the cylinder, strikes the hot plug in the cylinder head. The fuel injection timing varies with the load. At full load the beginning of injection is about 20 deg. ahead of dead center and the injection ceases at dead center. The ignition plug follows the usual Primm design. It is heated by a torch and then slipped into the cylinder head and locked by means of a screwed cap.

The engine is not devoid of striking features. It is much simpler than a Diesel engine and can be operated by any average mechanic. In many engines the frame becomes rather warm from the heat absorbed by the cylinder and piston. In this engine the cooling water enters the frame in front of the main bearings. Cored passages allow the water to pass toward the cylinders, in this way keeping the engine frame at all times much cooler than is customary with the usual design of two-cycle semi-Diesels.

Connections Between Brushes and Brush-Holders

Tendency Is Toward the Use of Flexible Connections Between Brushes and Brush Holders—Voltage Drop Between Brush and Holder May Represent an Appreciable Loss—Load Current Passing from Brush to Holder Causes Serious Injury to Both—Three Methods of Connecting Shunts to Brushes and Their Relative Merits

By WARREN C. KALB
General Manager, Corliss Carbon Company

During the last few years there has been a rapidly growing tendency on the part of manufacturers of electrical machinery toward the use of flexible connections between brushes and brush-holders or some portion of the brush-supporting rigging. These flexible connections are usually termed shunts or pigtails. Some of the reasons making the use of such a connection desirable are the elimination of the voltage drop between brushes and brush-holders, the prevention of the passage of load current through the tension spring of the brush-holder, the reduction of side burning and the insuring of equal distribution of current among all the brushes. Referring to the first reason given, the voltage drop between brush and brush-holder may not seriously impair the efficiency of a high-voltage machine, but on a machine of relatively low voltage the percentage of loss due to poor contact between the brush and brush-holder may represent an appreciable loss of efficiency. This drop may be as much as two or three volts or even more should the brush become coated with grease or oil. On a 32-volt machine such as used for farm lighting, it will be seen that this will represent 6 to 10 per cent loss in efficiency, which would be a prohibitive figure when it is so easily overcome by establishing a low-resistance flexible connection between the brush and brush-holder. This condition applies principally to box-type holders in which the brush has a free movement within the holder guides. The use of a shunt is not so important on clamp-type holders where much better contact is secured between the holder and the brush. This contact, however, is not as low in resistance as can be obtained by the use of a properly connected shunt, and for this reason shunts are used to a considerable extent even on holders of the clamp type.

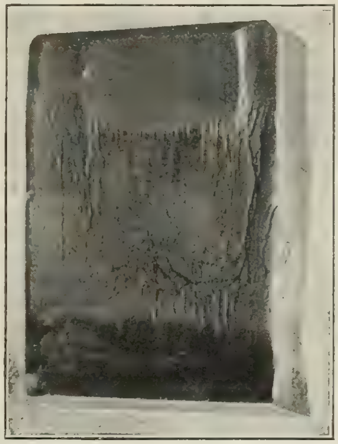
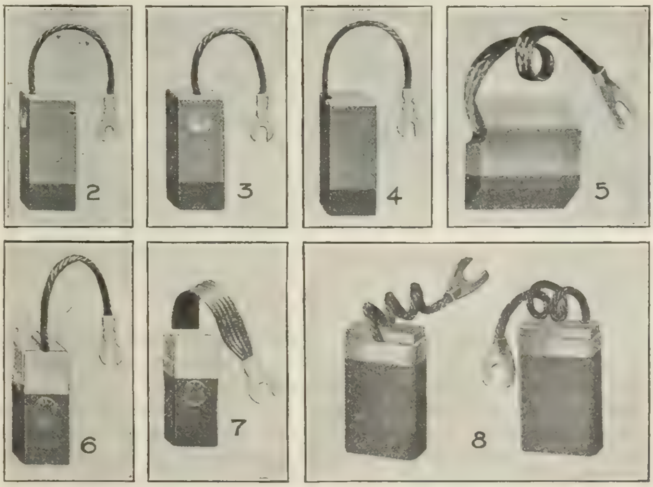


FIG. 1. EFFECTS OF OPERATING BRUSH WITHOUT A SHUNT

The most serious difficulty arising from the passage of load current through the tension spring of the brush-holder is the heating that will result, with the possibility of destroying the temper of the spring. Where this takes place, unequal tension on the brush is a certain result, leading to such troubles as excessive vibration, sparking and overheating of the brushes on which heavy tension remains.

In addition to considerable current passing through the tension spring when no shunt is used, a large amount will go directly from the brush to the sides of the brush-holder. This will not be evenly distributed over all the available bearing surface, but will be localized in a few points of contact at which the current density will be quite high. The play of the brush in the holder causes frequent interruption of the current at these points of contact, resulting in the drawing of small arcs, which rapidly burn away both the brush and the interior surfaces of the holder. Fig. 1 shows a brush operated without a shunt, and how serious this side burning may become under severe load conditions. The use of a flexible connection between the brush and holder will almost entirely eliminate such action, even under very severe conditions.



FIGS. 2 TO 8. METHODS OF SOLDERING SHUNTS TO BRUSHES

Equal distribution of load current among all the brushes cannot be too greatly emphasized and constitutes one of the most important reasons for the use of flexible connections. Unequal distribution of current not only causes serious injury to the brush which is carrying an excessive share, but through the glowing and sparking so produced may cause serious injury to the commutator, necessitating expensive repairs. Even where shunts are used, unequal distribution will sometimes exist if they are not properly connected to the brush or if the connection to the brush-holder is poor, whether due to dirty contact or to a loose screw. Troubles due to unequal distribution on machines where the brushes are equipped with shunts may often be eliminated by cleaning and tightening the contacts of all the pigtail terminals.

The method of connecting the flexible cable of the shunt or pigtail to the brush is of the greatest importance. In the first place, the connection should be of low electrical resistance. As an aid to this characteristic, it should have as large an area of contact as possible and the contact should be firm at all points. The use of solder is of considerable advantage in securing low resistance, but care should be taken in the construction of the connection so that there are no pockets where an excess of solder can gather to drop out on the commutator or cause the brush to stick in the holder should a temperature be encountered during operation sufficient to cause the solder to melt.

A second feature of importance is the mechanical security of the connection. Many connections are used successfully which depend entirely on solder to secure the cable to the brush. Such connections are subject to failure, however, when high temperatures are reached, and a connection that is secured mechanically independent of the use of solder possesses an appreciable advantage over the former type. Mechanical connections should also be free from a tendency to loosen under vibration or from the expansion of the metallic parts when heated. In this respect a screw-type connection possesses an advantage over the riveted type, inasmuch as it can be drawn up firmly while hot, whereas the riveted type is always attached to a cold brush. The metal is subject to greater expansion than the carbon when the brush becomes heated in service. All connections should be able to withstand a moderate pulling strain without breaking away from the brush, but excessive strain of this nature will not be encountered in service, so that the fact that a cable can be pulled from the brush by hand is not in itself sufficient reason for condemning a connection.

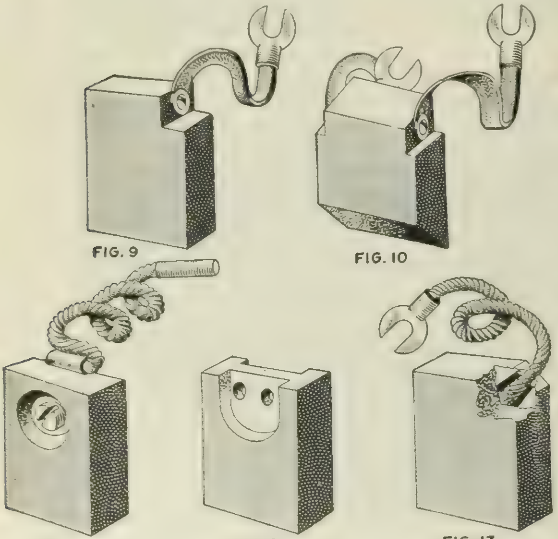


FIG. 9 FIG. 10 FIG. 11 FIG. 12 FIG. 13

FIGS. 9 TO 13. MECHANICAL METHODS OF CONNECTING SHUNTS TO BRUSHES

A third point to be considered in the method of connecting the cable to the brush is simplicity. This applies particularly to the machining operations required upon the carbon itself. Carbon cannot be machined efficiently with steel tools, inasmuch as it rapidly dulls the cutting edge of a tool of this character. All operations should be done with grinding wheels where they can possibly be applied. Of course, in drilling, counterboring and similar operations the use of a steel tool is necessary.

Methods of connecting the shunt to the brush may be grouped in three classes—soldered connections, mechanical connections and the combination of these two. Figs. 2 and 3 illustrate the simplest form of the soldered connection, consisting of a hole drilled into the top of the brush through which the cable is inserted, spread out in a counterbore drilled in the edge or side of the brush and there soldered. In this, as in all soldered connections, it is necessary that the brush be copper plated.

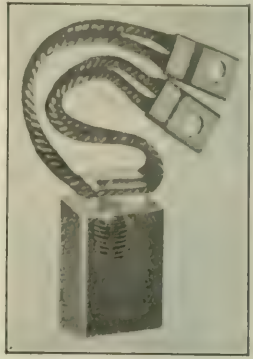


FIG. 14. LOW-RESISTANCE BRUSH WITH SHUNT

Fig. 4 is a modification of Figs. 2 and 3, in that the cable is inserted in a hole drilled through the width of the brush, countersunk at one end for soldering and slotted at the other end to give clearance to the shunt and avoid interference with the side of the brush-holder box. This connection is somewhat better than that in Figs. 2 and 3, inasmuch as the solder will draw back along the cable and give a larger area of contact between cable and brush. Fig. 5 is a modification of the type Fig. 4, and is quite commonly used on brushes with both top and face bevels. The only essential difference between Figs. 4 and 5 is that the edge of the brush is shouldered instead of slotted in the latter case.

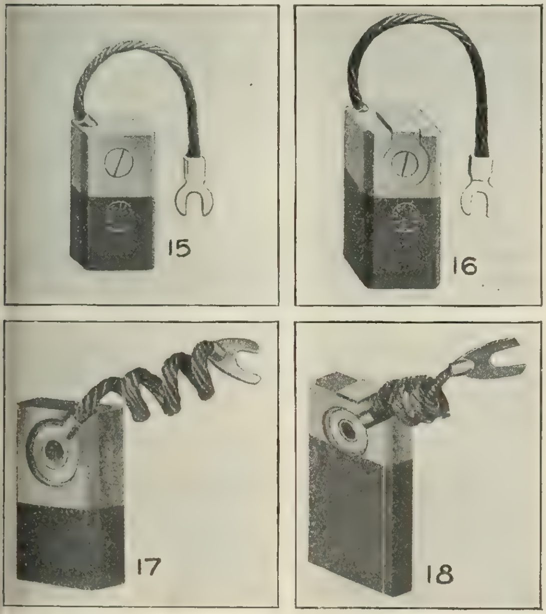
Figs. 6, 7 and 8 show strictly soldered connections. While there is a metal cap over the top of the brush in each of these types under which the cable is spread out, giving a large area of contact, the connection depends entirely upon solder for its security. These connections, particularly those in Figs. 6 and 7, are of very low electrical resistance.

Of the mechanical types there are numerous forms in which the cable is secured to the brush by means of a screw or nut. The brush in this case may be either plain or copper coated, the latter form usually being of slightly lower electrical resistance than the former. Another mechanical type in use to a considerable extent has the same appearance as the soldered type illustrated in Fig. 5, the difference being that the flat cable, which may be opened up into tubular form, is pressed into firm contact with the interior of the brush and there secured by a pin of the proper size, driven in from the opposite edge to that visible in the illustration. A modification of this type is shown in Figs. 9 and 10, in which the cable is secured by a tubular rivet passing through the width of the brush and spun over on the end. A detachable type, Fig. 11 is extensively used by one manufacturer, but is subject to the fault that a portion of the connection extends beyond the side of the brush, necessitating a deep slot in the brush-holder.

Fig. 12 shows the preparation of a brush for what is known as the saddle-type connection. This connection consists of a heavy sheet-copper clip or saddle fitting into the recesses of the brush shown in the figure and secured thereto by bolts and nuts. Flexible cable is attached directly to this saddle. This type is quite expensive from the standpoint of the preparation of the brush as well as the cost of the saddle, and as a result it is rapidly passing out of use.

For metal-graphite composition brushes in which the percentage of metal is very high, the connection in Fig. 14 is often used. In some cases, particularly on small metal-composition brushes, the cable is often secured to the brush merely by inserting a pin or screw alongside of the cable or through it after it has been inserted into a snug-fitting hole in the brush.

One other type, Fig. 13, quite extensively used, comes under the classification of mechanical connections. In this type a single hole is drilled into the brush, usually through the top or from a beveled upper corner. The diameter of the hole is larger than that required to accommodate the cable, and the hole is sometimes slightly undercut or enlarged at the bottom. After inserting the cable into the brush, copper powder specially prepared for this purpose, or a conducting cement having the characteristic of hardening after a short period, is tamped in alongside the cable, establishing firm contact and mechanical security between the cable and the brush. This connection has a pronounced advantage from the standpoint of simplicity, but is lacking in mechanical security. It also has a comparatively small area of contact, and while the electrical resistance may be low, there are failures when heavy currents are carried by an individual brush.



FIGS. 15 TO 18 COMBINATION TYPES OF CONNECTIONS

Of the combination types, Figs. 15, 16, 17 and 18 illustrate the two forms most commonly used, Figs. 15 and 16 being a screw-type connection and Figs. 17 and 18 a modification in which the cable is secured by a hollow rivet inserted through the thickness of the brush and spun over on the ends. These types, as will be noticed from the figures, can be made with or without a metal clip extending over the top of the brush to prevent wear under the tension spring of the brush-holder. Other modifications of this type are illustrated in Figs. 19, 20 and 21, which show various forms of lifting clips attached to the top of the brush. These are used on interpole rotary converters, started from the alternating current side, to lift the load carrying brushes out of contact with the commutator during the starting period. All the combination types here illustrated may be attached to copper-coated brushes without the use of solder, but the electrical conductivity is so greatly improved by the use of solder that this has become the almost universal practice.

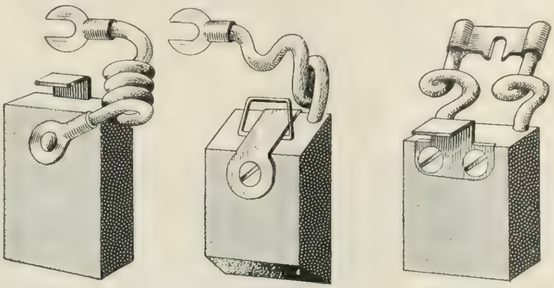


FIG. 19 FIG. 20 FIG. 21

FIGS. 19 TO 21. BRUSHES EQUIPPED WITH LIFTING CLIPS

Two forms of copper cable are used for pigtail connections, the braided form illustrated in Fig. 7 and the stranded form, Fig. 6. Braided cable is of advantage where flat contact surface is desirable, as in the connection, Fig. 7, or where a rivet or pin is to be inserted in the cable, as in Figs. 9 and 10. Braided cable, however, is not as flexible as stranded cable, and for this reason the latter is preferable in most instances. Wire of No. 36 B. & S. gage is fine enough to give the necessary degree of flexibility in all but the smallest cable, in which case wire as fine as No. 40 B. & S. gage may be used. In the table is given a list of carrying capacities for various standard sizes of stranded cable. These figures have been determined from actual industrial applications and have sufficient margin of safety that no appreciable heating will occur until the overload capacity of the brush has been greatly exceeded.

CARRYING CAPACITIES OF VARIOUS STANDARD SIZES OF STRANDED CABLES

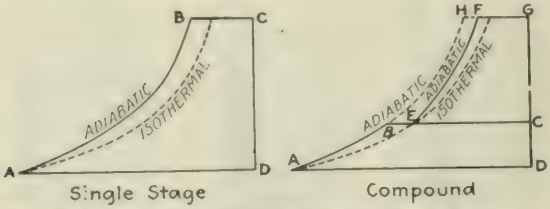
Number of Wires	B. & S. Gage No.	Circular Mils	Approximate Diameter of Cable Inches	Carrying Capacity Amperes
105	40	1,038	$\frac{1}{32}$	8
63	36	1,575	$\frac{3}{64}$	10
105	36	2,625	$\frac{1}{16}$	13
161	36	4,025	$\frac{5}{64}$	19
238	36	5,950	$\frac{3}{32}$	25
392	36	9,800	$\frac{1}{8}$	37
525	36	13,125	$\frac{9}{64}$	48
644	36	16,100	$\frac{5}{32}$	58
823	36	20,800	$\frac{3}{16}$	73
1,050	36	26,250	$\frac{13}{64}$	90

The Air Compressor in the Power Plant—I

By SNOWDON B. REDFIELD

Engineer-in-Charge, Engineering Department, Ingersoll Rand Company, Easton, Pennsylvania

A FEW remarks as to the theory of air compression, and particularly the indicator diagram. The theoretical, single stage, no clearance, adiabatic (no cooling), no valve-loss indicator diagram is shown in Fig. 1. From *D* to *A* is the intake line corresponding to the atmospheric pressure. Adiabatic compression takes place from *A* to *B;* at *B* the discharge valves open and the air is discharged from *B* to *C* at a pressure corresponding to the air system. At *C* the piston comes to rest, the discharge valves close and the pressure in the cylinder immediately falls to *D*, when the inlet valve again opens, to repeat the cycle. In Fig. 2 is shown a theoretical diagram of a compound compressor. In this case, at *B* the air is discharged along *BC* corresponding to the intercooler pressure. The length *BC* also represents the volume occupied by the heated, compressed air which was originally represented by the length *AD*, as cold free air. When the air *BC* has passed through the intercooler it has become cooled and the volume will be represented by length *EC*. If the intercooling has been complete, so that the air coming out of the intercooler is at the same temperature as that entering the low-pressure cylinder *AD*, the point *E* will be on the isothermal curve. The isothermal curve represents the relation of volumes and pressures if the air could be kept at the same temperature by some means of cooling all during the period of compression.



FIGS. 1 AND 2. THEORETICAL COMPRESSION DIAGRAMS

This article deals with the theory of air compression and with receivers, intake duct sizes, steam, air and water piping, regulators, lubrication and other things of interest to the man who operates air compressors.

The length *EC* then represents the volume of cooled air compressed to intercooler pressure which enters the high-pressure cylinder. Compression in the high-pressure cylinder then takes place along the adiabatic *EF* and discharge at line pressure takes place along *FG*.

As point *E* with complete intercooling is on the isothermal line, which started at *A*, it means that the product of the absolute pressure and volume at *E* is the same as the product of the absolute pressure and volume at *A*. Thus we can say

$$\text{Abs. press. } A \times \text{vol } AD = \text{abs. press. } E \times \text{vol. } EC, \text{ or}$$

$$\text{Abs. press. } E = \text{abs. press. } A \times \frac{\text{vol } AD}{\text{vol } EC}$$

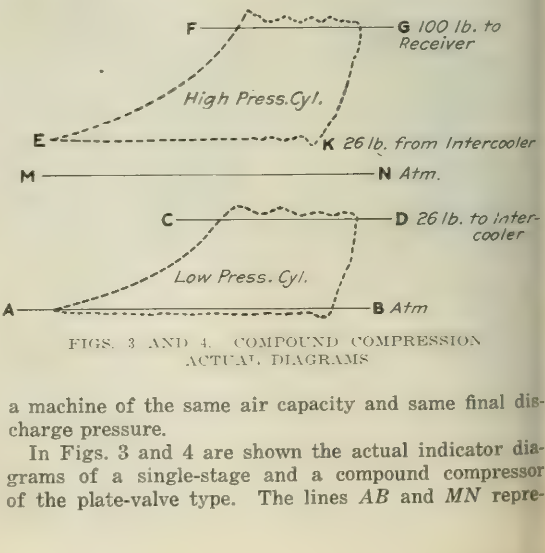
This means that the absolute intercooler pressure is the product of the absolute initial pressure (atmospheric) and the ratio of the cylinder volumes.

As an example, suppose that the low-pressure cylinder volume is 2.65 times the high-pressure cylinder volume, then the absolute intercooler pressure will be 14.7 × 2.65 = 38.9 lb. Subtracting 14.7 lb., the intercooler gage will read 24.2 lb.

If the compression had been single-stage, or even two-stage, *without any intercooling*, the entire diagram *AHGD*, which is the same as *ABCD* in Fig. 1, would have represented the work of compression. However, by compounding, giving a change for intercooling, the work is represented by *ABEFGD*, the saving by intercooling being area *BHFE*.

With compound compression to 100 lb. the theoretical saving is about 15 per cent of the single-stage work, and all of this saving is due to intercooling only. Excepting for the intercooling there is no saving of power by compounding, and unless a machine is properly designed the pressure losses through the valves and intercooler passages may largely offset the gain by compounding. A high-class compressor will show about 13 per cent saving in power over a single-stage machine at 100 lb. pressure.

Aside from power saving there are several other advantages due to compounding. One of these is a higher volumetric efficiency, because the amount of air trapped in the clearance spaces of the low-pressure cylinder at intercooler pressure will be less than if the pressure were of the discharge-pipe system. Another advantage of compounding is the condensation and separation of a good deal of the moisture in the air, and still another is the fact that with a compound unit the bearing pressures caused by the discharge pressure of each cylinder upon its own piston are much less than for compression in a single stage, with a machine of the same air capacity and same final discharge pressure.



FIGS. 3 AND 4. COMPOUND COMPRESSION ACTUAL DIAGRAMS

In Figs. 3 and 4 are shown the actual indicator diagrams of a single-stage and a compound compressor of the plate-valve type. The lines *AB* and *MN* represent the atmospheric line in both cases, and *CD* and *FG* represent the discharge lines. The areas below *AB* and above *CD* and *FG* represent the excess work required to force the air through the valves, into and out of the cylinder. It is in the reduction of these excess areas that a great deal of the engineering talent is directed in valve improvements. At equal rotative and piston speeds a machine of the poppet-valve type will show much greater excess work areas on the indicator diagram than a plate-valve machine. There are other items, also, such as heating and leakage, that are of equal importance in the matter of economy. The elimination of all these bad features and the securing of durability, reliability and accessibility combine to produce a high-grade air compressor.

It is best to connect the piping the full size of the openings in the compressor. The outlets are designed in accordance with the pulsating discharge of the cylinders. Beyond the receiver the pipe lines may be smaller, because the flow will then be steady and non-pulsating, and the pipe sizes may be determined by the velocity to be allowed. The allowable velocity will depend upon the length of pipe and how much pressure drop is permissible. In various handbooks there are several formulas and tables for figuring pressure drop in compressed air flowing in a main. Ordinarily, for steady flow, a velocity of 2,500 ft. per min. is conservative where distances are short. Beyond the receiver this may be figured by the well-known formula,

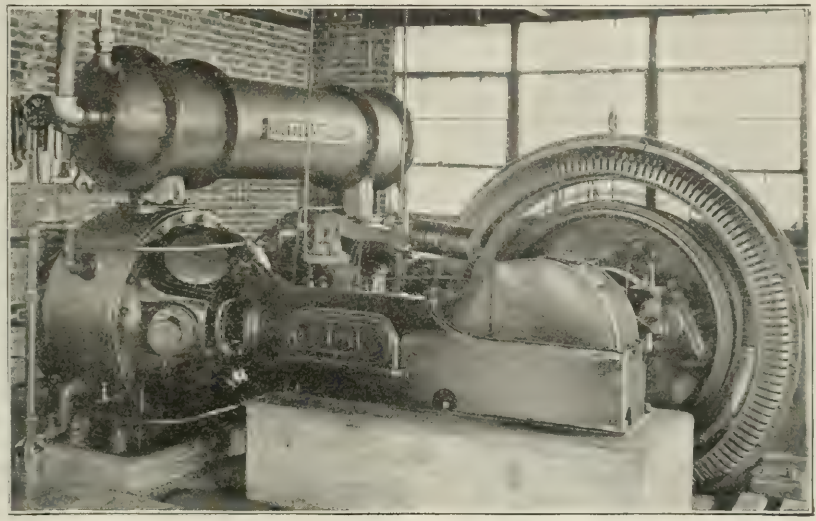


FIG. 5. DIRECT CONNECTED TWO-STAGE AIR COMPRESSOR WITH SYNCHRONOUS MOTOR AND CLEARANCE CONTROLLER

$$Quantity = Velocity \times Area\text{, or } Area = \frac{Quantity}{Velocity}$$

In this case the quantity is the compressed air volume, and to obtain this we must remember that the volumes are inversely proportional to the absolute pressures and directly proportional to the absolute temperatures. The absolute pressure is obtained by adding the atmospheric pressure (14.7 lb. at sea level) to the gage pressure, and the absolute temperature is obtained by adding 460 to the Fahrenheit temperature.

With air at 100 lb. gage pressure, from a compound compressor, the temperature in the first part of the discharge pipe will be about 200 deg. F., so we have:

$$Compressed\text{-}air\ volume = Free\ volume \times \frac{4.7}{100 \times 14.7} \times \frac{200 \times 460}{60 \times 460}$$

This assumes that the initial temperature of the free air was 60 deg. F., which is a fair average, and we have

$$Compressed\ volume = \frac{Free\ volume}{6.15}$$

For a close figure we can then say the hot compressed volume of the air is one-sixth of the free-air volume when the pressure is around 100 lb.

As an example, suppose the compressor delivers 2,800 ft. of free air per minute, then the compressed air beyond the receiver will be about 466 cu.ft. per min., with air around 100 lb. gage pressure, and applying the formula,

$$Area = \frac{466}{2{,}500} = 0.186\ sq.ft.$$

or 26.8 sq.in., corresponding closely to a 6-in. pipe. Under these conditions the pressure drop will be a little less than ½ lb. per 100 ft. of pipe. For a longer distance 7-in. pipe would be better giving about 1,700 feet velocity and a pressure loss of 2 lb. per 1,000 feet of pipe. Based upon the pulsating flow directly from the discharge of the compressor, the intermittent velocity would reach a figure much higher than the assumption of steady flow would indicate. For this reason it is customary for some builders to provide much larger cylinder outlet connections for the pipe joining the cylinder and air receiver.

If there is a stop valve in the discharge line from the compressor it is essential that a good-sized safety valve be located in the pipe between the compressor and the stop valve. If this is not provided there is serious danger of starting the compressor with the stop valve closed, which may result in the bursting of the compressor cylinder.

THE AIR RECEIVER SHOULD BE NEAR THE COMPRESSOR

The air receiver should be as near the compressor as practicable, and there should be a separate pipe from each compressor to the receiver. The practice of connecting a battery of compressors to a long header pipe leading to a receiver outside the building is not good. Under certain conditions this produces pressure surges in the air moving down the long pipe, which materially increases the power required to drive the compressor. These surges require energy to produce and, as they serve no useful purpose, are a direct waste of power. It is better to have a receiver for at least every two compressors and each machine connected through a separate pipe of its own, the piping to the receiver being as short as possible and the full size of the compressor outlet.

There is no established rule for the size of the receiver. If the character of the work is intermittent a more generous receiver capacity is advisable. However, it is possible in most cases to store only a relatively small amount of air in a receiver with permissible pressure fluctuation. A rough rule is to provide a storage of approximately one minute's supply of air. Thus for the 2,800-cu.ft. compressor we would have approximately 466 cu.ft. of compressed air per minute, so a cubic content of 400 cu.ft. would be liberal receiver capacity. This would be about 66 in. in diameter by 18 ft. long. The pipe leading the air from the compressor should enter the receiver near the top and leave near the bottom to assist separation of moisture and oil.

INTAKE AIR DUCT

Conditions of economy dictate that the compressor inlet should be connected to the outside air, instead of connecting with the engine-room cellar. It is a fact that the power to compress a cubic foot of air measured at intake conditions does not depend upon the intake temperature, but the amount of "stuff" delivered to the work (where the air is used) does depend upon this temperature.

To illustrate this, suppose that the compressor handles 1,000 cu.ft. of free air per min.; let the season be summer and the engine-room cellar be at 100 deg. F., while the outside temperature is 80 deg. F. By the time the air reaches the work radiation will have cooled it to about 80 deg. If we take 1,000 cu.ft. of air from the engine room at 100 deg. F. this will amount to $1{,}000 \times \frac{80 \times 460}{100 \times 460} = 965$ cu.ft. of free air at the work. If this air had come from outside it would have been $1{,}000 \times \frac{80 \times 460}{80 \times 460} = 1{,}000$ cu.ft. of free air at the work. This is a gain of over 3 per cent in air quantity for the same amount of power expended or of fuel saved for an equal amount of air, in favor of the outside air duct.

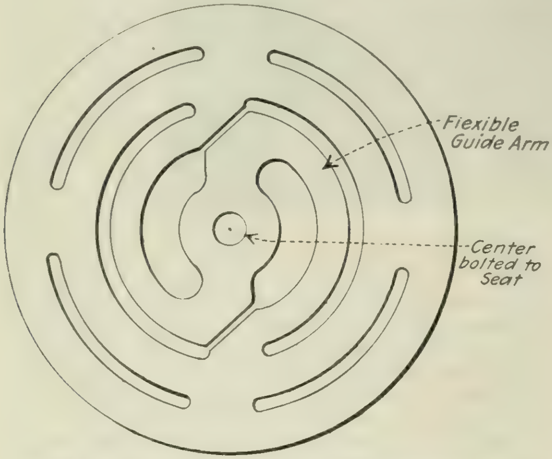


FIG. 6. PLATE VALVE, SHOWING FLEXIBLE CENTER

Now assume moderate winter conditions: say, outside temperature 20 deg. F., engine-room cellar 88 deg. F. and final air temperature in the shop 73 deg. F. The 1,000 cu.ft. of air taken in from the engine-room cellar would then be, at the work, $1{,}000 \times \frac{73 \times 460}{88 \times 460} = 970$ cu.ft.; but if taken in from out of doors we have $1{,}000 \times \frac{73 \times 460}{20 \times 460} = 1{,}100$ cu.ft. delivered to the work. This is a gain of 14.4 per cent in air quantity, or fuel saved by the outside air duct. Averaging summer and winter temperatures the actual saving in a mild climate can thus easily be 8 to 10 per cent of the power. This is 80 to 100 hp. in 1,000, and is obtained by a simple air duct, which needs no attention or lubrication or upkeep when once properly installed. In a cold climate the saving would be even greater.

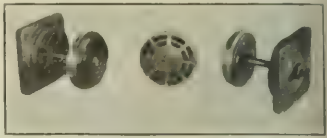


FIG. 7. PLATE VALVE COMPLETE

Mention was made that the intake duct should be properly installed. This should be emphasized, because the very heavy pulsations in an intake duct will destroy it if poorly built. A wooden duct is almost surely foredoomed unless constructed with extreme care and strength. A concrete duct, or large iron, steel or terra cotta pipe makes an excellent intake passage.

For intake ducts it is best to keep the velocities down. The lower the velocity the less the pulsations and the less the power consumed. A velocity of 1,600 ft. per min. is high enough except for very short intake pipes. If the pipe or duct is 20 ft. long it would be better to go even lower, say 1,200 to 1,300 ft. Being intake, or "free" air, the velocity may be figured directly from the uncompressed volume handled. For the 2,800 cu.ft. compressor an intake duct should have an area of not less than $\frac{2{,}800}{1{,}300} \times 144 \quad 310$ sq.in., corresponding to 20-in. diameter if round.

Not only is slow inlet velocity an advantage in reducing air friction and consequent pressure drop and power loss, but it also tends to stop the pulsations or pressure waves which often occur. Under suitable conditions these pulsations may actually serve to increase the volumetric efficiency and air output of a compressor by the inrush of air building up a pressure in the air cylinder just at the end of the suction stroke and the beginning of the compression stroke. It is sometimes claimed that volumetric efficiencies of over 100 per cent have been obtained by this means, but this is only "apparent" and by indicator diagram measurement. Actual air-quantity measurement by a nozzle will instantly show that the other losses, such as clearance re-expansion, heating of intake and leakage, tend to keep the actual air quantity appreciably less than the cylinder displacement.

Gain in volumetric efficiency by intake surge is not always to be desired, because the extra air has to be paid for in extra power and at no specially economical rate. This may even put a constant and troublesome overload on the electric equipment of a motor-driven unit.

One bad practice is to put the air-discharge pipes through the intake duct. This serves directly to defeat the gain of the cool duct, because the hot discharge pipe heats the incoming air. The writer knows of such an installation where the incoming air was heated 6 deg. F. by the presence of the discharge pipe in the intake duct. This was a direct throwing away of about 1⅛ per cent of power. Why deliberately throw away 11½ lb. of coal every time 1,000 lb. is shoveled into the furnace, all summer and all winter, day in and day out?

In estimating such a heating loss a rough figure is 1 per cent loss for each 5 deg. F. intake-temperature rise.

Steam Piping and Water Piping

In installing steam-driven compressors it is of course essential that steam pipes be amply large to avoid steam pressure drop. Another essential is a steam separator at the compressor steam cylinder entrance; connect this separator drain to a steam trap. Some of the most highly economical steam-driven compressors are built with piston valves, and it is well known that these valves cannot handle slugs of water as freely as the flat type. These piston valves, however, lend themselves to automatic cutoff governor control and to superheat, thus securing high economy. The steam separator is a good piece of insurance when properly drained to a trap; but it is curious to note that separators are sometimes seen without any drain pipe. What mysterious influence the operator attributes to such a device is hard to see.

Next in importance to air and steam piping comes water piping for jacket cooling and intercooling and sometimes aftercooling. The jackets do not need as much water as do the intercooler and aftercooler, as there is much less chance for absorption of heat through the jackets. The principal function of the water jackets is the preservation of the lubricant, while the intercoolers are a direct source of power saving. For every 10 deg. F. that the high-pressure inlet temperature exceeds the low-pressure intake temperature there is an increase of power of closely 1 per cent. Both intercooler and aftercooler serve to remove moisture from the air by condensation.

Jacket Water Should be Warm to the Hand

For the jackets of a compound unit the total water required for the two cylinders need not usually exceed 1 to 1½ gal per 100 cu.ft. of free air. Thus, with reasonably cold water (60 or 70 deg. F.) the 2,800 cu.ft. compound compressor could get along nicely on 35 gal. per min. for the two cylinder jackets alone. For the intercooler of a high-grade compound, 100-lb. unit, it is usually safe to figure on from 2½ to 3 gal. per 100 cu.ft. of actual free air. On this basis the intercooler of the 2,800-ft. unit would require from 70 to 85 gal. per min., if the intercooler were of efficient design.

For most compressors a water pressure approximating 20 lb. per sq.in. is usually sufficient, and if possible it is best to have the outflow water piping discharge into an open funnel. By this means both the quantity and temperature may easily be observed. It is best to adjust jacket water so that as it leaves it just begins to feel warm to the hand. Any more than this is really a waste of water and any less may quickly become hot and cause excess cylinder heating and oil carbonization.

Water for intercoolers and aftercoolers is best regulated by a thermometer in the *air* leaving the cooler. There is a point beyond which even an enormous increase in water quantity will not produce appreciably better intercooling. Of course all water jackets should be so piped that they may be completely drained to insure against freezing in case the engine room should become cold. All first-class compressors are designed to provide for this, but the water piping should be arranged to accommodate this condition also. This also applies with equal force to intercoolers and aftercoolers.

It is a good thing to clean out the sediment and scale which may accumulate in the jackets. Large machines often have handholes in the outer jackets to assist in this cleaning, and the occasional application of scrapers and a waterhose will help on all sizes. Intercooler and aftercooler tubes need this attention occasionally. Most coolers are made so that the tube nest may be removed for inspection, repairs and cleaning.

Regulator Piping

Piping which leads air to and from the various regulating devices deserves serious consideration. In the first place, as distances may be appreciable, it is well to provide good-sized connecting piping so that a sufficiently large volume of air may be passed to operate the regulators promptly. Certainly nothing less than ⅜-in. piping should be used even for moderate distances.

There are two broad classes of regulators—those which control the speed of the compressor to suit the demand for air and those which regulate the air quantity independent of speed. In the first class come the Corliss engine-driven units and also the well-known type of "air ball governor." With these devices which take up definite positions relative to the air demand, it is usually essential to give them a little "life" or movement by connecting the pressure-regulating pipe to the discharge pipe of the compressor. By this means the pulsations of the air being discharged will serve to keep the governor parts in a condition of free movement. On the other hand, if the regulator is such that it does not operate until the air pressure reaches some definite predetermined point it is best to have the regulator as free from pulsations as possible by connecting the regulating piping to the air receiver. Unless this is done the pulsations may cause the regulator to go on and off many times due simply to pressure waves set up in the discharged air. If the connection is made to the receiver nothing will happen until a definite pressure is reached, and there should be no continued fluttering of the regulator.

Speed Control When Pressure Falls

With the governors that control the compressor speed according to the demand for air, there is usually a piston balanced by a spring or weight, or both, this piston being connected to the governor in such a way as to close or open the steam supply or alter the steam cutoff independently of the centrifugal part of the governor. In this type, then, the centrifugal action serves merely as an upper speed limit, and the compressor cannot exceed a certain speed no matter how low the air pressure may fall. Such a governor should be so adjusted that, if the air mechanism fails or the air pressure fails, the centrifugal mechanism will surely hold the machine within safe limits of speed. The air piston should move freely, but of course should not be such a loose fit as to allow leakage.

To prevent the governor piston from becoming rusted by the moisture that will come over with the air through the regulator piping a small receiver should be provided to catch the water just before it reaches the regulator. This receiver may be easily constructed of, say, a 4-in. pipe about 12 in. long and closed at each end with a pipe cap. Standing this receiver on end, the regulator piping from the air system should enter the top and also leave from the top to go to the regulator. A drain valve should be tapped into the bottom of this small receiver and care taken that the condensed moisture is blown out of it at least once a day.

Of course the air piston of the regulator should be properly lubricated; a lubricator is invariably provided by the builder.

RELIEF VALVES REDUCE "NO LOAD" POWER

Regulators of the constant-speed class—that is, those which act suddenly at predetermined pressures—are often of the "all-on and all-off" type. With these regulators some form of pilot valve controlled by the air pressure acting upon a piston or diaphragm, resisted by a spring or weight, or both, admits air to the piston of the regulator proper. Thus, when the pilot valve has moved to a certain point, a port is uncovered that passes air to throw the main regulator piston. This piston moves a valve in the intake pipe, which closes off the air supply to the compressor, drawing a high vacuum and greatly reducing the horsepower of the compressor during the unloaded period.

With these regulators which close the intake it is often customary to provide some sort of automatic relief valve which at the same time opens the discharge to the atmosphere. This prevents excessively high compression of what little air leaks through the intake regulator, which would be from the vacuum in the intake to the full discharge pressure of the line. It also reduces the "no load" power, by compressing the air in the cylinder only to atmosphere instead of the full discharge pressure.

Owing to the undesirability of controlling large compressors of the electrically driven type by this sudden single step from full power to minimum power, there are some regulators built which control the machine in graduated steps. One of these as built by the Ingersoll-Rand Co. operates by adding clearance pockets to the ends of the cylinders, part of the air being compressed into the pocket and part being discharged as soon as the pressure in the pocket has reached discharge pressure. By providing four pockets for each cylinder, two at each end, each large enough to contain half the air in one end of the cylinder, it is so arranged that the unloading is in four steps: Three-quarter load, half load, quarter load and no load. With this type of regulator by the useful re-expansion of the pocketed air the reduction in cylinder power is in remarkably close relation to the reduction in air capacity, thus tending to high partial-load economy. In a compound unit the action is, of course, the same in both cylinders.

ADVANTAGES OF THE STEP CONTROLLER

One convenient and economical feature of this four-step controller when used with electric drive is that it may be so set that at no time will the machine operate at more than a predetermined partial load. This is convenient for repair work at night or on holidays, when only a small amount of air is required. Thus, the machine may be so locked that it cannot take more than, say, half load, and so it is necessary to run a generator only large enough to take the smaller load. If this were not so arranged it would be necessary to run a generator of full capacity and this would run unloaded most of the time, and consequently with poor economy.

When electric power is purchased the unit rate is sometimes based upon the maximum demand, so that this form of stop or lock may serve directly to cut the maximum demand and thus the unit rate.

For some types of steam-driven compressors fitted with a speed governor and air-cylinder regulator it is customary to provide a steam regulator. This device is usually controlled by the same pilot valve which actuates the air-cylinder regulators, and its purpose is to slow the machine down to the minimum speed necessary to insure rotation during the unloaded period. By this reduction in speed while the air end is unloaded, less steam is consumed than if the centrifugal governor were allowed to maintain full speed.

Still another type of regulator for intermittent service with electric drive is the automatic start and stop. With this device a pilot valve or switch actuated by the air pressure starts and stops the motor automatically. Also, to relieve the motor of the heavy inrush of current at starting, special unloading devices unload the compressor before starting or after stopping. In this way the motor can start under light torque, and when at or near full speed the regulator is again automatically thrown to put full load upon the compressor, which then pumps air until again stopped by the controller.

Such an equipment as last described should be used only when very intermittent service is required, such as for fire whistles or for air charging an automatic sprinkler system. Care should be taken to keep all the electric contacts in good condition and to see that the starting unloader is in order so as to save the motor during starting periods and also to keep down the power consumption.

DIRECTION OF ROTATION

One question always of interest is: What is the best direction of rotation for compressor? In a power-driven machine, in which all the driving power is applied to the shaft, either through a wheel or by a motor mounted on the shaft, the machine should run "under." Rotation in this manner with a power-driven machine tends to keep the crosshead down on the lower guide, preventing the knock that would be produced by the lifting of the crosshead if the guides and shoes became worn. Considering the outward stroke the crankpin draws the connecting rod outward and downward, and considering the inward stroke the crankpin pushes the connecting rod inward and downward. Thus the crosshead is held down on the lower guide.

The described series of motions and forces in a power-driven machine are usually easily understood, but the conditions in, say, a steam-driven compressor of the straight line, or tandem construction, are not so universally understood.

To study this matter, consider a tandem machine with the steam cylinder between the crosshead and the air cylinder, and imagine the machine to run "over," as in most steam engines. Starting with the outward stroke, the steam pressure in the steam cylinder is at its maximum and the air pressure at its minimum. Under these circumstances the excess power goes into the flywheels, causing the machine to accelerate; the thrust of the piston rod, with the rising connecting rod, certainly tends to depress the crosshead. Somewhat beyond mid-stroke the air pressure has built up and the expanding steam pressure has decreased so that the steam and air loads may be equalized. At this instant all the steam power goes directly into the air piston. Beyond this point the air load will increase and the steam load decrease, so that the air load will far exceed the steam load.

The extra power now required to compress and discharge the air must come from the flywheels, having been stored therein at the beginning of the stroke as previously described. During this latter part of the stroke the power is coming from the crankpin, just as in the power-driven machine; but with the compressor running "over" in this case the crosshead will tend to rise.

Consideration of the inward stroke reveals the same situation: During the first part of the stroke the crosshead will be drawn down, and during the latter part of the stroke it will be thrust upward. If, now, the direction of rotation be reversed and the series of events again analyzed the same conditions will apply. For this reason a tandem steam-driven compressor may run either way so far as the raising or depressing of the crosshead is concerned. This applies equally well to cross-compound or duplex units. In the construction of certain machines, however, the builders have provided oiling devices that will function in one direction and not in the other, therefore it usually is essential to run the machine in the direction intended by the builders.

COMPRESSOR LUBRICATION

One of the most important items in running an air compressor is lubrication. In modern machines the running parts are usually inclosed in a crankcase and run in oil. The oil is made to circulate from the bottom of the bed over all the bearings, pins and guides and then runs back into the bottom of the bed again.

The air cylinders are sometimes lubricated by a sight-feed oiler so designed that the pulsation of the air pressure assists the feed of the oil. Also, sometimes the air cylinders are lubricated with a positively driven oil pump.

Two principles should be maintained in lubricating an air cylinder. The first is to use only the right kind of oil and the second is to use it sparingly. To be the right kind, air oil should be rather light-bodied and have a flash point above 300 deg. F. It should not carbonize under air-cylinder temperatures. These temperatures range around 260 deg. F. for compound compression to 100 lb. pressure and 360 to 375 deg. F. for single-stage to the same pressure.

HOW TO OBTAIN THE RIGHT KIND OF OIL FOR AIR CYLINDERS

Probably the best way to secure the right oil for air cylinders is to buy oil specially made and recommended by only first-class and highly reputable oil concerns. Being in the business and having highly skilled chemists and engineers in their employ, as well as reputations to maintain, their judgment is usually a good guide. At any rate a short trial of a sample will soon demonstrate the quality of an oil for air-compressor service.

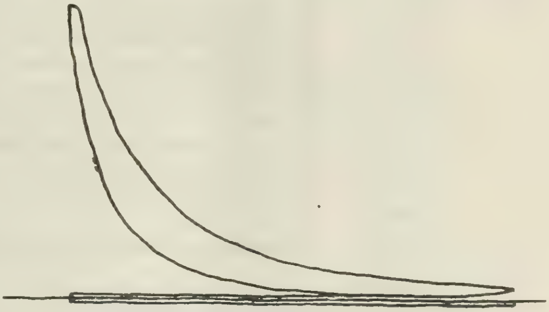
As to the second principle—to use the air cylinder oil sparingly—after a machine has been well run in three or four drops per minute are enough for a good-sized cylinder. If too much oil is used it will certainly result in excessive carbonization. Another evidence of too much oil is to see it coating the outsides of the cylinders and piping, having worked its way through the joints. This is bad practice.

One very important point is to see that the air receiver has all the accumulated oil drained out of it every little while. If too much oil is used or the receiver is not properly drained, gases may be formed which may ignite spontaneously and cause a bad explosion. This is a point that should be scrupulously observed in order to secure safety as well as continuity of service.

It is often recommended that a solution of soft soap or laundry soap and water be fed to the cylinder at stated intervals to clean out carbon deposit. This solution may be fed through the regular air-cylinder lubricating devices. Of course, after this treatment the interior of the cylinder may rust quickly unless the soap solution is followed up with oil for some time before shutting down. Never, under any circumstances, should kerosene or gasoline be used to clean out an air-compressing cylinder. Its use may easily lead to a disastrous explosion.

Excessive Back Pressure

A flour mill of 120 barrel capacity which is driven by a 360-hp. Diesel oil engine fails to mill up to its rated capacity. It was felt by the management that the engine was too small for the load. It is quite true that a larger engine would have been more suitable. Nevertheless, with a proper installation the engine would have fully met the load demands.


EXCESSIVE BACK PRESSURE

Like most Diesel plants, no indicator cards were ever taken by the engineer. In fact no attempt was ever made to set the engine valves other than by measuring the valve rocker-arm clearances. In changing the atomizer the factory engineer had occasion to use his indicator. The diagram, taken from No. 1 cylinder, fairly represents the condition of affairs in all four of the cylinders. It is apparent that the exhaust valve opened entirely too late. This does not explain the excessive back pressure which served to lower the brake horsepower of the engine considerably. It was found that the exhaust pipe ran horizontally about fifty feet and then rose vertically along the wall of the flour mill. The total length of the exhaust line was more than 100 ft. and included two 90-deg. and two 45-deg. elbows. The pipe had not been increased in size to compensate for its length.

Unfortunately, no alteration has yet been made, and the engine, of course, still fails to carry the mill. In installing oil engines precaution should always be taken to secure a short exhaust line, although it should always be carried out of the engine room.

Some Milwaukee Plants of Interest

SINCE 1914, the year in which the annual convention of the National Association of Stationary Engineers was last held in Milwaukee, there has not been much new construction in the power plants of the city. The stations that were listed then in *Power's* convention number, Sept. 1, 1914, are still of interest, however, and worthy of a visit. Besides, a few small plants have been installed, and additions have been made to older plants which should be instructive to the visitor. As all engineers know, Milwaukee is a manufacturing city of the first rank with a varied line of products, many of which are equipment for the power plant. These manufacturers are well known, and an inspection of the shops and the products turned out will be welcomed. Also Milwaukee is one of the greatest coal-distributing points on the Upper Lakes, and its facilities for handling this fuel should prove attractive. Then there are the breweries with their large refrigerating and ice-making plants, the municipal pumping station at North Point, the tanneries, knitting mills, candy manufactories and a great variety of industrial plants of interest. Probably the one particular plant that will be of paramount interest is the powdered-coal installation at the Oneida Street Station of the Milwaukee Electric Railway and Light Co. As told in *Power*, March 2, 1920, five 468-hp. water-tube boilers are equipped to burn pulverized fuel and there is the necessary equipment for pulverizing, drying, conveying and blowing the fuel into the furnace. Through many vicissitudes and changes in furnace volume and shape, the installation has been brought to a satisfactory condition, where its operation compares favorably with the most modern and recent methods of combustion. The plant has created much interest in engineering circles and will be in full operation during the convention. By the same company construction work has been started on the new Lakeside Plant designed initially for burning pulverized coal. The initial installation is to consist of eight 1,306-hp. boilers supplying steam to 20,000-kw. turbines. The installation is not far enough along for inspection, but the story of the plant will be found on other pages of this issue.

It is to be expected that such an industrial city as Milwaukee will have many interesting power plants. The visitor will not be disappointed. The pulverized-coal burning installation in the Oneida Street Station is one of the most widely discussed in engineering circles. The largest station in the city is the Commerce Street plant. For labor-saving devices and apparatus for checking performance, the Phoenix Knitting Works takes first rank.

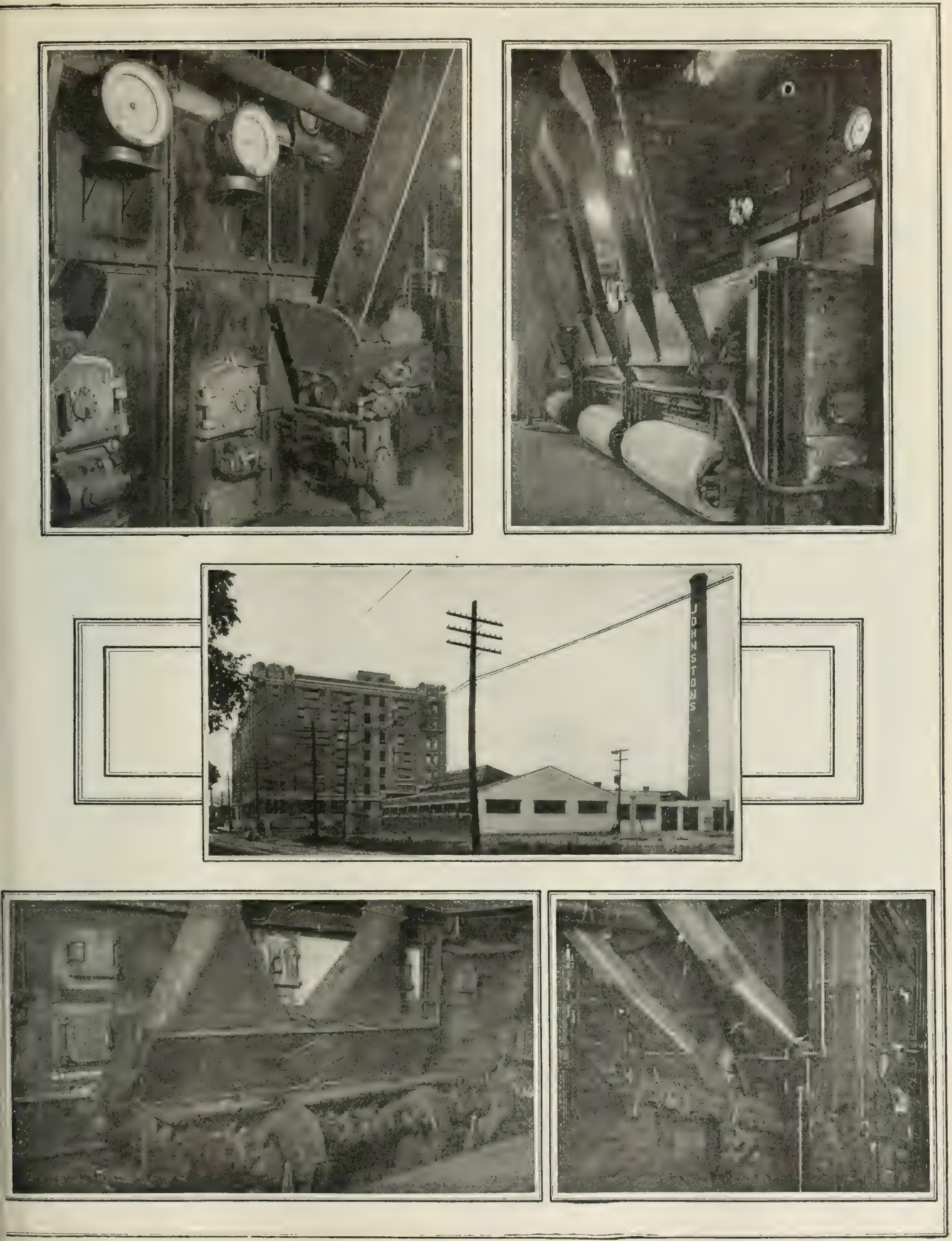
To those who have not had a previous opportunity, a visit to Commerce Street Station of this company should have its attractions. It is the largest power station in Milwaukee, having a generating capacity of 61,900 kw. and 17,000 hp. in boilers, but with its vertical engines, discharging into low-pressure turbines and its high-pressure vertical Curtis turbines, it ranks among the older stations. Since the last convention the only change of any moment was equipping 17 of the 24 boilers with new underfeed stokers. Depending upon the capacities of the boilers, these stokers use seven, eight or nine retorts, and each is driven through a silent chain by a variable-speed motor of the direct-current shunt type. One of these stokers is shown in an accompanying illustration.

One of the smaller stations of recent origin is the new power plant of the Phœnix Knitting Works. It has a capacity of only 750 hp., but is so completely furnished with labor-saving devices, meters and instruments that it is of decided interest. With the older plant, of 500 hp. capacity, it is serving seven of the ten buildings used by the company. The boiler room has four 300-hp. vertical water-tube boilers equipped with Type E stokers. Being a lake port, Milwaukee formerly received much of its coal from Pittsburgh and West Virginia, so that underfeed stokers are in common use. Of late, Elve screenings from southern Illinois have been burned with excellent results. The plant uses about 800 tons of fuel per month with an average evaporation of about 8 lb. of water per pound of coal and on test 8.92 lb. Each boiler has a steamflow meter, an efficiency meter, a CO_2 recorder used in common and a portable indicating instrument, a feed-water regulator, an automatic stop valve and dampen regulation at each uptake and the stack. There is overhead bunker service, the coal being elevated in a continuous bucket conveyor. Ashes are removed by a steam-jet conveyor. In addition the plant has a water softener, an open metering heater and an air-conditioning outfit with temperature regulation supplying 75,000 cu.ft. of washed air per hour to the mills. Exhaust fans draw out impure air.

In the engine room there is one unit, a 750-hp. poppet-valve engine driving directly a three-wire direct-current generator to supply the direct-current variable-speed motors in the mills. The plant is centrally located and the distance of transmission short, so that the line loss is comparatively low. The switchboard has the usual instruments and equipment and in addition a recording wattmeter to register the output. An engine stop protects the generating unit.

Because all exhaust steam is utilized the year around for drying, in the dyehouse, and for heating the buildings and feed water, the economy obtained in the plant is exceptionally high.

For years the Pfister & Vogel Co. has maintained one of the industrial show plants of the city at the Menominee Tannery. It has 3,100 hp. in horizontal reaction turbines, six water-tube boilers equipped with chain grates, an immense water-softening plant having a capacity of 150,000 gal. per hour and an air washer capable of supplying 40,000 cu.ft. per minute to the office building, with thermostatic control to turn on



VIEWS OF SOME INTERESTING POWER PLANTS IN MILWAUKEE

Top Left—Boiler Room, Phœnix Knitting Works. Top Right—Forced Draft Chain-Grate Installation Burning Coke Breeze, Milwaukee Coke and Gas Co. Middle—New Factory and Power Plant, Robert A. Johnson Co Lower Right—Motor-Driven Underfeed Stokers, Commerce St. Station. Lower Right—Pawling & Harnischfeger Co. Boiler Room.

direct radiation when the room temperature drops below 70 deg. There are special facilities for coal and ash handling and in the basement a central hydraulic system for twelve elevators. At the Bayview Tannery, not far away, two 1,000-kw. turbines have been recently installed.

PAWLING & HARNISCHFEGER PLANT

Farther west on the South Side is the new power plant of Pawling & Harnischfeger, which was put into operation early in 1918. It has 1,000 hp. in three water-tube boilers equipped with underfeed stokers driven by individual direct-current variable-speed motors. The forced-draft fans also are motor-driven. The operating pressure is 150 lb. and the superheat 125 deg. Artesian water for the boilers required a softening plant which is used during the four summer months when there are no returns from the heating system to give a pure water supply. Coal is handled by an electric monorail hoist from railway car to storage or to the overhead bunker. A steam-jet conveyor discharges the ashes into an open pit, from which they may be transferred to a railway car by the hoist previously mentioned.

In the engine room there are a poppet-valve engine driving a 500-kw. direct-current generator, a 100-kw. direct-connected Corliss unit and three air compressors. The plant is well equipped with instruments to indicate the efficiency of operation. It has differential draft gages connected over the fire and at the uptake, a CO_2 recorder, recording thermometers on the feed water and the steam lines, and a recording steam-pressure gage. A tunnel connecting the plant with the shop buildings carries on racks in the usual way the heating mains, the returns, water piping and the electric supply cables, the main distributing board being located in the shop.

JOHNSON PLANT TO BE HIGHLY ECONOMICAL

Two blocks away the Robert A. Johnston Co. is completing a new seven-story-and-basement factory building for the making of fancy biscuits and candies. It will be served by a power plant, installed in a building of its own, which should prove highly economical owing to utilization of the exhaust steam to the fullest extent. Exhaust steam supplemented by live steam will be required for cooking; it will be utilized for heating the building and in the operation of a 150-ton absorption system installed for the making of ice and the refrigeration of a chocolate-hardening room. The combination for utilizing the exhaust is thus ideal—heating in the colder months, refrigeration in summer and a constant demand throughout the year for coking. The economy should be many-fold that obtained in the average industrial power plant or in fact in the most highly developed condensing installation.

Four return-tubular boilers equipped with superheaters will supply steam at 150 lb. pressure and 150 deg. superheat. Rocking grates are temporarily installed, but provision is made for stokers, an overhead bunker and conveyor. A vacuum steam-jet system is to handle the ashes. There are two generating units driven by combination poppet-valve and uniflow engines, movement of a control valve determining whether the engine will operate on the counterflow or uniflow principle. The generators are 240-volt three-phase 60-cycle machines. Their output will be used directly for lighting and constant-speed motors. Direct current for variable-speed motors will be obtained through a 100-kva. synchronous motor-generator set. Effort has been exerted to make the plant attractive and to contribute to the comfort of the operating force by installing shower baths, toilets, locker rooms, etc.

A recent installation that has been attracting widespread interest in Milwaukee and vicinity is the four new water-tube boilers of the Milwaukee Coke and Gas Co., equipped with Coxe forced-draft chain-grate stokers for burning coke breeze. The boilers are rated at 412 hp. each. The two boilers first installed were furnished with stokers 8 ft. 8⅜ in. wide and 15 ft. long, giving an effective grate area of 130.5 sq.ft., which bears a ratio to the heating surface of 1 to 31.57. In the next installation and in the unit now going in the same width of stoker was retained, but the length was reduced to 13 ft. 8 in. The grate surface is thus 119 sq.ft. and the ratio to the heating surface 1 to 34.6. Through a series of gears the stokers are driven by 1½- to 3-hp. motors with a speed range of from 400 to 1,600 r.p.m. The boilers operate at 165 lb. pressure. They are equipped with steam-flow meters and, to afford a check, a venturi meter on the feed water. Overhead bunkers are provided.

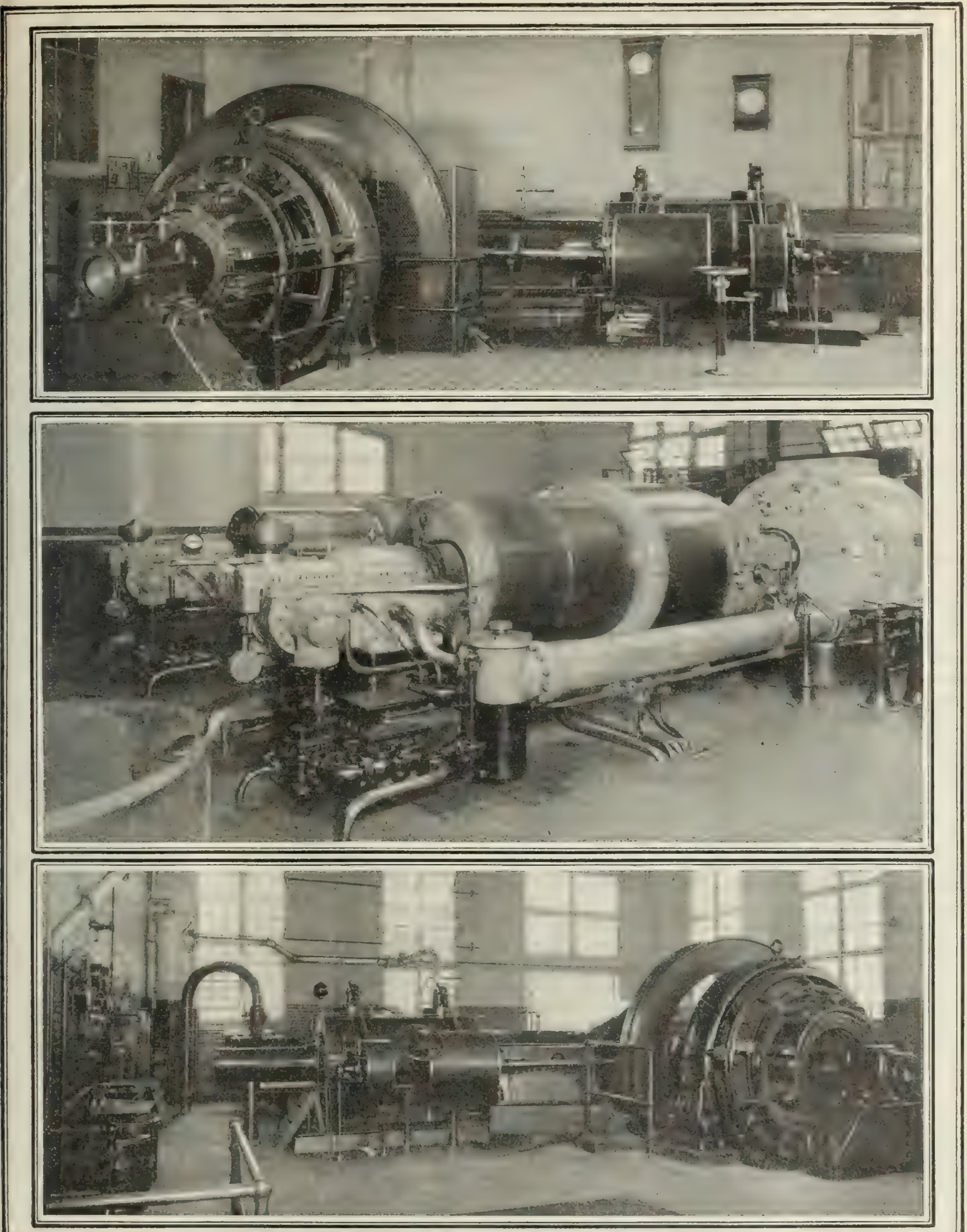
In daily operation the best results have been obtained at 150 per cent rating. The load is variable, dropping below this average at night and pulling up to 200 per cent of rating during the day. On ten-hour tests at 150 and 175 per cent rating conducted on the first two units, an over-all efficiency of 72 per cent was obtained when burning straight breeze having the following proximate analysis on a dry basis: Fixed carbon, 78 per cent; volatile, 7.57 per cent; ash, 14.43 per cent. The moisture in the fuel ran about 18 per cent. As fired, 24.5 and 27.7 lb. of breeze per square foot of grate per hour was burned at the two ratings given. On a dry basis these figures reduce to 20.11 and 22.8 lb., respectively. With the boilers operating at 150 per cent rating the ash analyzed 27.75 per cent fixed carbon, 0.31 per cent volatile and 71.94 per cent ash. The general operation has been most satisfactory, and with continued experience improvement is anticipated.

EIGHT BOILERS FIRED WITH EXHAUST GAS

In the older part of the power plant there are eight waste-heat boilers running on the exhaust gas from the ovens. Steam is supplied to the generating and pumping plants. The exhaust is used partly for heating purposes and the remainder passes to mixed-pressure turbines to be converted into electrical energy.

The manufacturing end of the plant is most interesting and will be open for inspection. The company is a maker of furnace coke and is equipped to recover such byproducts as light oils, benzol, naphthalene, tar, ammonia and ammonium chloride, and when all byproducts have been recovered, the waste or surplus gas is sold to the city. The entire equipment, including a complete ammonia concentration plant, is interesting as the opportunity of viewing such an installation is seldom afforded.

Faulty oil distribution is probably the cause of overheating as frequently as anything else. The oil may be fed into the bearing at the wrong point or perhaps the grooves do not convey the oil to all parts of the bearing. The feed pipe may not be of sufficient size to supply the bearing with an adequate amount of oil or the oil reservoir may be too small to permit of proper cooling.



VIEWS OF SOME INTERESTING POWER PLANTS IN MILWAUKEE

Top—Generating Unit, Phœnix Knitting Works. Middle—Turbine Room, Pfister & Vogel Plant. Bottom—Generating Unit, Pawling & Harnischfeger.

Electric Elevator Machinery—Thrust Bearings

By M. A. MYERS

Electrical Engineer, The Maintenance Company, New York City

Ball-type of thrust bearings as well as button and dish types are discussed. These types are divided into two classes—those which are located on each end of the worm-shaft and those located on the free end of the worm shaft only. The assembling of these thrust bearings and their adjustment is explained.

OBSERVING Fig. 1, it will be seen that an overcounterweighted car will produce a forward thrust of the worm toward the motor, as shown by the arrow. It makes no difference if part of the counterweights are car weights, as the car is simply lightened by that much. Reverse the conditions, making the car heavier than the weights, and the worm thrust naturally changes toward the rear. Means must be provided to take care of these thrusts on suitable bearings in the gear case or otherwise, and the thrust bearings must be liberally designed, as their duty is severe.

A type of worm-gear reduction requiring no thrust bearings, known as a tandem gear, is shown in Fig. 4. Two worms and wormwheels are used, and the load and wear are distributed between them. The worms are respectively left- and right-hand cut, and the wormwheels are meshed to each other as well as to the worms. The thrusts of the worms being opposed and equal, the use of thrust bearings is unnecessary. Where the duty is severe and room for the installation is sufficient, the tandem-gear machine has commendable features.

Fig. 2 shows a worm complete with *A*, the front wormshaft bearing; *B* and B, the front and back ball-thrust bearings; *D*, the back wormshaft bearing; and *G*, the stuffing box to prevent oil leakage. These parts are shown separated in Fig. 3, which gives a clear indication of their form. Each ball-thrust bearing consists of two hardened-steel raceway plates, *P*, bearing respectively against the worm flanges and the front and back bearing faces; and the balls held in a bronze cage or retainer.

The parts of the wormshaft and bearings are so proportioned and machined that when assembled within the gear case and the worm bearings bolted fast, the worm will turn freely with practically no end play. A slight allowance must be made for expansion due to increased temperature in operation. A sixty-fourth to a thirty-second inch will be ample. Any slight adjustment may be made by varying the thickness of the gaskets under the worm bearing (or bonnet) flanges. For larger adjustments recourse is sometimes taken to filler plates or shims behind the steel raceways. The flange gaskets may be of paper, ordinary tar paper giving good results. Ball thrust bearings, properly fitted and liberally designed, should show little wear. If, however, through lack of oil, poor oil, grit or other reasons, the balls and races become worn and rough, the fact will be manifested in grinding, groaning or both, and the only remedy is new thrust parts, both balls and raceway plates.

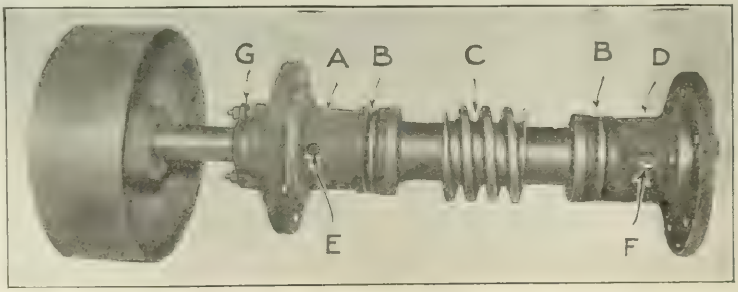


FIG. 2. WORMSHAFT AND THRUST BEARINGS

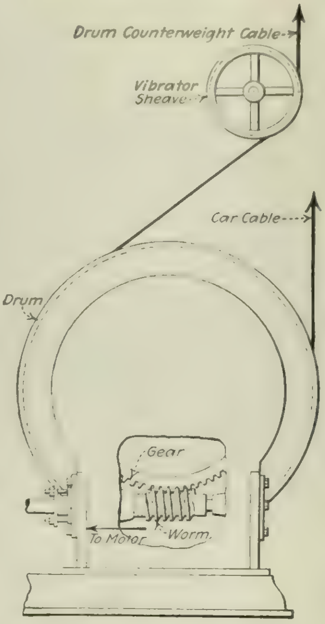


FIG. 1. SINGLE-GEARED ELEVATOR MACHINE

Fig. 5 shows a system of alternate bronze and hardened-steel rings for the front, and alternate bronze and steel "buttons" for the back thrusts. They are assembled similarly to the ball thrusts just described. Such thrusts are made adjustable to take up the wear. The adjusting screw and locknut are located in the back wormshaft bearing. The front and back buttons are provided with integral "tongues" to fit in grooves in the end of the shaft and the end of the adjusting screw to prevent wear of either. Sometimes the front and back rings in the front thrust are likewise tongued or pinned, to prevent turning. The bronze buttons and rings are grooved for oil. This type of thrust bearing is being superseded to a large extent by ball thrusts. Occasionally, adjustable front thrust bearings will be found on the order of those shown in Figs. 6, 7 and 8. Fig. 6 shows what is known as the wedge thrust bearing, in which the inner edge of the front wormshaft bearing is beveled as at *A*. A hollow wedge *W* encompassing the wormshaft is fitted to slide on this bevel and is held in adjustment by the adjusting bolts *S* and *S'*. The bearing edge has a squared projection or tongue *T*, which acts as a guide to the wedge. The thrust rings *R*, *R'* and *R''* are of bronze, between which are thin hardened-steel rings. The ring *R* is provided with four pins *P* which project within the hollow of the wedge, preventing the ring from turning but not interfering with the adjusting of the wedge. Ring *R''* is pinned to the worm flange as shown. If it is desired to adjust the worm toward the rear, it is only necessary to loosen the locknuts *NN'*, and unscrew *S*, and screw up *S'* until the desired position is obtained, and vice versa. Another type of adjustable front bearing thrust is shown in Fig. 7. *C* is a bushing machined to a good sliding fit in the front head *A*. The head is tapped for the adjusting bolts *S* and *S*, which are squared at *D* for a wrench and provided with threaded extensions for the stuffing-box gland *G* and which, at the other end are recessed into the sliding bushing, preventing it from turning. To adjust the worm toward the rear, simply loosen the stuffing-box gland and the locknuts *N* and *N*, and screw the adjusting bolts *S* and *S* in evenly, which will force the bushing *C* toward the rear. If it is desired to shift the wormshaft toward the motor, unscrew the adjusting bolts and bring up the worm by means of the rear-thrust adjusting bolt to the required amount.

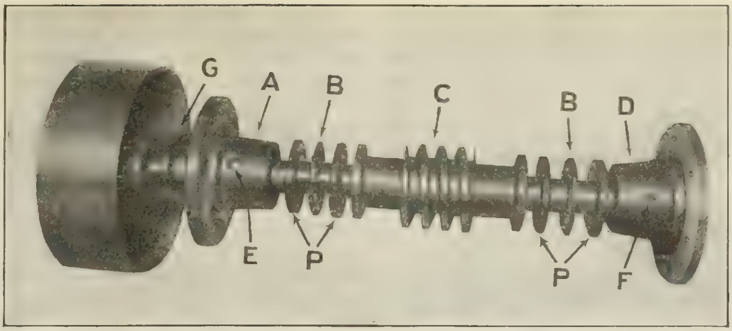


FIG. 3. SAME AS FIG. 2, WITH PARTS OF THRUST BEARING SEPARATED

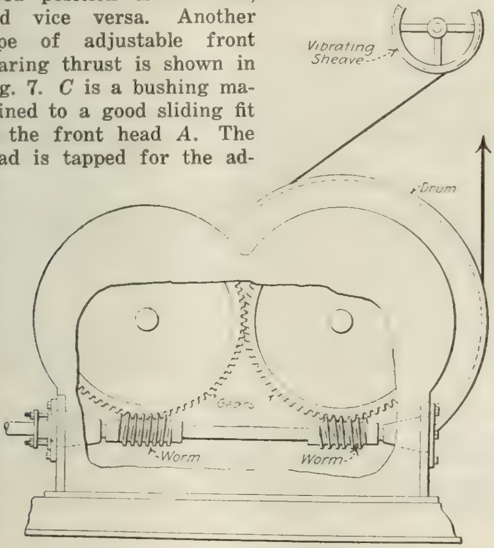


FIG. 4. TANDEM-GEARED ELEVATOR MACHINE

Fig. 8 is similarly adjusted by loosening the stuffing-box gland *G* and the large locknut *N* and screwing the threaded bushing *C*, which also constitutes the wormshaft bearing, either in or out as desired. In the cases of Figs. 6, 7 and 8, the back thrust bearing is an ordinary adjustable-button arrangement, similar to that shown in the rear wormshaft bearing of Fig. 5. In adjusting the front or back thrusts, care must be taken not to jam the wormshaft too tightly between them. A Hindley worm, which is curved to fit the arc of the wormwheel, as in Fig. 9, must, if it has adjustable thrusts, necessarily be adjustable both ways to keep the worm accurately centered, to avoid binding and cutting. To adjust such a worm the handhole of the worm case should be opened and the worm and wormwheel adjusted according to the manufacturer's markings.

The type of thrust shown in Fig. 5 has the advantage of sturdiness and simplicity. The disadvantage rests in the fact that when the front thrust, which is usually the first to wear, must be repaired or renewed, it is necessary to remove the worm from the case to make such repairs or renewals. To overcome this objection, both thrusts may be placed in a case or bonnet at the end of the rear wormshaft bearing or, as it may be termed, at the free end of the wormshaft.

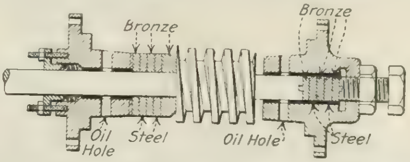


FIG. 5. WORM WITH STEEL AND BRONZE THRUST BEARINGS

A patented adjustable thrust of this character is shown in Fig. 10. The free end of the wormshaft is turned down, as at *P*, and threaded with a left-hand thread for the combination double ball race and "bull ring" *F*. The end of the wormshaft is shouldered again at *Q* and threaded right-handed for the flanged locknut *H*. To assemble this thrust, the rear head *A* is bolted in place on the gear case and the front adjusting ring *C* is screwed in place into it. The raceway plate *D* is placed in the recess of *C* as shown. Then comes the first ball cage and balls *E*, after which the bull ring is screwed in place by means of a spanner wrench in holes *F* in its periphery. The washer *I* is placed and the locknuts *H* set up tightly. Then the second ball cage

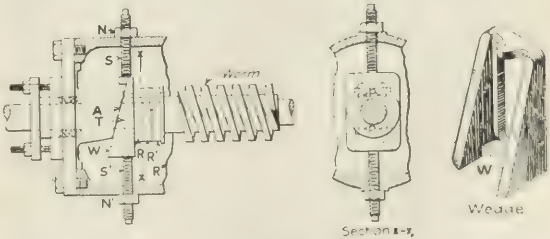


FIG. 6 WEDGE-TYPE ADJUSTABLE THRUST BEARING

E'', is put in place, after which the back adjusting plug *G*, with the ball raceway plate *D'* set in its recess, is screwed into the casting end. The front-thrust adjusting ring is first adjusted by means of a spanner wrench in the holes *x* and *x*, cover *M* being removed for this operation. The adjusting ring and plug *G* is then set up by a spanner wrench in the holes *x'* and *x'* to give

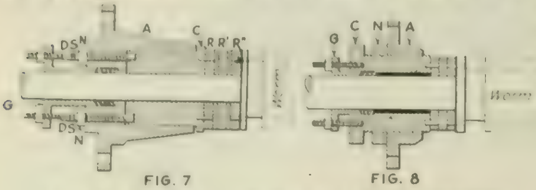


FIG. 7 FIG. 8

FIGS. 7 AND 8. ADJUSTABLE TYPES OF THRUST BEARINGS

the wormshaft the proper freedom without end play. Adjusting ring *C* and plug *G* are provided with a number of slots on their peripheries in which the setscrews *K* and *K* are set. The greater the number of slots the finer the adjustment. For example, if there are five threads per inch and twelve slots, adjustments of one-sixtieth of an inch will be obtained. The thrust case is finally filled with gear oil and the cover *M* bolted down. When the thrust is forward, the bull ring is pulled against the front balls; when the thrust is toward the back, the bull ring is pushed against the rear balls. In either case the thrust is transmitted through the raceway plates, the adjusting ring or plug, as the case may be, to the head, which, being bolted to the gear case, transmits the thrusts thereto.

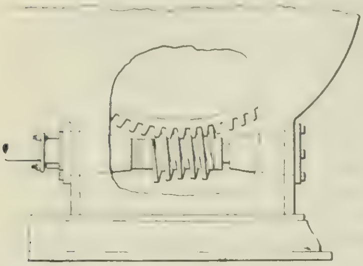


FIG. 9. HINDLEY TYPE WORM AND GEAR

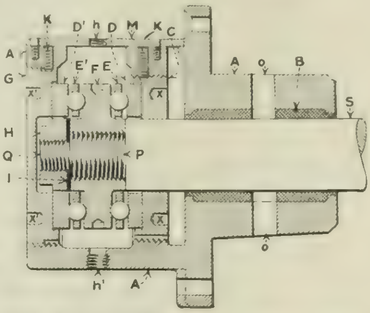


FIG. 10. ADJUSTABLE TYPE DOUBLE BALL-BEARING THRUST BEARING

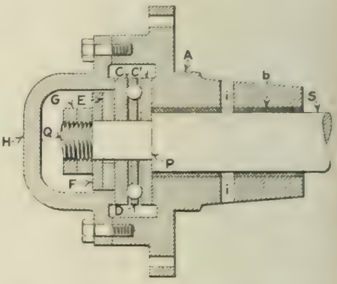


FIG. 11. ADJUSTABLE TYPE SINGLE BALL-BEARING THRUST BEARING

A thrust bearing in which both front and back thrusts are taken by a single set of balls is shown in Fig. 11. The free end of the wormshaft is machined to a smaller diameter at *P* and threaded at the end *Q*. The thrust parts in their installation order are the inner raceway plate *C'*, which bears against the shoulder formed by the shaft reduction; ball cage with balls *D*; outer raceway plate *C*; filler plate *E*, which is keyed to the shaft by a Woodruff key; plain filler plate *F*; nut and locknut *G*, or there may be but one nut with a cotter pin through it and the shaft; and the bonnet *H*. With a forward thrust the raceway plate *C* is pulled against the balls and the thrust transmitted through *C'* to the head *A*. With a backward thrust *C'* is pushed against the balls and the thrust transmitted through *C* to the bonnet *H*, which is bolted to the head. Adjustments can be made by means of thin filler plates and varying the thickness of the bonnet gasket.

Fig. 12 represents a free end ring and button thrust such as used by the A. B. See Elevator Co. The wormshaft end is threaded and keyseated at *P*. The installation order is first the thrust ring *R''* which is prevented from turning by pins into the head casting *A*; then thrust ring *R'* and thrust ring *R*, which is pinned to the "bull-ring" nut *N* and screwed with it to the shaft and the straight key inserted at *P*. Button *B''* is pinned to the shaft end and is next put in place. *B*, which is pinned to the threaded adjusting cap *C*, with *B'* are put in place with the cap and the latter screwed into place. *C* is locked by a wrench-like arrangement *W* or a similar device. The thrust actions are directly against the head casting *A* for forward thrust and against the adjusting cap *C* for back thrusts.

Fig. 13 represents a type of ball cage used with perfect flat ground raceway plates, sometimes found in elevator machines. It is used to advantage when replacing ordinary ring thrusts with ball-bearing thrusts.

No discussion of elevator thrust bearings would be complete without mention of the old "prism" thrusts, Fig. 14, which are still to be found on old machines of the Otis Elevator Co. The general idea is to increase the wearing surface over that offered by plain button thrusts, by means of flanged bronze sleeves or bushings *A*, in addition to the hardened-steel buttons *B*, and pairs of small levers or prisms C and C,' to equalize the thrusts between sleeves and buttons. Like with ordinary button thrusts, the back thrust *T* is located at the end of the wormshaft, but the front thrust *T'* is mounted ahead of the motor in a housing bolted to the motor bearing. The rear bronze sleeve bears against the worm flange and is prevented from turning by a tongue *D* on its flange, which fits into a groove in the back cast-iron bonnet. This sleeve also becomes the

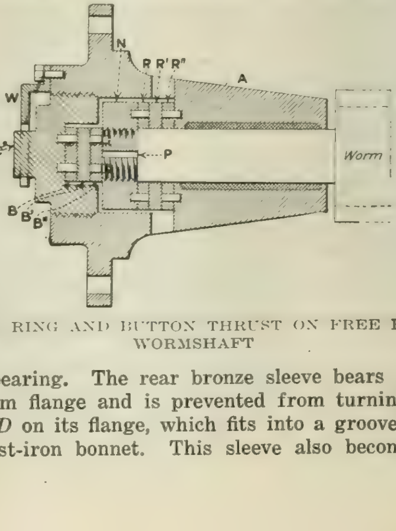


FIG. 12. RING AND BUTTON THRUST ON FREE END OF WORMSHAFT

rear wormshaft bearing. The front bronze sleeve bears against a hardened-steel ring *F* which in turn is fitted against a shoulder on the motor shaft and is held from turning by a round pin *P*. Two diametrically opposite tongues *E* sliding in slots in the bronze sleeves, prevent the hardened-steel buttons *B* from turning. The bronze sleeves are also slotted at *G*, into which the prisms fit and are held in this position by the adjusting screws *H*. The knife-edge prisms or levers bear against the buttons and sleeves in one direction and against the adjusting screws in the opposite direction. An enlarged view of the prisms is given below *T* and *T′*, showing how they are designed to knuckle together. It will be seen that if the sleeves and buttons wear unequally, the prisms will tend to rock one way or the other, thus keeping the thrusts equalized between buttons and sleeves. Obviously, the thrusts may be exposed for inspection by merely removing the bonnets. Adjusting screws are often found screwed up tightly with several thin shims under their heads, instead of locknuts as shown in the figure. Adjustments are then made by simply removing or adding to the shims.

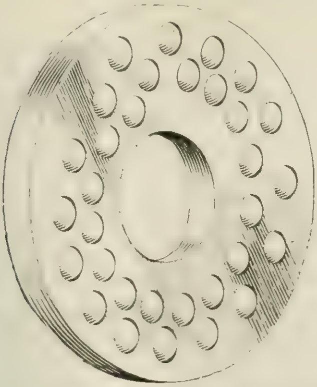


FIG. 13. BALL PLATE FOR THRUST BEARING

The combination brake pulley and coupling of these machines is split parallel to the shafts. In assembling, the armature is placed in its central position in the motor frame with its end thrust bearing applied and adjusted; the worm thrust bearing is also adjusted. A cylindrical fiber filler of the same diameter as the shaft is used to fill the space between the armature shaft and the wormshaft, and the split-pulley coupling installed. It is sometimes found advisable, instead of adjusting the prism thrusts for backlash, to open the coupling and insert a longer fiber filler.

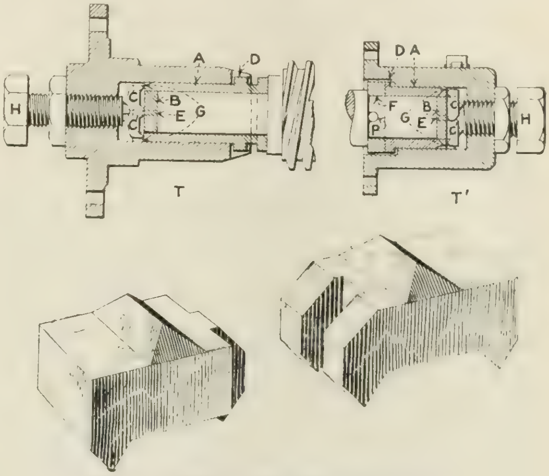


FIG. 14. PRISM-TYPE THRUST BEARING

An elevator worm must not be allowed to have backlash. An apparently insignificant backlash rapidly becomes aggravated, and serious damage may result. When abnormal end play is noticed (and it is particularly noticeable when the machine is brought to a stop) immediate steps should be taken to adjust or repair the thrust bearings.

Effects of Voltage and Frequency Changes on Induction-Motor Operation

By FRASER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

AN INDUCTION motor should not be used on a circuit of voltage different from that for which it is intended. If the voltage is high, the iron loss is increased and the copper loss decreased. If the voltage is low, the iron loss is decreased and the copper loss increased. These variations tend toward a localization of the heat either in the iron or in the copper, and if the variations are large enough ,the concentration rather than a distribution of the losses insures the liability of future burnouts and troubles. It should also be borne in mind that the torque of an induction motor, the frequency remaining constant, varies as the squares of the applied voltages, so that this feature has to be given due consideration in addition to the localized heating effects in either the iron or copper circuits.

If a motor designed for 60 cycles is operated at rated voltage on 50-cycles, the results are as follows: The field strength is increased but the iron loss remains about constant. Magnetizing current is increased. The constant losses—core loss, windage and friction—remain approximately the same or, if anything, are slightly reduced, because, while the flux densities increase 20 per cent, resulting in a probable slight increase in core loss even on 50 cycles, the reduction in windage and friction at the lower speed is likely to more than offset any added core loss. The reactance on 50 cycles is lower than at 60 cycles, thus increasing the short-circuit current, starting and pull-out torques.

Assuming a constant horsepower output at either frequency, then the power factor is lower, owing to the increased magnetizing current, and the decreased power factor slightly increases the copper loss.

If anything, the efficiency will tend to increase slightly, but in general it may be stated that it remains about constant because the total losses remain approximately constant. This latter naturally means that the motor temperature increases, because the speed and hence the natural ventilation are decreased.

The table shows some test results on a 5-hp. 440-volt three-phase 60-cycle 1,200 r.p.m. (synchronous speed) squirrel-cage motor operated on both 60 and 50 cycles.

CHARACTERISTICS OF 5-H.P. INDUCTION MOTOR WHEN OPERATED ON 60 CYCLES, ALSO 50 CYCLES

	60 Cycles 1,200 R.P.M.	50 Cycles 1,000 R.P.M.
Magnetizing amperes	2.8	3.7
No-load loss in watts	300	270
Full-load p.f. (5 hp.)	0.862	0.81
Full-load eff. (5 hp.) per cent	85.2	85.2
Maximum starting torque in percentage of normal	176	245
Maximum starting current in percentage of normal	530	600
Maximum torque in percentage of normal	280	380
Hottest spot temperature rise, deg. C.	35	43

Ordinarily, any reduction in speed should be accompanied with a corresponding change in the horsepower rating because it is obvious that a continuous rated motor with a temperature rise in the hottest spot of 50 deg. C. would get too hot at a lower frequency. The chances are that the terminal voltage would also have to be reduced to keep the temperature within safe limits.

OPERATION ON INCREASED FREQUENCY

Under these conditions and assuming a moderate increase in frequency, the opposite effects to operation on low frequency can be noted. The net result, the voltage and output remaining constant, is as follows:

The field strength is decreased, but the iron loss remains about constant and the magnetizing current is decreased. The constant losses, if anything, are increased, principally owing to the increased windage and friction at the higher speed. The reactance is higher, thus decreasing the short-circuit current, starting and pull-out torques. Power factor is higher, owing to the decreased magnetizing current. Copper loss is decreased because of the decreased power factor. Efficiency will tend to be lower, by reason of the increased constant losses, which are likely to more than offset the decreased copper losses. The heating will be less, owing to the ventilation being increased by the increase in speed.

OPERATION ON LOW VOLTAGE

With the power output and frequency remaining constant, the effect of operating an induction motor on low voltage is somewhat the same as when operating on increased frequency. The chief difference comes in the localization of the losses as noted here:

The field strength and iron loss are decreased. Magnetizing current is decreased. Constant losses are decreased owing to the decreased core loss. The reactance remains constant, therefore the short-circuit current, starting torque and pull-out torque are decreased.

Owing to the decreased magnetizing current the power factor is higher. On account of the increased load current resulting from the lower voltage the copper loss is increased. The efficiency may be lower because of increased copper losses, which are likely to more than offset the decreased iron losses. Under the foregoing condition the worst feature of operation, provided the torque characteristics are satisfactory, is the fact that the added losses are not uniformly distributed but become localized in the copper, the iron losses actually decreasing. These copper losses increase as the squares of the currents and for this reason are likely to cause dangerous localized heating.

With the power output and frequency remaining constant, the effect of operating an induction motor on increased voltage is somewhat the same as when operating on decreased frequency. The chief difference comes in the localization of the losses as noted here:

The field strength and iron loss are increased. Magnetizing current is increased. Constant losses are increased, owing to the increased core loss. The reactance remains constant, therefore the short-circuit current, starting torque and pull-out torque are increased. Owing to the increased magnetizing current the power factor is lower. Since the voltage is higher the copper loss is decreased due to the decreased load current. Because the decreased copper losses are likely to more than offset the increased iron loss, the efficiency will be higher.

Under this condition of operation the losses are not uniformly distributed but are localized in the iron, the copper losses in this case being actually decreased.

OPERATION ON LOW VOLTAGE AND FREQUENCY

If both the frequency and the voltage decrease, as when the speed of the supply alternator drops, the effects previously outlined are combined. Since the drop in voltage is accompanied with a simultaneous decrease in the frequency, the magnetizing current remains practically unchanged within certain limits. On account of the decrease in voltage the output decreases, but not as if the decrease in pressure took place without the accompanying decrease in frequency. The output decreases in direct proportion to the voltage and not as the squares of the voltages, as would be the case if the frequency remained unaltered.

An increase in frequency is equivalent to weakening the motor field, while a decrease is equivalent to strengthening it. On the other hand, a decrease in voltage tends to weaken the field, while an increase strengthens it, and if both voltage and frequency decrease together, the field strength will remain practically constant. The speed decreases, however, and the output becomes less.

Steel Melts From the Inside

"Steel Melts from the Inside" is the claim made by G. P. Blackiston, a practical steel man, of Canton, Ohio. Metal, before melting, is packed in pots. In the mixture used at the time of the discovery numerous pieces of octagon bar steel had been packed in pots and placed in the furnace. When the melting was well under way, one of the pots broke and was immediately removed from the furnace and set aside. After the pot was cooled, it was observed that chunks of metal were present which seemed to have the original shape they possessed at the time they were inserted in the vessel. Investigation showed the pieces to be hollow.

Pure iron has a higher melting point than steel, and the more carbon there is in the steel the lower its melting temperature. The outer layer of these bars of tool steel received the heat first, but this heat was, no doubt, immediately transferred to the inner portion. As the heat continued to be added, it is believed that the carbon was burned out of the outer layer and that it became, in fact, a low-carbon steel approximating iron itself. The inner layer still retained its carbon and would of course melt at a lower temperature, which explains why it had entirely melted while the outer layer was intact.

Rebabbitting Engine Parts—I

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

The first of two articles giving complete and easily understood directions for rebabbitting engine bearings and other parts.

THERE are a few parts of an engine that keep an engineer guessing. One of theme is the babbitt in the bearings. A bearing will get hot once in a while for some reason or other, and if it is babbitted the question is, How long will the babbitt stand before it begins to run? It may be nursed along with oil, grease, soap, graphite, water and even ice until the ominous little bright drops finally begin to ooze out at the sides or are spattered over engine base and floor and there is no help for it but to stop the engine.

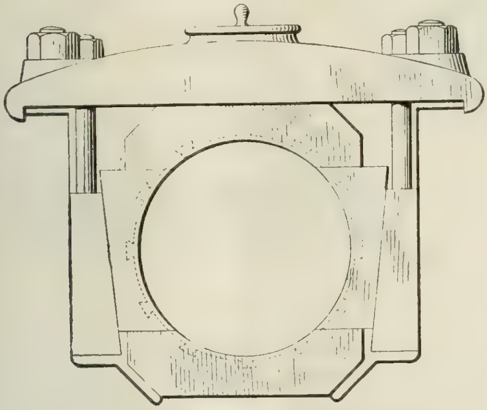


FIG. 1. COMMON TYPE OF MAIN BEARING

Occasionally, the nursing process can be stretched out till "the whistle blows," when a "beautiful" job is waiting for engineer and helpers to replace the bearing or boxes, if he has been wise enough to provide for any spares; otherwise a job of rebabbitting is to be done, which is often carried far into the night. The principal parts of an engine that are lined with babbitt are the main bearing, outer bearing, crankpin boxes, crosshead shoes and occasionally eccentric straps and crosshead-pin boxes. In construction size and shape these vary greatly, as also do the methods of lining them with babbitt. The object of lining certain surfaces of an engine with babbitt is to prevent cutting, which is more liable to occur where two hard surfaces run together, and to make the surface renewable in case of water.

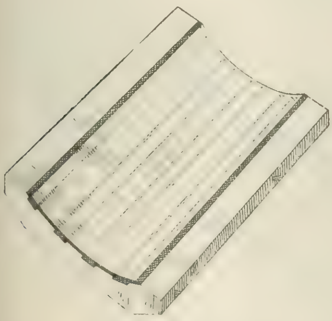


FIG. 2. BABBITT GROOVES FROM END TO END OF QUARTER BOX

In Fig. 1 a common type of main bearing is shown. It consists of lower and upper shells and two quarter-boxes. The principal wear is in the lower shell, next in the quarter-boxes; the wear on the upper shell on horizontal engines is negligible. The thickness of the babbitt in the shells varies, according to the size of the bearing, from ¼ to ¾ in. The babbitt is held in place by recesses, grooves, anchors or buttons of various shapes. The dovetailed grooves seem to be the favorite design. The size and number of the grooves vary, according to the diameter of the shaft, from ⅜ in. at the narrow part for a 6-in. shaft to ¾ in. for a 24-in. diameter; the taper is about 30 deg. and the depth from 3/16 to ½ in. In some cases the babbitt and grooves are carried right through from end to end, as shown in Fig. 2, which is considered to be the best practice on large bearings. On bearings less than 10 in. in diameter the space for the babbitt is generally chamfered as illustrated in Fig. 3. This reduces the bearing surface somewhat and also exposes the shaft to being cut by the hard ridge at the ends if there is any considerable wear in the bearing. It is an excellent thing for an engineer to keep tab on the wear of the bearings. This can easily be done by making a gage from a fixed point on the foundation plate or floor to the center of the shaft, as shown in Fig. 4, or by gaging the space between the upper box and the shaft by using a feeler. An occasional try will show whether the shaft goes down or not. The wear of the quarter-boxes can be ascertained by taking up the bolts at the end of the pillow block

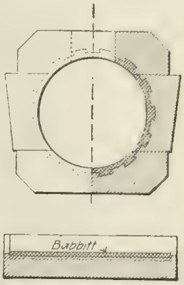


FIG. 3. SPACE FOR BABBITT CHAMFERED

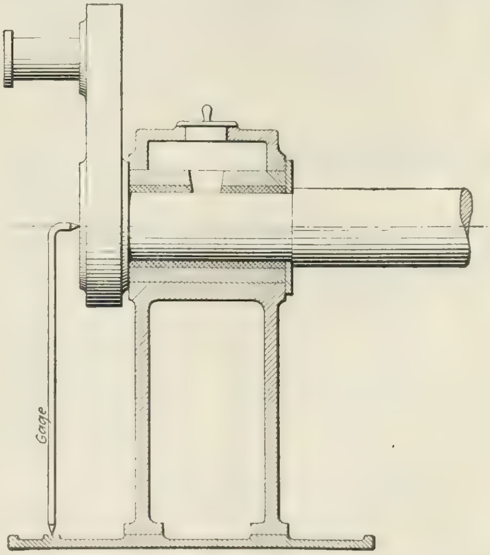


FIG. 4. GAGE FOR DETERMINING WEAR OF MAIN BEARINGS

or the wedge bolts if the latter construction is used. The customary taper of the wedges is $\frac{1}{4}$ in. per inch; therefore, if the bolts are $\frac{3}{4}$ in. in diameter with standard threads, 10 per inch, one turn of the nut or bolt advances the quarter-box $\frac{1}{10} \times \frac{1}{4} = \frac{1}{40}$ inch.

A conventional outer bearing for the smaller sizes is shown in Fig. 5. The wear is practically all on the lower box and can be readily measured on the outside. If a heavy flywheel is used for belt or rope transmission and located near the outer bearing, the latter is often subject to greater wear than the main bearing, which is due to the fact that the shaft rotates in the outer bearing always in the same position, while in the main bearing it is moved forward and back on horizontal engines.

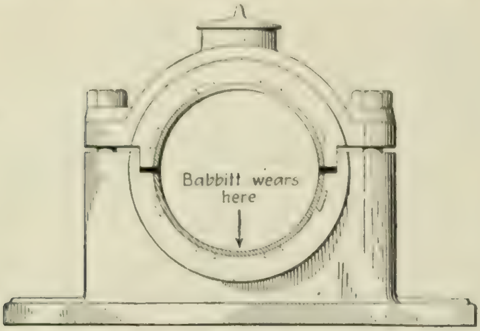


FIG. 5. WEAR OF THE OUTER BEARING IS ON THE LOWER BOX

Direct-connected engines are provided with more elaborate outer bearings, similar in construction to main bearings. As a rule they are well protected from oil leakage or dirt by means of shields and covers, as shown in Fig. 6. By removing the shield on the outside, the end of the shaft is revealed, and if anything goes wrong with the babbitt, it can immediately be detected. The lower shells are sometimes provided with wedges as a ready means of taking up wear, but although this is quite a convenience the practice seems to have been abandoned by engine builders. The tendency is to construct the bearings for quick and easy removal of the boxes, making the surfaces cylindrical, as shown in Fig. 7, instead of flat. Cylindrical shells can be rolled out by lifting the shaft slightly; the removal of a flat-bottomed box is often quite a problem. Unless there is room enough between the pedestal and eccentric to slip the box out below the shaft, the latter has to be jacked up sufficiently for the box to be rolloed out, which means a lift of $\frac{1}{2}$ to 1 in. according to the size. This is quite a job on a direct-connected engine, for instance, having an air space of less than $\frac{1}{4}$ in. between armature and polepieces. Where the taking out of the boxes meets with difficulties, rebabbitting is put off as long as possible, often to the detriment of the shaft.

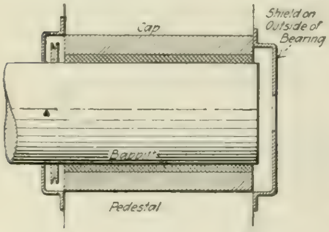


FIG. 6. OUTER BEARING FOR DIRECT-CONNECTED ENGINE. SHAFT PROTECTED BY SHIELD

While it is a simple matter to babbitt boxes in factories where all the facilities are at hand and where the work is done by men specially trained for it, it is different in an emergency case in the engine room. Still, there is nothing mysterious about it if some common sense and a certain amount of precaution are used. Cleanliness is here next to godliness, just as it is anywhere else. If the job is not to be done in a cleanly manner, it better be left alone, unless a man wants to take chances in pouring and have the metal thrown about and he get burned. Molten babbitt will not stand for any foolishness.

There are many kinds of mixtures that go by the name of "babbitt." The metals used to make babbitt are tin, copper, antimony, lead and zinc, in a variety of compositions; different mixtures will serve different purposes. Anyone can make his own mixtures if he has the facilities. The accessories required to prepare a mixture without copper in small quantities are a forge, ladle and some ingot molds. A suitable ladle and ingot mold are shown in Fig. 8. For larger quantities and for alloys containing copper one or more crucibles and a furnace will be required. The composition of genuine babbitt is generally taken to be 89 parts tin, 3 copper

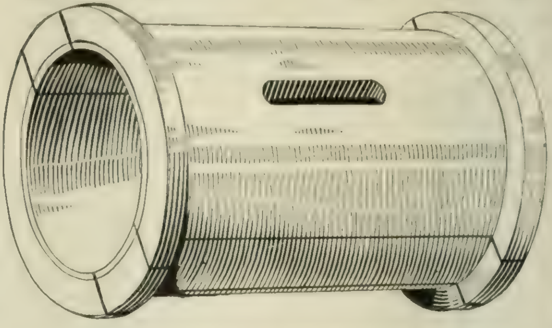


FIG. 7. CYLINDRICAL MAIN-BEARING BOXES

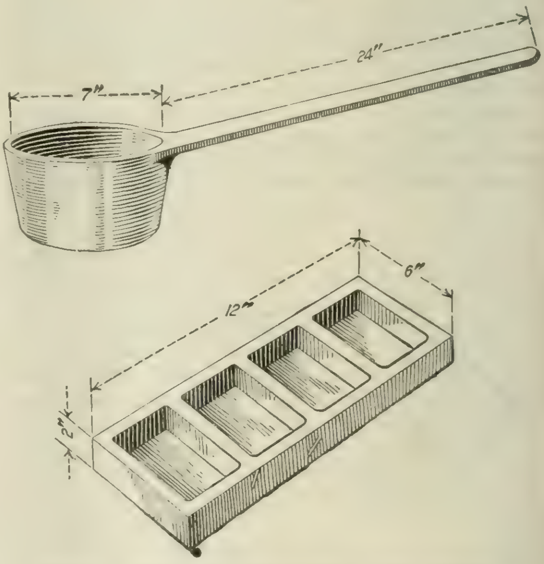


FIG. 8. LADLE AND INGOT MOLD FOR BABBITT

and 8 antimoney. This is a good all-round mixture, largely used on engine work; its expense is a small item where wearing quality is to be considered. Copper requires a high temperature for melting. For this reason for repair jobs alloys of zinc and tin in the proportion 80 zinc to 20 tin, or of lead, antimony and zinc in the proportions of 78, 20 and 2 may be used for moderate pressures and speeds. The metal having the highest melting point is melted first, and the others are added gradually. The molten mass must be stirred to make the mixture uniform; otherwise the heaviest metal, like lead, will remain at the bottom.

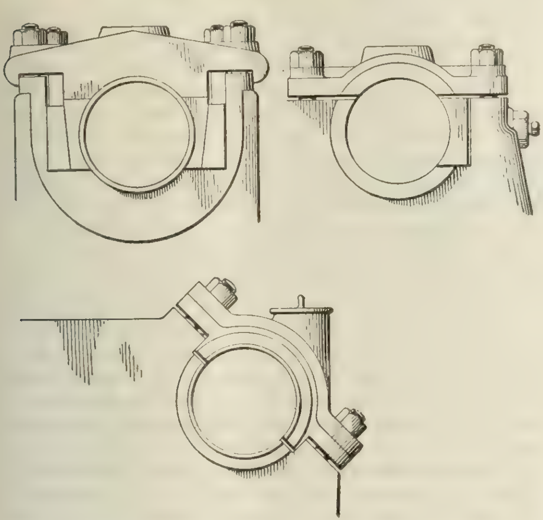


FIG. 9. TYPE OF MAIN BEARING WITHOUT REMOVABLE BOTTOM BOX

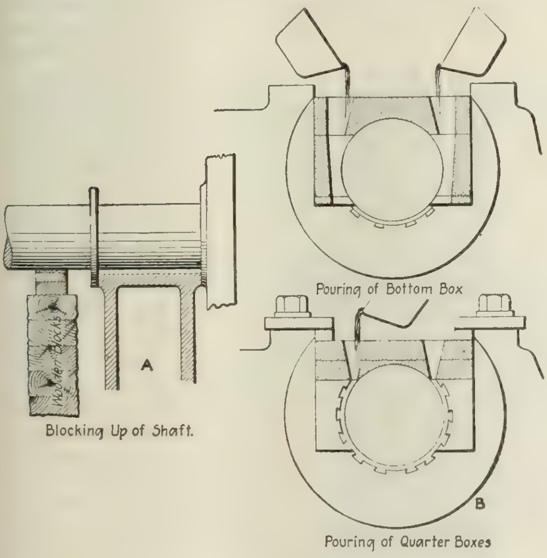


FIG. 10. METHOD OF BLOCKING UP THE JOURNAL AND POURING THE BABBITT

Large numbers of engines are running without any removable boxes in the main bearing; others are provided with one or two quarter-boxes. The different designs are shown in Fig. 9. To rebabbitt bearings of this kind it is necessary to remove the shaft, then cut out all the old babbitt and clean out the recess in the pillow block. If no proper mandrel is available, the bearing can be rebabbitted by using the shaft, if it is in good condition, although this is not considered good practice. In case the shaft is to be used it must be blocked up in position, as shown in Fig. 10, "*A*," and for the particular bearing shown wood strips and blocks are inserted in the pillow block, and molding sand or fireclay rammed in on the sides, with regular gates and vents for pouring the metal. Care must be taken to keep sand and dirt out of the space for the babbitt. The shaft should be warmed before the metal is poured. All openings at the crank and collar must be closed with fireclay to keep the babbitt from running out. The metal is poured from one or both sides according to the size of the shaft.

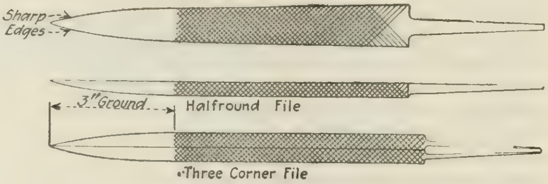


FIG. 11. SCRAPERS MADE OF OLD FILES

After the bottom of the bearing has been poured, the clay or sand must be removed and the space for the quarter-boxes cleaned. The latter are then put into place and secured with wooden blocks, as shown in Fig. 10, "B." Pieces of thin asbestos board are generally placed under each box to keep the babbitt apart, and after all openings at the ends have been closed the babbitt is poured into the boxes. Finally, the cap is put in place and the babbitt is poured either through

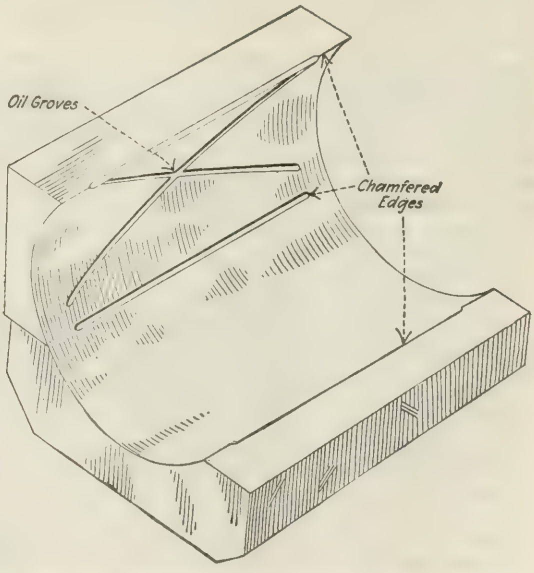


FIG. 12. CHAMFERED EDGES AND OIL GROOVES

openings in the top or through gates at the ends. It is essential that all parts with which the new babbitt comes in contact must be warmed, otherwise the metal will be chilled and not fill the boxes.

The next thing in order will be the removal of cap and boxes and a thorough cleaning of the pillow block. The shaft should be lifted high enough so that the bearing can be scraped; quarter-boxes and cap must also be scraped and fitted to the shaft. A good scraper can be made from a half-round file or from a good-sized three-cornered one, as shown in Fig. 11. In each case the end of the file is ground on a fine emery wheel for a distance of about three inches and the edges are sharpened on an oilstone. Care should be taken not to draw the temper of the file. Oil grooves in the bottom of the bearing are of little use; the sharp corners at the top of the grooves must be removed and the edges chamfered. This will lead the oil underneath the shaft. In the quarter-boxes oil grooves may do some good; their object is to give the lubricant a good start on its downward course. Fig. 12 shows the chamfering of the edges of the lower bearing and quarter-box and the oil grooves in the latter. The grooves may be cut with a cape chisel and smoothed with a round file.

Maintaining Correct Average Frequency

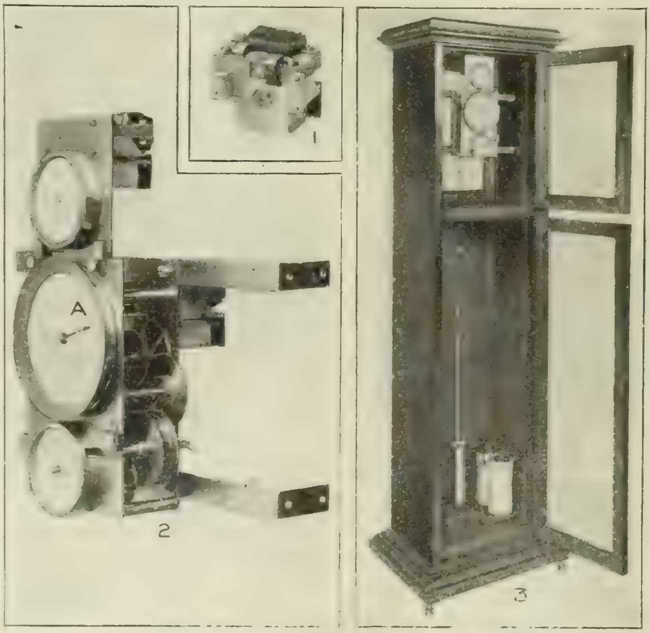
In synchronous motor application the latest departure is the installation of a very small self-starting motor in a clock, where it is used, in connection with a high-grade clock movement, to compare the speed of a synchronous generator with exact time, in order to give a continuous check on generator frequency. Since any change in the speed of the generator is reflected in the speed of this small motor, whereas the clock speed remains constant, the combination forms an accurate method of maintaining constant average frequency.

These small motors can also be used on the system in place of clock mechanisms to drive graphic recording instruments, demand meters and time switches. By the use of this motor the synchronization of records from graphic meters and demand meters will be made possible—something that has always been desirable, but somewhat difficult of accomplishment heretofore. In practice a master clock, Fig. 3, containing two movements, one electrical and one pendulum-operated, is located near the switchboard. The face is equipped with two pointers, one black, the other gold, rotating independently about the same center, on a dial *A*, Fig. 2, called the operating dial. The black pointer is so geared to the pendulum clock as to make one complete revolution every five minutes. The gold pointer is geared to the small synchronous motor so that when the frequency is correct it will rotate at the same speed as the black hand. All that the operator has to do is to hold the two pointers together—he will then have a fixed relation maintained between standard time and generator speed, or cycles and time. This can be done by adjusting the speed governors of the prime movers. The master clock does not obviate the use of a frequency meter, or indicator, since it will not show instantaneous fluctuations in speed. Moreover, by using a frequency indicator near the master clock the latter may be used as a constant check on the accuracy of the former.

The little synchronous motor, Fig. 1, which is the vital part of the electric component of the clock, is only $2\frac{1}{4}$ x $2\frac{5}{8}$ x $2\frac{9}{16}$ in. in size, and is wound for operation on a 110-volt circuit. It consumes less than 4 watts at 110 volts 60 cycles, but can be made for any one of the standard commercial frequencies. It is self-starting under load, reaches synchronous speed in less than a second and holds speed as long as the current is uninterrupted.

There have been developed two forms of master clock, known as the type "A" and type "B." The principal difference in operation is that in the "B" type both the motor and the clock mechanism act on the same index hand, through gearing, so that the synchronous motor tends to drive the hand in one direction, while the clock mechanism tends to drive it in the opposite direction.

If the rate of the clock and motor are the same the hand rests at zero on the scale, but if the speed of the motor varies the hand is moved slowly in a clockwise or counterclockwise direction according to whether the variation is a gain or loss in speed. In this way the clock is caused to indicate variations in average frequency. The installation of these master clocks will not eliminate fluctuations which are dependent to some degree on load variations, speed-governor response or steam pressure — features of operations that are more or less constantly encountered—but it does insure the maintenance of a more uniform as well as correct average frequency. The clocks and motors are manufactured by the Warren Clock Co., Ashland, Mass., and are being handled by the General Electric Co., Schenectady, N. Y.



FIGS. 1 TO 3. CLOCK FOR CHECKING GENERATOR FREQUENCY

Fig. 1—Self-starting synchronous motor for use in clocks. Fig. 2—Clock dials and mechanism. Fig. 3—Frequency clock complete.

The Care of Refrigerating Plant Auxiliaries

By B. C. HILL

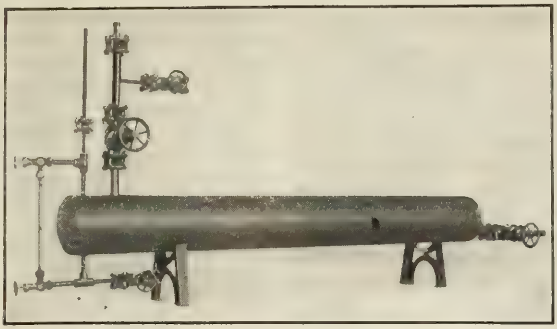


FIG. 1. TYPICAL AMMONIA RECEIVER

THE liquid receiver is a tank usually mounted up on the wall in the engine room or on the roof, and if on the roof, generally under the ammonia condenser The builders of recent types of ammonia condensers seem to have lost sight of the fact that the reduction in condensation surface from one-half to one-third required for the older types has also cut down the liquid-holding capacity or storage capacity required to take care of "pump-outs" in case of trouble. There have been a number of instances where the writer has found it necessary to install additional receiver capacity, as it was found that when the receiver was shut off for pumping down or shutting down to make minor repairs, it would be filled to capacity and the liquid would back up to the condenser, cutting down the condensation surface to such an extent that the condensing pressure would rise from a normal of 150 to 160 lb. to 200 or 220 lb. in five or ten minutes, making it necessary to slow down the compressor.

There is no fixed rule for the size or holding capacity of a receiver. In the writer's work the receiver capacities have been increased to a ratio of about one-fourth cubic foot to one ton of refrigeration, or say about 432 cu.in. per ton, which experience shows is satisfactory and ample to take care of pumping out the refrigerating coils without unnecessarily raising the condensing pressure. Another important use I have made of the liquid receiver for many years is as an air or foreign gas extractor. The velocity of the liquid passing through the liquid line from the condenser to the receiver will carry a portion of the noncondensable gases to the receiver, and while the plant is in operation the flow is continuous from condenser to receiver, which will not allow the gases to ascend through the liquid line to the condenser until the plant is shut down; provided, however, that the liquid is high enough in the receiver to seal the line leading to the evaporating coils. In this case the noncondensable or foreign gases can be drawn off at the top of the receiver by placing a ½-in. extra-heavy short nipple and valve, so that these will not be easily broken off, and then reduce from ½ in. to ¼ in. and run the latter line to some convenient place and submerge it in a bucket or barrel of water. Next, open the half-inch valve slightly, and if bubbles appear on the surface of the water, there are gases in the system other than ammonia, and they can be worked out slowly while the plant is in full operation.

As already explained, some of the noncondensable

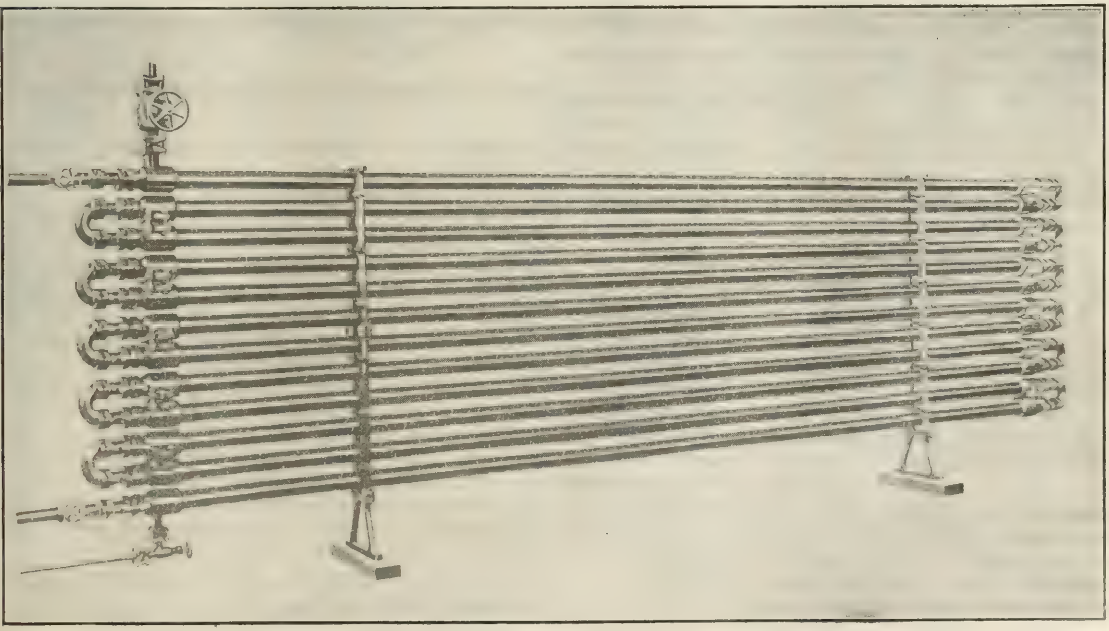


FIG. 2. DOUBLE-PIPE AMMONIA CONDENSER

gases are carried from the condenser to the liquid receiver, and if the outlet from the receiver to the evaporating coils is sealed, they will be trapped in the receiver because they cannot get out at the top of it while the plant is in operation, nor can they get out at the bottom on account of the liquid seal to the bottom outlet.

This trapping of the gases in the receiver causes a slight pressure in the receiver above that of the incoming liquid, and as the outgoing liquid is continuous, the liquid level in the glass will gradually drop to a point where the bottom opening will be uncovered; or in other words, the liquid seal will be broken, which allows the gases to pass out into the liquid line, reducing the pressure in the receiver and generally filling the glass gage to the top or above, depending on the amount of foreign gases, the amount of ammonia in the system and upon the working conditions.

CLEAN-OUT LINE FROM LIQUID RECEIVER AND OIL TRAPS

The clean-out connection to the receiver should be made at the bottom and extend up inside in a vertical position a distance of six to eight in. The six or eight in. of pipe that extend inside the receiver should have a running thread cut or have the pipe turned down in a lathe, small enough to pass through a standard-size tapped hole. Before making-up the pipe in the receiver, however, have a plug welded in the end of the pipe so it faces up, and then perforate it with enough ¼-in. holes to at least equal the area of the line. The plugged end and perforations will insure against the line stopping up, as more or less rust and dirt will always work through the system and lodge in the liquid receiver and oil trap. For this reason the clean-out line on the receiver should be opened at least once a week to make sure that it is not stopped up, and on the oil trap the clean-out line should be opened every day to remove oil, if there be any, and to make sure that the line is clear.

The liquid outlet line leading from the receiver to the evaporating coils should take the liquid from eight to twelve in. from the bottom of the receiver, and the bottom of the gage glass should be located at least two in. above the liquid outlet.

The gage cocks should be of the automatic closing type, and for additional safety a rope should be attached to the lever or wheel leading to a safe distance so that the cock can be closed by a simple pull of the rope in case the glass should break and the cock fail to close automatically.

PURGING AMMONIA CONDENSERS TO REMOVE FOREIGN GASES

The best time to relieve the refrigerating system of air, decomposed ammonia and numerous other gases that go to make up noncondensable, impure or foreign gases is when the plant can be shut down for about five or six hours. Pump all the ammonia out of the evaporating coils into the condenser, shut down the compressor and allow cold water to run over the condenser coils for five or six hours, which will condense all the ammonia gases that are condensable. Then open slightly the purge valves which are provided at the top of each stand of coils, and watch them until a white vapor closely resembling that of exhaust steam appears, when the purge valves should be closed.

Purging condensers is necessary to the successful operation of a refrigerating plant, but is not a "cure-all" and should not be overdone, as it is an item of expense that runs into considerable loss of ammonia and money.

Excessive condenser pressure is caused by an overaccumulation of non-condensable gases, dirty condenser coils, insufficient supply of condensing water, temperature of condensing water too high for the amount of condensing surface, too much ammonia in the system; where the Block and other similar types of condensers are used, a shortage of ammonia will cause high condensing pressure.

It is the engineer's business to know, in case the condensing pressure is running too high, what is causing the trouble. This pressure should at all times be kept as low as possible, as high pressure means more power, more coal, more ammonia leaks, more blowouts, more wear and tear to machinery, more shutdowns and more of everything in general except output of the plant; and all go to increase operating costs.

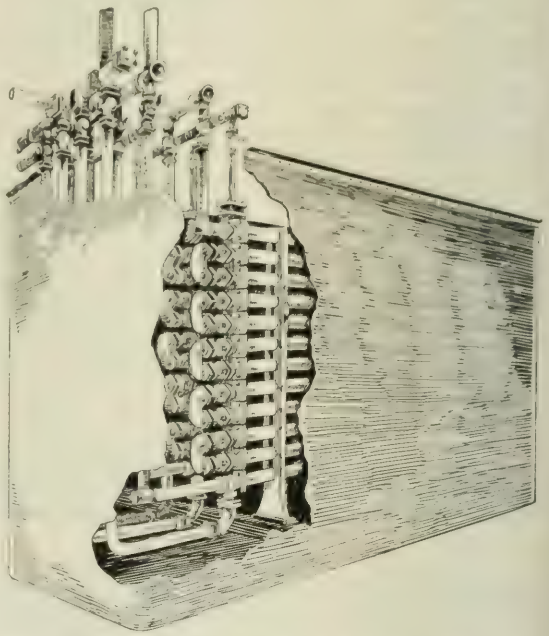


FIG. 3. LOOKING INTO A DOUBLE-PIPE BRINE COOLER

If the condensing pressure is running too high and the condensers are clean and a normal supply of water is given with no undue rise in temperature, the engineer should proceed to take the temperature of the water leaving the condenser. By adding eight or ten degrees and consulting tables on properties of saturated ammonia, the condensing pressure corresponding to the temperature can be found, and if the condensing pressure is found to be much higher than shown in the tables, it is a good indication that the condensers need purging. For example, assume that the temperature of the water leaving the condenser was found to be 88 deg. F.; adding 10 deg. gives 98 deg. F. and the corresponding pressure due to this temperature would be, as taken from the tables, 191 lb. If the condensing pressure is running much higher than this, it is evident that the condensers need purging.

In condensers of the Block, York, Ball and other types the efficiency and capacity depend on a supply of liquid being carried in the condenser, and a shortage of ammonia will cause high condensing pressure. Without an ample supply of liquid part of the condensing medium is removed, and the hot gas coming in contact or mixing with the cooler liquid in the condenser has the same effect as the *jet* steam condenser where the condensing water is injected directly into the exhaust steam.

The suction pressure should be carried as high as the temperature conditions will permit, as the capacity of the machine depends mainly on the suction pressure or number of pounds of gas delivered to the condenser, returned and re-evaporated in the evaporating coils. One cubic foot of gas at 30 lb. will weigh twice as much as one cubic foot at 15 lb., and omitting the heat of compression, 30 lb. suction pressure will produce twice as much refrigeration as 15 lb.; provided, however, the boiling point of the liquid is low enough to do the work required.

Oil Separator on Discharge Line

As an extra precaution against oil and other deposits being carried over into the ammonia condenser, an oil or ordinary high-pressure steam separator, with a guaranteed working pressure of 300 lb. per sq.in., should be placed in the discharge line between the compressor and the condenser, and a 1-in. line led from it to a trap located below the separator, preferably in the engine room. The trap can be made of extra-heavy pipe with a ratio of about 10 cu.in. volume per ton of refrigeration.

Relative Value of Top and Bottom Feed of Ammonia to Evaporating Coils

The writer changed, on request, one 350-ton and one 150-ton brine tank from bottom feed to top feed. The evaporating coils in the brine tanks in question would evaporate enough ammonia with the bottom feed to maintain a suction pressure ranging from 18 to 25 lb., depending on the temperature of the brine, and this, too, with the machines running to the limit of their speed. The headers were changed in the spring of the year from bottom feed to top feed. Be assured it was a trying job to pull that plant through the following summer.

The best that could be had from the tank coils was an evaporation sufficient to carry a suction pressure on the machines of from 10 to 16 lb. and the machines not running up to the limit. There was loss in capacity of from 25 to 40 per cent. The first cool spell that coming fall all hands were put into the tanks to change the headers back to the bottom feed, with the result that the suction pressure could be carried at from 15 to 25 lb. with no trouble.

Now the question arises: Why this marked difference between the bottom and top feed? With bottom feed the coils will fill up completely with liquid, and as the whole external surface of the coil is in direct contact with the heated brine, the liquid will rise to a point where the saturated gas that is being evaporated and driven ahead of it will reach the top header at a temperature sufficiently low to frost the suction line leading to the compressor. When this point is reached, the coils will be filled to their working level and should be regulated the same as feeding water into a boiler, as before explained. The liquid completely covering the inside surface of the pipe and being surrounded by the heated brine on the outside causes violent boiling of the liquid which sets up or forces a fast circulation and rapid evaporation of the liquid ammonia; the principle is the same as that of the water-tube boiler.

The "top-feed" is where the liquid enters the top coil and gravitates downward to the bottom outlet, the heat being applied by the surrounding brine the same as with bottom feed. But in this case the results are somewhat reversed, as the coils are only *partly* filled with liquid ammonia, and instead of transferring heat from the brine to the liquid, it is being transferred to a small portion of the liquid and a large portion of saturated gas which is being superheated as it is forced downward to the outlet end of the coil. For example, consider a water-tube boiler with the inner surface of the tubes only partly filled with water and you have a a good illustration of a "top-feed" brine coil or brine cooler.

Operation and Adjustment of Turbine Machinery—VI
Shaft Packing

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

SHAFT packing should not require adjustment at frequent intervals. It is, however, often difficult to dismantle, adjust and assemble. This packing has been perfected so that trouble is seldom experienced, but as troubles may be expected, their characteristics and causes are listed here. This list refers to high-pressure packing primarily, but what is true of it is true, to a large extent, of inter-stage and exhaust packing.

1. Leakage resulting in steam coming out of the casing, or lowering of vacuum. Causes: (a) Wear of packing rings; (b) weakened springs; (c) broken packing resulting from assembling or from vibration (the latter sometimes causes the packing to become jammed and broken; packing is also sometimes broken by moving the rotor in an improper manner while adjusting); (d) water coming through with steam; (e) bad alignment of the nozzle, which builds up pressure and vibration; (f) sprung shaft; (g) shaft running out of true due to unbalanced rotor; (h) back pressure in the drain due to back pressure of the sewer or to wind blowing into packing drain pipe.

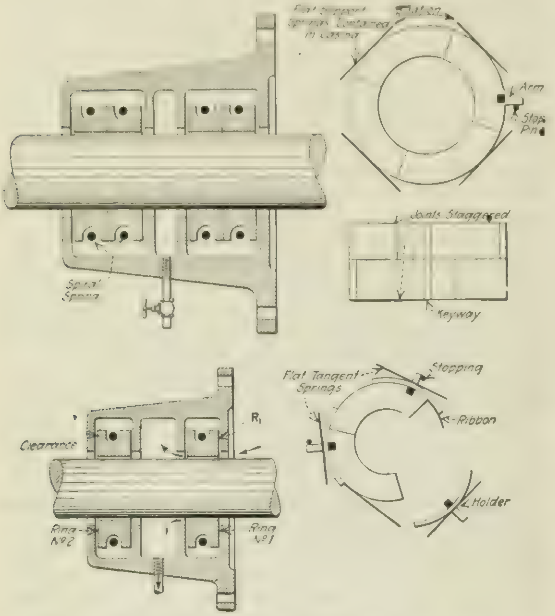
2. Cutting of shaft. Causes: (a) Rings fitted too small; (b) rings becoming jammed in the holders; (c) spring in shaft; (d) unbalanced rotor.

3. Heating of shaft. Causes: Packing rings fitted too tight.

4. Vibration. Causes: (a) Rings fitted too small for the shaft, especially in large machines and in inter-stage packing rings; (b) rings jammed in the holders on account of dirt and sediment from the steam; (c) rings slipping out of place from moving the rotor or from violent and sudden vibration.

5. Rubbing noise. Causes: Usually caused by metallic rings becoming jammed or slipping out of place so as to touch shaft.

Packing troubles in small machines cause heating more than vibration, but in larger units vibration usually occurs before heating. Sometimes a sudden period of vibration will occur several hours after refitting of the packing; with some types of packing rings it is easy for them to be displaced temporarily. When they work back into place, the ring may be a trifle too small, producing vibration. Unless vibration or heating seems to be serious, it is usually good practice to keep the machine running until the packing has worn large enough to free the shaft.



STEAM TURBINE PACKING

Upper Left—Carbon ring shaft packing. Upper Right—Flat support spring for the carbon packing rings; below are rings with staggered joints. Lower Left—One ring instead of two in a compartment. Lower Right—Another way of supporting a carbon packing ring.

TYPES OF PACKING

The most familiar type of shaft packing is made of carbon rings, and there are many ways of holding them in place. The method most employed is shown, upper left, which represents the garter-spring type. This ring is made of three or four segments held in circular shape by means of spiral springs stretched around it. The ring is supported by flat springs which allow it to move around in accordance with the position of the packing casing in relation to the shaft, so that it can take its proper position after expansion or contraction has changed the position of the casing. See the illustration.

Two rings are used together in a single compartment, as shown above. The joints of the rings are staggered. To keep the ring from turning, there is an arm keyed to it as shown. This contacts with a pin which is fastened in a carbon casing. The pin therefore holds the arm and prevents the ring from turning in the direction of rotation. The keyway also holds the rings in the staggered position so that the joints of both rings cannot come together while the key is in place.

This packing is varied by using one ring instead of two in a single compartment, as shown, the flat support springs not being used. The assembled packing illustrated is for the exhaust end of a non-condensing turbine. A little steam leaks around ring No. 1, and there encounters the drain by which it is much easier to reach atmosphere than through ring No. 2. This combination is about the easiest to adjust satisfactorily.

At the lower left a carbon ring is supported differently. Instead of using garter springs together with flat supporting springs, this ring uses flat springs tangent to the ring at several places. The springs at the bottom of the ring support the weight in addition to holding the spring in its circular form and are therefore usually a little stronger than the upper springs. It will be seen that the packing is free to move with expansion of the turbine casing.

Two kinds of joints—the butt joint for interior rings, and the lap for the outside ring—are used. In this position there is little steam pressure, and in such a case the joints are not arch-bound, therefore the ring is allowed to bear against the shaft all the way around. Copper ribbons are generally used over each joint. The clearance in each joint is usually about $\frac{1}{16}$ in.

Carbon rings do not always have their weight supported, as the garter-spring types are sometimes used without supporting springs. All types of rings must have some arrangement to keep them from turning with the shaft.

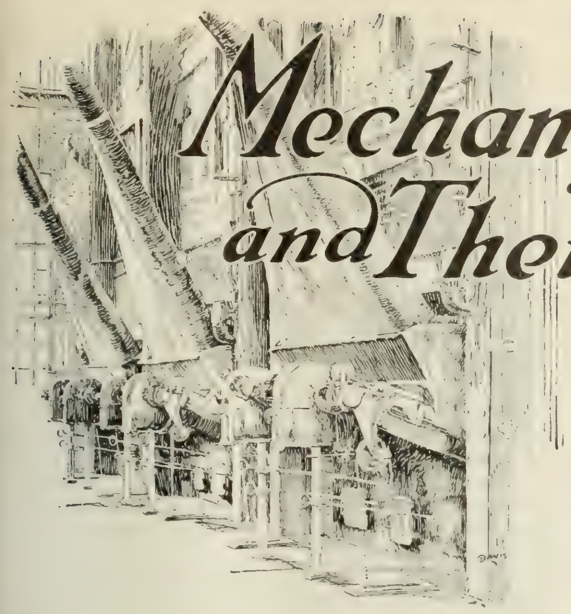
Metallic packing rings are frequently used. Rings of this character are usually made with saw teeth so that they will wear when in contact with the shaft. Saw-tooth rings are sometimes known as labyrinth-type packing on account of the broken path of the steam when leaking past the ring. These rings are often provided with a collar which prevents them moving too near the shaft. They may be held in place by any combination of springs previously described. This type of packing is used between stages of the impulse turbine.

The stuffing-box type of packing is used mainly on small machines of impulse type. The material of this packing usually consists of babbitt metal or other soft anti-friction alloy stranded, and sometimes mixed with asbestos. In some machines rings of soft fiber packing are placed between the metallic rings.

Another type of packing is known as water-seal packing. This consists of two rings of carbon or metal as indicated, with water supplied between them. Provision is made for draining the water to keep it in constant circulation. This method is used in sealing against a vacuum and also in holding low-pressure exhaust steam. The circulating water condenses the steam that leaks past the inner ring and also tends to keep the rings and shaft cool.

A well-known type of water packing is constituted as described; there goes with it a small centrifugal pump placed on the shaft of the turbine. This pump throws the water in a fine spray against the packing rings, thus generating a pressure due to the velocity of the water, which is effective in sealing against exhaust steam or a vacuum.

Mechanical Stokers and Their Operation



Dealing with the classification of the principal types of mechanical stokers and their general application to boiler service. General instruction is given regarding the operation of each type of stoker and the method of banking and bringing the stoker into service again; also data regarding the draft of each type of stoker required at different rates of combustion.

UNTIL recently mechanical stokers were practically limited to handling bituminous coal. Anthracite is difficult to burn successfully on the average design of stoker, but a mixture of half anthracite and half bituminous coal can be burned with more or less success, and as a matter of fact many stoker operators have been obliged to use such a mixture during the last year, owing to their inability to secure a sufficient supply of soft coal.

The advantages of stokers are the adaptability of burning the cheaper grades of fuel; a saving of labor in plants over, say, 500 hp. capacity when provided with coal and ash-handling machinery; economy in combustion, with proper management especially when forcing the fires; uniformity of furnace conditions, the fires being maintained at an even thickness and being cleaned of ash either continuously or intermittently, depending upon the design. These features have an influence toward prolonging the life of the boiler.

A certain amount of skill is required on the part of the operator in handling stokers, otherwise the fires may become filled with holes, which will allow excess air to enter the furnace, and there may also be considerable loss of fuel in the ashes. Control of the air supply is an important item in the successful operation of stokers, but in every installation, if the best firing practice is to be had, the engineer in charge will have to work out the right amount of air, the depth of fire to be carried and the rate of feed.

Stokers can be classified under three general types—traveling grates, overfeed and underfeed. These three types are more or less familiar to steam users. The traveling or chain-grate stoker, Fig. 1, consists of an endless chain composed of small bars passing over sprockets at the front and rear of the furnace. From a coal hopper fuel is fed onto the front end of the stoker by gravity and is ignited as it passes under the ignition arch and, owing to the movement of the grate, is carried toward the rear of the furnace as combustion takes place. If the stoker is properly operated, the combustion of the fuel has been completed by the time the fire reaches the back end of the grate, and the ashes and refuse are carried over the end into the ashpit. A water box, bridge wall, or similar arrangement at the rear end acts as a seal to prevent the admission of excess air at that point. Other designs are provided with hand-operated dampers by which the air supply is controlled. Some chain-grate stokers are slightly inclined toward the rear of the furnace and others are horizontally placed.

Most chain-grate stokers are operated with natural draft, although some are used with forced draft. An ignition arch is necessary in order to deflect the heat and ignite the coal as it comes from the hopper. A flat arch gives uniform ignition over the entire width of the grate surface. Although natural or forced draft can be used, certain coals are not adaptable for use with forced draft. On chain-grate stokers coking occurs at the entrance of the stoker, but as the ignition arch is comparatively long the air and volatile matter are effectively mixed. Clinker troubles are absent, except some along the side walls, as the grates are automatically cleaned of ashes.

As this type of stoker has a large area, it can be forced to an average of 250 per cent of the boiler rating with a fuel combustion rate of around 48 lb. per square foot of grate area per hour, when burning coal that is suitable for the type. There is a probability, however, that at this rate of combustion the grate would become overheated when burning low-ash coal. The result would be high maintenance cost.

For efficient operation the draft must be under control and the damper operated between the closed and open position and the stoker not operated with the damper either wide open or entirely closed. Furthermore, the stoker should be so handled that no unconsumed fuel will be carried over the end of the grate; this can be avoided by regulating the thickness of the fire and by the damper adjustment. The variation of the fuel bed is governed by the load carried and by the fineness of the coal and its volatile properties. Experience has shown that it is better to run a thick fire slowly rather than a thin fire rapidly. An average speed for the chain-grate stoker is about 3½ in. per min. If the live coal feeds over the end of the grate into the ashpit, the fuel is being fed either too fast or too thick or not enough draft is being supplied. For ideal operating conditions the fuel should be consumed upon reaching the rear end of the stoker, but the back end of the grate should never be allowed to become bare. The speed of the stoker should be such that the volatile of the coal will have been driven off before the coal has traveled one-half of the grate length.

When forcing fires with the chain-grate type of stoker, the damper should be placed wide open, the feed gate lowered, the grate travel speeded up and the coal loosened up. This can be done by the use of a suitable flat-end bar by running it through the furnace, turning it over and pulling it out without disturbing the surface of the fuel bed, repeating the operation until the entire surface has been gone over. Using a slice bar to break up a fire will cause smoke, and although there is no plant that will operate smokelessly under any and all conditions of service, the degree of smoke formed depends largely upon the ability of the men handling the stoker.

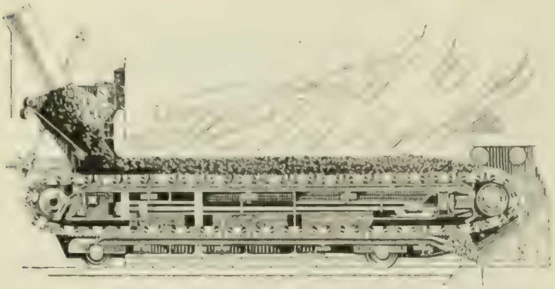


FIG. 1. CHAIN-GRATE TYPE OF MECHANICAL STOKER

Chain-grate stokers are practically adapted to Middle Western coals which run around 22 to 25 per cent of ash. Coals containing as low as 10 per cent ash can also be burned upon them. High-ash coals will require a draft as high as 0.6 in. over the fine and about 1 in. at the damper when burning 40 lb. or more of coal per square foot of grate surface per hour with an average depth of 5¾ in. of fuel on the grate. Burning the same amount of coal, but of lower ash content, a draft of about 0.4 in. will do. When using forced draft, the air pressure over the fires may vary from atmospheric to 0.15 in. of water with a varying pressure in the wind box of 1 in. to 4 in. of water. For average results a minimum of 0.25 in. draft in the furnace should be available.

One method of approximately figuring the desired draft is to assume that about 10 lb. of coal can be burned per square foot of grate surface for each 0.1 in. draft in the furnace. Thus with a draft of 0.4 in. 40 lb. of coal could be burned per square inch of grate surface, and as high as 60 lb. of coal with an 0.6 in. draft. From 200 to 250 per cent rating and even higher can be obtained with this design of stoker, with natural draft.

Overfeed stokers are divided into two general classes. In one the coal is fed into the hopper at the front end of the furnace to the upper part of the grate, which inclines downward at an angle of about 45 deg. toward the rear of the furnace, Fig. 2. As the grates are reciprocating, taking alternate straight and inclined positions, the motion gradually works the burning coal to the bottom of the grate. Combustion is completed on a dump plate at the bottom; this plate also provides a means for dumping the accumulation of ashes and clinker. As the coal is coked on the upper end of the grate, the volatile gases are driven off and are ignited and burned in their passage over the bed of burning fuel on the lower portion of the grate.

The other design of overfeed stoker, Fig. 3, provides for the coal being fed from the side for the full length of the stoker and at the top end of the grate, which inclines toward the center of the furnace. These grates are given motion by means of rocking bars and the fuel is gradually carried to the bottom end of the grate, where a grinder reduces the clinker and deposits it into an ashpit.

These stokers are adaptable for burning either coking or free-burning coal, the latter because the movement of the grate keeps the fuel broken up, which prevents it from coking. Under ordinary operation a draft of 0.25 in. of water is required with natural draft; the maximum draft is about 0.6 in. About 50 lb. of free-burning coal per square foot of grate surface per hour is the maximum consumption and a maximum of 35 lb. per square foot of grate surface per hour when burning high-carbon coking coal can be obtained. Economical operation of from 150 to 200 per cent of rating can be easily carried and higher ratings have been obtained.

When the stoker is equipped with a dumping plate, the clinker and ashes collect on it and when a sufficient amount has been accumulated, it is dumped into the ashpit. Trouble is frequently experienced with clinker when burning some grades of coal. The larger pieces have to be broken up in order to pass the dump plate into the ashpit. Too frequently, the operator will attempt to break up the clinker by slamming the dump plate. This is poor practice as it causes live coal to fall into the ashpit. If the fireman is careless in doing this work, considerable burning fuel will be deposited with the ashes and wasted. A careful fireman can greatly reduce this loss. The longer the dumping process requires, the greater will be the heat loss due to the

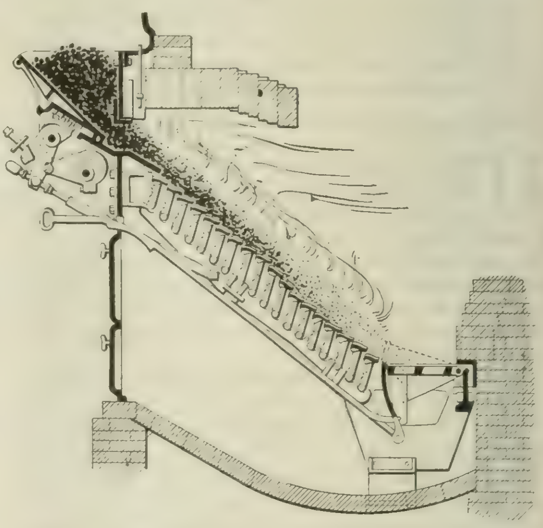


FIG. 2. FRONT-FEED OVERFEED TYPE OF STOKER

inrush of cold air in the furnace while the push-hole door is open.

When the crusher, which forms the central part of the furnace, is used, the clinker is automatically taken care of, as it grinds it up and deposits it in the ashpit. The clinker is softened by blowing steam between it and the grinder and between the grates at the lower end. This steam is supplied from the exhaust of the stoker engine.

Fusing of clinker to the side walls and bridge wall is one of the troubles experienced with overfeed stokers if the fires are neglected. This can largely be prevented by slicing the fires and dumping the ashes before they become fused. The dumping interval will be determined by the grade of coal being burned and by experience. If dumping is done at too short intervals, the combustible will not all be burned, whereas if too long periods are allowed between dumpings, although the fuel will all be burned, there is the probability of clinker formation. As with any other type of stoker, or hand-fired grate for that matter, the grate must be covered with fuel, the thickness depending upon the load. This will prevent the admission of excess air as will occur with an uneven fire.

Poking the fuel of either front- or side-feed overfeed stokers generally tends to cause the burning fuel to slide down much faster than it would, due to the natural movement of the stoker grate, and this will necessitate the feeding of new fuel on the upper end of the grate in order to cover the base surface.

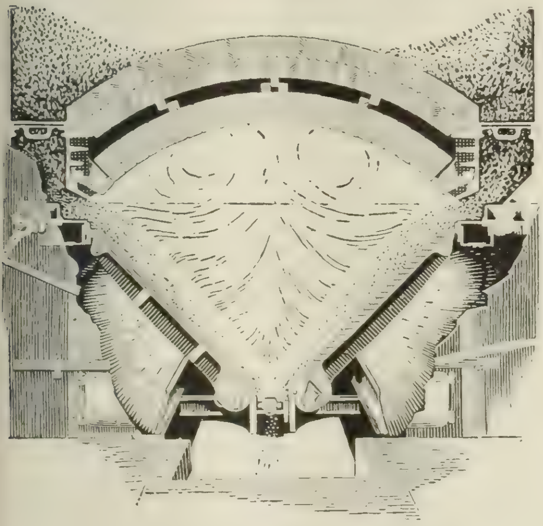


FIG. 3. SIDE-FEED OVERFEED STOKER

Fire Thicknesses Depend on Kind of Coal

Fire thicknesses are to be governed largely by the kind of coal burned, but a fire about three or four inches thick will give good results under ordinary circumstances. The fire should be kept even, and in the case of a side-feed stoker, if there is a tendency for one side to build up thicker than the other, the feed on that side can be reduced, or the thin side can be built up by means of a socket wrench.

If, in cleaning fires, all the clinker will not drop, it must be broken up with a bar and pulled out with a hook. If a crusher is used, its speed depends on the kind of coal used and its clinkering properties. When banking the fire of a side-feed overfeed stoker, remove all clinkers and pull the coke to the front end of the grate and then cover the live coals with fresh fuel. All doors should then be closed and the damper left open just enough to allow the gases to escape up the chimney. Of course the fuel magazine should be empty. When starting up from a banked fire, the live coals should be spread along the bottom of the grate and covered with coal from the magazine and then the draft doors and dampers should be opened.

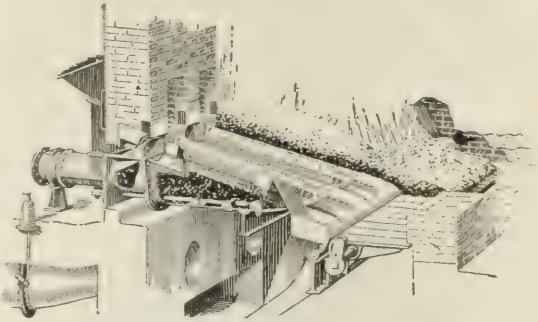


FIG. 4. UNDERFEED TYPE OF STOKER

Stokers equipped with fuel magazines require that they be kept evenly filled with coal so that an even distribution of fuel will be had. Always so gage the fuel supply that when shutting down the stoker there will be no coal in the hopper and the fire will have been burned out; otherwise it will be necessary to empty the magazine to prevent the coal from catching fire.

These stokers are adaptable for variable loads because they may be operated with reduced grate area by allowing the bottom of the grate to fill partly with ashes. Ashes should not be allowed to collect in the ashpit, as this will cause burned grates. The distance from the grate may be from 5 to about 9 feet.

Underfeed stokers have been in use for years, and many of the largest installations are of this type. They have the advantage in that the tuyeres are covered with green or partly coked coal, which tends to protect the grate. Practically the entire furnace area is utilized to distill volatile matter, and all the air supplied to the furnace is thoroughly mixed with the volatile gases before it has escaped from the fuel bed. Another favorable condition is that the combustible gases pass through the hottest fire zone before reaching the furnace. Furthermore, no arches are required as with most other types of stokers, thus saving considerable in first cost and in upkeep.

Three Hundred Per Cent of Rating Maintained

Underfeed stokers can be forced up to 300 per cent of rating, which rate can be maintained continuously, and burn from 60 to 65 lb. of coal per square foot of grate surface. As to the stoker's efficiency in general, the best is obtained when the boiler is operated at not less than 100 per cent of rating.

With underfeed stokers the coal is pushed forward and upward by a ram or rams, so that the fire is always on top. The fresh coal is pushed forward and upward and is gradually heated and coked. The volatile is driven out during the coking process and mixed with the air that is admitted through the tuyere opening. Forced draft is used, the air supply being controlled by a damper. Coal is fed into a hopper on the outside of the furnace and falls by gravity to the front end of the plunger retort and is then pushed into the furnace.

Underfeed stokers are made in two designs. In one the coal is pushed into a central part and is then fed over the grate area on both sides of it, Fig. 4. After the proper adjustments have been made the coal is fed automatically and each stoker can be operated independently. Such stokers may be cut out of service and banked while light loads prevail and held in readiness to be put back into service. To maintain a banked fire for several days, it is only necessary to feed additional coal occasionally, keeping the dampers closed. To start from a banked fire, remove the ashes, open the damper and air grates, and then start the stoker. With this design of stokers no slicing or poking of the fire is necessary as the stoker takes care of the breaking up of the fuel bed.

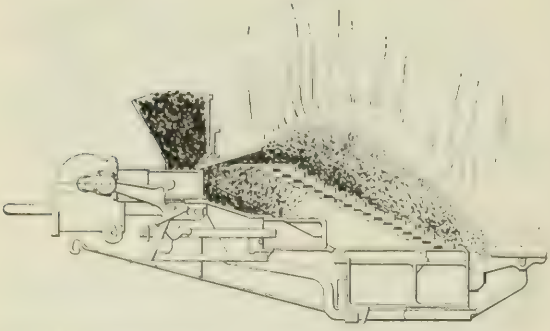


FIG. 5 UNDERFEED GRAVITY-FEED TYPE OF STOKER

As with any other kind of stoker, the proper supply of coal and air is of the greatest importance and the relation of available draft to the amount of coal to be consumed must be studied by the men in the boiler room. As about 8 lb. of coal can be fed at each stroke of the ram and as the stroke of the ram may be regulated from one to about eight per minute, the amount of coal necessary to be burned for a given load can be easily regulated. A draft of 2 in. will generally supply sufficient air to take care of four strokes per minute, which would be feeding 32 lb. of coal. This would permit of all combustibles being burned by the time the coal reached the dump plate, when one is used.

Live coal should be prevented from accumulating on the dump plate as such accumulations tend to increase the temperature and result in the fusing of the ashes into a clinker which is difficult to dump. Attempts to dump large clinkers by working the dump plate will cause the loss of good fuel by its being dumped into the ashpit. When large clinkers form on the dump plate together with combustibles, close the ashpit door and open the grids in the air box, if so constructed, thus putting the dump plate under forced draft. The stoker should be stopped at the same time until the fuel on the dump plate has become at least partly consumed, closing the grids again as soon as possible.

Fire about 10 to 12 in. thick is usually carried and the cleaning of the ash and clinker should in general be at least once in every two hours. If the furnace is being run lightly, unburned coal may be worked onto the dump plate, in which case it should be winged back with a suitable bar.

THE GRAVITY UNDERFEED STOKER

The other design of underfeed stoker is known as the gravity feed, Fig. 5, and is used extensively in Eastern power plants. The several makes are similar in many respects. Coal is fed into the hopper by various means and rams force it into the furnace, which controls a sloping grate and the refuse moves automatically toward the bottom as the combustible is consumed. As the coal leaves the plunger, it begins to coke and then moves farther into the furnace, where it is consumed.

When starting a gravity underfeed stoker, care should be taken not to carry a fire too heavy or too hot on the ash plate, which can be protected from the furnace heat by covering with ashes. After the stoker is in operation, the ash plate should not be kept open any wider than necessary to just allow the ashes to fall through, and it is best to keep it closed sufficiently to maintain a layer of ashes over the opening and a fixed bed of ashes over the plates so as to protect them.

Sometimes it becomes necessary to dump hot clinkers and refuse into the ashpit, in which case they should be cooled by playing a stream of water over them after dumping. No water, however, should reach any part of the furnace. Very large clinkers may be dumped by withdrawing the ash-support plate in order to let the clinker drop through.

The fires are banked as with other types of stokers. First shut off the air supply and push in coal until the required depth of the bank is obtained. This depth will depend on the length of time the stoker is to remain idle. It is best not to allow very much, if any travel of the side bars when the fires are banked, and the fire should not be allowed to burn down to the tuyere plate or air box, as when the air box becomes cracked fuel will fall into it and become ignited, which will further damage the box.

When starting from a banked fire, first turn on the air and then start the side bars at their normal travel and run the stoker with the hopper empty if the banked fire is heavy, thus preventing feeding of fresh coal until the bank bed has been broken up by the side bars and it has burned down to normal thickness.

Underfeed gravity stokers are adaptable to burning bituminous, semi-bituminous and semi-anthracite coal. Forced draft is used, and for normal rating 1.5 to 2 in. pressure in the wind box is about what is required with a 0.03 in. suction in the furnace. Maximum loads require from 3 to 6 in. pressure in the wind box and 0.05 in. suction in the furnace. Long-continued loads of from 250 to 300 per cent of ratings can be maintained and even daily peaks of 400 per cent can be carried. Under normal rate of combustion 40 lb. of fuel can be burned per square foot of grate area per hour and from 60 to 80 lb. of fuel can be burned during short peaks of, say, two to three hours.

Overspeeding fans for the purpose of increasing the volume is not practicable, as this will rapidly increase the power consumption. Fans are designed to deliver a certain number of cubic feet of air at a certain pressure when running at a certain speed. Any diversion from the stipulated speed will, of course, produce a different delivery curve, pressure curve and power-consumption curve. For instance, by doubling the speed, twice the amount of air will be handled with four times greater pressure than before, but with an expenditure of eight times as much power for driving the fan.

In conclusion, the life of stokers, blower equipment, etc., depends upon the usage they receive. With proper care a stoker should be serviceable for at least fifteen years. If it is neglected or abused, its life is reduced and the maintenance charge will be higher than it should be. A stoker cannot be expected to give satisfactory results if given no attention other than filling the hopper with coal. Ignorance and careless handling have ruined many a stoker.

Multipliers for Use with Portable Voltmeters and Wattmeters

By H. C. Yeaton

When it is required to use a voltmeter to measure the voltage of a circuit which is in excess of the instrument's rating, an external multiplier may be used and connected in series, as shown in Fig. 1. When a multiplier is used with a voltmeter, the readings have to be multiplied by a constant. This constant K can be determined from the formula,

$$K = \frac{R_i + R_m}{R_i},$$

Where R_i equals the resistance of the voltmeter and R_m the resistance of the multiplier.

When a multiplier is made to be used with a particular instrument, the resistance in the multiplier is so calculated and adjusted that the multiplying constant is an even number. Suppose that a voltmeter has a scale of 150 volts, the resistance being 1,800 ohms, and it is desired to have a multiplier with a ratio of 2: 1, so as to adapt the voltmeter for use on a 300-volt circuit. The resistance of the multiplier is $R_m = (KR_i) - R_i$. By substituting in the formula, the required resistance is obtained; that is, $R_m = (2 \times 1{,}800) - 1{,}800 = 1{,}800$ ohms.

If it is required to use a voltmeter on a circuit in excess of its voltage rating and a multiplier with an even constant is not available, any multiplier can be used provided it will withstand the watts load to which it will be subjected and the resistance is sufficient. Suppose that a voltmeter has a scale of 150 volts, the resistance of the voltmeter being 2,800 ohms, and the multiplier available happens to have a resistance of 3,300 ohms. The value of constant K by which the voltmeter readings will have to be multiplied by, is

$$K = (2{,}800 + 3{,}300) \div 2{,}800 = 2.18$$

Therefore the readings of the voltmeter would have to be multiplied by 2.18 to obtain the correct voltage of the circuit being measured.

As a single-phase wattmeter has only one potential element, the same procedure may be followed for determining the resistance or constant of a multiplier, as that explained in the foregoing, covering voltmeters. Fig. 2 shows the connections of a single-phase wattmeter used with a multiplier.

A polyphase wattmeter has two potential elements, therefore it is necessary to connect a multiplier in each potential circuit, as in Fig. 3, when the meter is to be used on a circuit in excess of its rated voltage. Each multiplier will have a constant, and the average of both constants will be the constant that should be used to multiply the readings by, in order to obtain correct results.

If a multiplier was to be made for use with the polyphase wattmeter, the former's resistance would be so calculated and adjusted that the multiplying constant would be an even number. Suppose that a polyphase wattmeter had a voltage rating of 150 volts and it was desired to have a multiplier with a ratio of 2: 1, so as to adapt the meter for use on a 300-volt circuit. In Fig. 3 assume that the resistance of the potential circuit AB is 2,000 ohms and the resistance of the other potential circuit CD is 2,100 ohms.

The resistance to be used in series with potential circuit AB is $R_m = (2 \times 2{,}000) - 2{,}000 = 2{,}000$ ohms, and that in CD is $R_m = (2 \times 2{,}100) - 2{,}100 = 2{,}100$ ohms.

If it is required to use a polyphase wattmeter on a circuit on which the voltage is in excess of that of the meter's rating, and a multiplier with an even constant is not available, any multipliers may be used, providing that the resistance in the multipliers is sufficient to meet the particular requirements and they will not heat excessively. It is advisable to use resistances of approximately the same values in series with each potential element, so that the elements of the wattmeter will be nearly balanced.

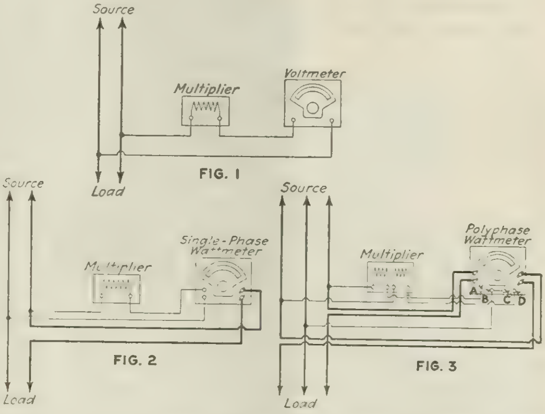


FIG. 1

FIG. 2

FIG. 3

FIGS. 1 TO 3. CONNECTIONS FOR USING A MULTIPLIER WITH VOLTMETERS AND WATTMETERS

Suppose that a portable polyphase wattmeter has a voltage rating of 150 volts and the resistance of the potential circuit AB, Fig. 3, is 2,000 ohms and that of CD is 2,100 ohms. It will be assumed that the multiplier available for AB is 2,300 ohms and the resistance of that available CD is 2,000 ohms. It is required to use the wattmeter on a 300-volt three-wire three-phase circuit. The constant for AB potential circuit is $K = (2{,}000 + 2{,}300) \div 2{,}000 = 2.15$, and for the CD potential circuit is $K = (2{,}100 + 2{,}000) \div 2{,}100 = 1.95$. Averaging these constants gives $(2.15 + 1.95) \div 2 = 2.05$. Therefore the readings of the polyphase meter would have to be multiplied by the constant 2.05 to obtain the correct results of the circuit being measured.

Charles W. Naylor

ROUNDING out his thirty-fourth year in the service of Marshall Field & Company, the subject of this sketch gives a striking example of loyalty. He has had many opportunities to better himself financially by engaging in other work, but his heart has been with the firm that he, and his father before him, have served for so many years. No engineer in Chicago is more popular. The firm appreciates his rigid attention to duty and the efficient supervision of the work under his charge. His associates like his human qualities, and his fellow engineers from coast to coast recognize his ability. Charles William Naylor hails from old Albion. He was born at Leeds, England, Oct. 29, 1858. His father, William Naylor, was a locomotive engineer on the railways in the Manchester district. To get away from railway work, which was distasteful to the new bride, the family took passage for America when Charlie was eleven months old. The trip from Liverpool to New Orleans, in a combination steam and sailing vessel, took five weeks, so that young Naylor had his first birthday anniversary on the ocean and in Southern waters. Up the Mississippi River the journey was pursued to Southern Illinois, the family settling at Mt. Carmel, now the center of the vast Illinois coal and oil fields, but coal and oil were far from the dreams of the people thereabouts at that time. Immediately after the Civil War the family moved to western Missouri, later to Vincennes, Ind., and in 1868 to Chicago, then a prosperous city of 150,000 inhabitants. From that time on young Naylor received the benefits of excellent public schools, and he took full advantage of the opportunity. He was always studious and forward in his classes, graduating with honors from the Central High School at the age of seventeen.

CHARLES W. NAYLOR

At this period of his life Charlie was taken in hand by his father, who was proud of his ability and wished to give him all the advantages of a good education in his life work. His own words to his son best express his sentiments: "Boy, I am going to send you to college—you deserve it—but for fear you will be too proud to work after you get a degree, you are first going into the shop. I will place you with the Crane Company for two years." The dictates of his father were followed, and as Charlie had had previous experience in shop work during his summer vacations, he was a good mechanic at the end of the stipulated period. Much of his success in his subsequent engineering work he attributes to the experience and training gained at this time.

Entering the University of Chicago, he excelled in the sciences and mathematics, receiving the degree of B.S. in 1881. During his college days he became a member of the Greek letter fraternity, Psi Upsilon. After graduation he had the usual desire to see something of the world. Having gained a working knowledge of the transit, he went with the Illinois Central Railroad and finished out the year surveying through Tennessee and Mississippi. A dangerous swamp fever cut short his days of roving. He returned to Chicago and entered the employ of the Hay & Prentice Co., then the largest firm of steam-heating and ventilating engineers in the West. Not long after he was called to the position of first assistant engineer with the firm of Field & Leiter, now Marshall Field & Co., where he is chief engineer today and is just rounding out his thirty-fourth successful year with this great corporation. Throughout this period and particularly from his twelfth to his twenty-fifth year he burned the midnight oil, hungry for a knowledge of the arts. However, he was not unmindful of his health and physical well being. For ten years he was a frequenter of the gymnasium, taking a consistent and intelligent course of athletics. Though slight of build, he is something of an athlete and can do his distance and jump with the good ones to this day. On his college nine he played third base when such things as masks and gloves were unknown. For many years he was secretary of the Union Athletic Club, composed of active athletes, and officiated on numerous occasions at annual meets of the American Athletic Union. He is still fond of outdoor sports.

In 1890 he joined the National Association of Stationary Engineers and has been an ardent supporter of this organization ever since. He was national president in 1893 and national secretary from 1897 to 1899. Charlie has attended twenty-five of its annual conventions, and when it comes to his local, No. 28 of Chicago, he seldom if ever misses a meeting. Here he has filled all official positions. For six years he has been a member of the association's national educational committee, part of his duties being to edit the first three volumes of its handbook, and he is now engaged on the fourth volume.

His efforts and his interest have not been limited to one organization, for he has been a member of the Western Society of Engineers since 1905 and a member of the American Society of Mechanical Engineers since 1895. Of the Chicago branch of the latter society he was a director for three years and for some time its secretary.

Since 1895, from October to April of each year, Naylor has lectured on steam engineering before the evening classes of the Y. M. C. A., being by seniority dean of the faculty. His success in this line is attested by hundreds who have attended his classes. He is a rapid, fluent talker, original in his methods of stating facts and positive in his convictions. He insists on his pupils getting the "idea of the thing." Keeping away from the orthodox methods of pedagogy, like Professor Perry, of London, he is looking for results and the men under him seldom forget a thing after it is explained in his "get-to-the-point" way.

For many years he was official marker for the advanced engineering examinations of the Chicago Civil Service Commission. During the late war he was one of the volunteers who served with the Fuel Administration in Illinois. He has always had an ingenious turn of mind and has originated and marketed numerous improvements in machinery, although he has never taken out a patent.

In the daily performance of his work Charlie dislikes red tape. He trains his subordinates to be rapid thinkers and self-reliant and for these very reasons holds the respect and esteem of the men who at one time or another have been in his service.

Annual Convention N. A. S. E. at Milwaukee

Prospects are bright that the thirty-eighth annual convention of the National Association of Stationary Engineers will be a record breaker. It is to be held in Milwaukee during the week of Sept. 13. Convention headquarters is to be at the Hotel Wisconsin, and the exhibits and business sessions will be held in the Auditorium, an ideal building for the occasion. Special committees have been appointed to handle each specific detail of the convention. There will be technical papers and welfare discussions, following the practice at recent conventions, and for the field-day exercises Washington Park will be at the disposal of the visitors. Baseball, horse races, boat races, outdoor sports and entertainment of every description are on the program given under the auspices of the Milwaukee Chamber of Commerce. In addition there will be inspection trips to industrial plants, the pulverized-coal installation of the Milwaukee Electric Railway and Light Co. and other points of interest. The indications are that Milwaukee will surpass all previous performances as a convention city. The program in detail follows:

Sunday, Sept. 12, 10 a.m., annual convention of the Wisconsin State Association at the Republican House.

Monday, Sept. 13, 9 a.m., business session of the Wisconsin state convention at the Republican House. Official registration of officers, delegates and visitors to the national convention at the Milwaukee Auditorium will begin at 9 a.m. During the day the local reception committee will meet delegates and visitors and escort them to the Milwaukee Auditorium. At 2 p.m. there will be visits to some of the Milwaukee industries. At 8 p.m. the Mechanical Exposition will be opened at the Auditorium with the convention committee chairman, Charles F. Bindrich, presiding. There will be addresses by Horace A. Smith, president of the National Exhibitors' Association, and John J. Calahan, president of the National Association of Stationary Engineers, followed by a band concert in the exhibit hall.

Tuesday, Sept. 14, 10 a.m., opening exercises of the convention will be held in the Auditorium, Charles F. Bindrich, presiding. There will be an address of welcome to the State of Wisconsin by Gov. E. L. Phillips, the response by National President John J. Calahan, an address of welcome to the City of Milwaukee by Mayor Daniel W. Hoan and addresses by National Vice-President Alfred Johnson, Phil A. Grau, general secretary of the Milwaukee Association of Commerce, and Past President Roderick McKay. At the end of the opening exercises National President John J. Calahan will announce the convention committees. The official photograph will be taken on adjournment. At 1:30 p.m. the first business session of the convention will be held in Juneau Hall, Auditorium, where all business sessions will convene. It will be devoted to the reports of officers and standing committees presented in abstract, a

HOTEL WISCONSIN, CONVENTION HEADQUARTERS

NATIONAL CONVENTION COMMITTEE, N. A. S. E.
Left to right: Seated—John A. Wickert, secretary; Charles F. Bindrich, chairman; Thomas W. Armer, Charles A. Cahill. Standing—Harry E. Fritz, H A. Barr, Harry J. Mistle, J. A. Prudell.

lecture at 3 p.m. on "Science and Engineering," by Ben S. Elliott, professor of mechanical engineering, University of Wisconsin, and at 4 p.m. the annual meeting of the Life and Accident Department. After 4 p.m. there will be a visit to some Milwaukee industry and at 8.30 p.m. the exhibit hall will open. A very interesting program is being arranged.

Wednesday, Sept. 15, 9 a.m., business session for presentation of reports, official roll call of officers and delegates and routine business; 10:30 a.m., a lecture on "Importance of the Operating Engineer" by H. B. Wilder, of Detroit. At 11:30 a.m. there will be an address by a representative of the American Red Cross Association. The exhibit hall will remain open from 8:30 a.m. to 12 noon and from 7 p.m. to 10 p.m. The afternoon will be devoted to the field-day exercises, including baseball, horse races, boat races, running races, outdoor sports and entertainment of every description, at Washington Park, Milwaukee's most beautiful recreation spot, given under the auspices of the Milwaukee Association of Commerce. At 8 p.m. moving pictures of industries in Milwaukee will be presented at the Auditorium.

Thursday, Sept. 16, 9 a.m., business session, reports of convention committee; 10:30 a.m., lecture on "Thermometer and Pyrometer in the Power Plant," by W. J. Neely, of Chicago; 11:15 a.m., official visit to convention by the Ladies' National Auxiliary; 11:30 a.m., Memorial services; 1:30 p.m., business session, legislation committee reports; 3 p.m., topical discusion on "Capacity and Maintenance Costs" opened by Charles A. Cahill, consulting engineer, Milwaukee; 4:30 p.m., visit to some Milwaukee industry; 8 p.m., entertainment at the Auditorium by the National Exhibitors' Association. A special program is being prepared for the visiting ladies' comfort and pleasure.

Friday, Sept. 17, 9 a.m., business session, final committee reports, unfinished business, election of officers, election of the next place of meeting; 8 p.m., public installation of officers and annual ball at Auditorium.

THE AUDITORIUM, MILWAUKEE, WIS., WHERE ALL MEETINGS AND EXHIBITS WILL BE HELD

EDITORIALS

Convention of the National Association of Stationary Engineers

FOR the fourth time in its history the convention of the National Association of Stationary Engineers will be held in Milwaukee. The meeting next week will be the thirty-eighth annual convention of this body.

Both the business sessions and the mechanical exhibit promise to be among the largest in the life of the association. That there are approximately two-hundred and fifty booths at the exhibit, more than have appeared in any year since the outbreak of the Great War in Europe, is but one more of the many signs of the reorganization of business upon sounder economic lines than has been the rule in the troubled years of the recent past.

It is to be expected that high railroad passenger rates will keep at home many who otherwise would attend. But representation always is large. The technical papers sessions, started but a few years ago, have been more popular than many expected them to be. This year interest in these sessions promises to be greater than ever. A material increase in membership is one of the outstanding features of the year.

Has the Public a Right To Know What It Costs To Mine Its Coal?

A BIG principle is at stake.

Has the public a right to know how much it costs to produce the fuel upon which its existence depends and how much the producer realizes by its sale?

The Federal Trade Commission demanded this information for the public. The coal producers challenged the right of the Commission to demand it and procured an injunction by Mr. Justice Bailey of the Supreme Court of the District of Columbia restraining the Federal Trade Commission, "its members, agents, assistants, deputies and employees, from taking any steps or instituting or causing to be instituted any proceedings to enfore said order or to require the plaintiff to fill out and file the prescribed form of report."

Pending an appeal of this or a similar case to the United States Supreme Court, the Federal Trade Commission has issued reports based upon voluntary returns from a comparatively few operators. The summaries of the five monthly reports so far issued are as follows:

	Jan.	Feb.	Mar.	Apr.	May
Average Cost per ton f.o b. at mines	2.32	2.43	2.34	2.76	2.77
Average price per ton realized at mines	2.74	2.74	2.76	3.26	3.31
Number of operators reporting	1,589	1,431	1,068	812	680

It will be noticed that the number of operators voluntarily reporting has fallen steadily away, and the Commission in its last report announces that unless a sufficient number of reports are received to make the figures representative it will discontinue the issue of the monthly report until its authority to collect the information is affirmed or denied by the Supreme Court.

The decision of the court will be watched for with keen interest by those who are awake to the import of the issue involved. The relation to the industries, institutions and homes of the country of those who have fastened upon and undertaken to exploit the natural fuel resources of the nation are different from those of a vender of molasses taffy. The people are willing to leave the winning and distribution of their fuel supply to private enterprise so long as they are satisfied that it is done with a fair degree of efficiency and at a reasonable profit, but they have a right to know how much it costs and how much the producer and middleman are taking from them for it. And the question is vital to everybody whether he ever buys a pound of coal or not, for the cost of fuel enters as an element into the cost of manufacture and distribution of everything that he does buy.

It will be a momentous decision—let us hope that it will be right.

Connections Between Brushes and Brush-Holders

SPARKLESS commutation of modern direct-current machinery has been obtained by a very extended series of refinements in design. These refinements have been not only in the machine itself, but also in the brushes. The introduction of interpoles and compensating windings and a better proportioning of parts have played an important rôle, as also have improvements in commutator construction, but the development of brushes on a scientific basis has contributed to satisfactory operation of direct-current machinery as much as or more than any other feature. Although the modern brush may not be all that might be desired under all conditions, nevertheless it does meet a majority of applications satisfactorily. Future investigation by the various manufacturers will no doubt result in improved characteristics.

No matter how well a brush may be suited to a given application, it will fail to give good service if not properly applied and maintained. One of the frequent causes of brush trouble is high resistance between the brush and holder, either from loose or from improper connections. In this issue Warren C. Kalb's article, "Connections Between Brushes and Brush-Holders," very carefully analyzes the necessities of such connections. It is a generally accepted theory that in a clamp type of holder all that is required is to keep the brush securely fastened to the holder. However, the surfaces in contact with the brush will corrode to a greater or less degree and cause a change of resistance, which in turn will produce an unequal distribution of current in the brushes. The heating that results from this unequal distribution may be sufficient to destroy the characteristics of the brushes carrying the excess current and cause sparking. With the pocket type of holder lack of or improper connections cause a current flow from holder to brush that disintegrates both, and produces excessive heating, which destroys not only the brush characteristics but also the tension springs. This not infrequently leads to difficulties that can be remedied only by a complete renewal of the brush-holders. From

Mr. Warren's analysis it is evident to those who have had experience with direct current that many of the chronic cases of brush trouble can be traced directly to improper connections between brushes and brushholders, and that one of the most fruitful sources for maintaining satisfactory operation is to give careful consideration to the brush connections.

National Electric Safety Code Explanatory Edition

THERE have been promulgated in this country many different National codes of recommended practice in various branches of engineering. Representatives of these are the Boiler Code and Test Code of the American Society of Mechanical Engineers; Standardization Rules of the American Institute of Electrical Engineers; National Electrical Code of the National Board of Fire Underwriters; National Electrical Safety Code of the Buerau of Standards. The revised edition of the last-mentioned is to be issued some time during this year. No matter how carefully a code may be prepared, it is almost impossible to express the true meaning of every item in words alone. Proof of this is found in the application of some of the codes now in use. Not infrequently those who have to be guided in their work by the rulings misinterpret them or the inspector in one district will put upon a certain rule a different interpretation from that held by an inspector in another locality. Such practices lead to confusion, delays, unnecessary expense and dissatisfaction and are detrimental to the proper harmony among those who are to be guided by the code and those intrusted with its enforcement.

There have been published at various times interpretations of the different items in a number of these codes, which show by illustrations what the authors who formulated the rules had in mind and how they intended the regulations should be applied. This has generally been further elucidated by illustrations of examples of the best practice in applying the rules. Those who have availed themselves of these explanations appreciate their great value in properly interpreting and applying the regulations in their work. It has recently been announced that the Bureau of Standards, Washington, D. C., has under advisement the preparation of a pictorial edition of the National Electrical Safety Code, in which the meaning of the rules will be shown largely by illustration. The value of such an edition in applying this code can hardly be overestimated. There is probably nothing that could be done that would do more toward popularizing the use of the National Electrical Safety Code than the publication of this explanatory edition.

Price Relief Slow but Steady

THESE are times when everything costs a lot of money. Whether one goes to buy a center punch or a house, one is astounded at the price demanded. It was a little more than a year ago that President Stone, of the Brotherhood of Locomotive Engineers, in a letter to President Wilson, stated that his men did not ask for more wages, but urged immediate action to the end that the cost of living be lowered. Since then there have from time to time appeared reports and interviews that at last prices were coming down. Disappointment, not relief, usually followed. So many times has this happened that people have become suspicious or look for increases every time prices are reported as falling.

But a new situation has developed. Prices of raw materials are on the decline, and generally, the price curves will continue in that direction despite the increase in freight and passenger rates. High labor charges will, of course, continue as one of the great factors in keeping prices high. In this connection, however, it is of interest to note that last month immigration into the United States from Europe was higher than at any time since the war. This increase, if long continued, would doubtless affect the labor market, both skilled and unskilled.

Economic recovery from such a colossal upheaval as the Great War of necessity is slow. Reports from Europe show the several countries there to be steadily coming back to normal. America's recovery is probably the most rapid of all. The effect will be to lighten the cost burden in the power plant and to relieve the engineer-in-charge of the many additional worries he has been subjected to these three or more years. But relief will not come hurriedly, though it comes steadily.

Who Gets It?

THE average cost per ton of bituminous coal f.o.b. at the mines as voluntarily reported by some of the operators varied from $2.32 in January to $2.77 in May of this year.

The annual report of the Board of Public Works of Pawtucket, Rhode Island, gives the price per ton of coal used for its pumping stations during 1919 as from nine dollars to ten dollars and a half.

The Public Service Corporation of New Jersey, in petitioning for authority to increase the price of gas, urges as one of its reasons that it is obliged to pay fourteen dollars a ton for coal.

Mayor Creamer of Lynn testified before the Senate Investigation Committee that coal operators with whom the city had contracts at around nine dollars per ton could not fill their contracts at that price, but would sell them quantities of coal at sixteen dollars.

Admiral Benson, chairman of the Shipping Board, says that the board is paying from eighteen to twenty dollars a ton for bunker coal at Atlantic and Gulf ports.

You know how much you are and have been paying.

You know, or can easily find out, the freight rate from the mines to your plant.

Who is getting the difference?

And why are they allowed to continue to get it?

Almost all means for speeding up transportation and increasing the efficiency of transmission of intelligence have been utilized in the construction and operation of power systems. Wireless telegraphy and telephony have already found a place on some power systems for emergency transmission of messages. The latest acquisition to transportation in power-plant construction is the airplane, as is now being used by a construction engineer on one of the large systems on the Pacific coast. This is a beginning. How far can it be applied?

What is high speed for power machinery? Not so long ago it was a few hundred revolutions. However, with the introduction of high pressure steam and the steam turbine, there seems to be practically no limit except the rate at which steam will flow through an orifice. The speed at which some modern steam turbines operate would a few years ago have done justice to the vivid imagination of a mind like that of Jules Verne.

CORRESPONDENCE

Attention to Details

The engineer must get out of the old rut of letting things slide along in the easiest way if he wishes to remain in the good graces of his employer and rise in his position. Attention to the little details and keeping the engine and boiler room neat and clean will impress an owner or manager as much as ability to repair a breakdown in a rush or skill in operating. In fact, breakdowns are not tolerated in the modern plant except in the most extreme cases, and economical operation is paramount.

The engineer can, if he will, save his employers considerable money by doing some of the little things that in many cases are turned over to outside help. Take the piston rods of boiler-feed pumps, for instance. I have found them badly worn, with shoulders at each end, and instead of sending them to a shop to be turned up I have done a very business-like job with a file and made them last twice as long before sending them out for repairs. If the piston rings of the steam cylinders are too loose and leak steam, take them out and peen them lightly all the way around on the inside with a ball-peen hammer. This will expand and set them out against the cylinder wall and make a tight fit. The hammer should be used very lightly or else the rings will be expanded too much.

More or less trouble is caused by the locknuts on the piston rod in the water end of pumps coming loose. This can be prevented by drilling a hole through the rod just back of the outside nut and inserting a cotter pin or a copper wire to keep the nuts in place.

In one plant that I was operating two pumps were taken from another plant and installed for boiler-feed service. The brass valve cages of these pumps were loose when received, and the bonnets of the pumps were so badly worn that the cages would leave their seats. I drilled holes in the edge of the cages and tapped them for countersunk screws, but this did not prove a success. I then had a ⅛-in. brass plate cast which took in the whole top of the pump and fitted over the cages. This held the cages in place, and the pumps were practically as good as new.

Vacuum pumps to work successfully need constant care. Particular attention should be paid to pumps with piston steam valves. These need more oil than any other pump I have had experience with. In many cases I have taken such pumps apart when they were not working just right, and all they needed was a little more oil.

Care should be taken not to run a vacuum pump too fast. If this is done and you lose the head of water, so to speak, in the system the pump will almost invariably give trouble. In making this statement I have particular reference to a heating system where a fan or blower is used and where the vacuum pump lines are in direct connection with the manifolds. In this case it is necessary to have water in the lines, otherwise air will be pulled into the system.

In a system of this kind I had considerable trouble with the manifolds and steam coils becoming airbound. I remedied the trouble by drilling and tapping each manifold for a ¼-in. pipe. At the end of the header I placed a regulating valve to control the outflow, which was run into the air duct. By properly manipulating this regulating valve so as to keep up a slight circulation from each header, I had no further trouble with cold coils or manifolds; all of them were of even temperature, and it was surprising how much hotter the air was when it entered the shops.

In shops where a large amount of heat is required it is necessary to be on the job during cold weather, especially if it gets down toward zero. One must know just how fast to run the fan engines to maintain the maximum temperature and obtain the most economical operation. Many engineers seem to think that the faster a blower engine is run the more heat will be delivered, but this is not so. If a certain speed is needed the temperature of the hot air entering the shops will be lowered. In heating buildings at night with live steam considerable fuel can be saved by connecting all the pump exhausts directly into the feed-water heater. I did this in one plant and raised the temperature of the feed water 60 deg.

It is evident that in any large plant the engineer has got to be on the lookout all the time for opportunities to improve the service or the operating economy of the plant. Slipshod methods and guesswork are things of the past. Cleanliness, neatness, attention to details and a wideawake attitude must be cultivated by the man who would succeed in this field. C. MOLTERN.

St. Bernard, Ohio.

Trouble with Loose Piston Head

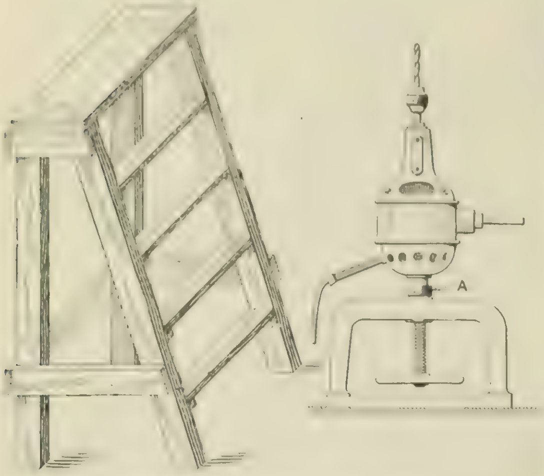
Referring to the questions asked by Thomas W. Airey, on page 149 of the July 27 issue, I think that it would have been better to have made the rod with the same taper and with a shoulder on the rod instead of giving it more of a taper.

The advantage of heating the piston and putting it on the rod while hot would be that with the rod cool and the piston hot and a good fit, it would contract and be much tighter when cool. D. G. SIMMONS.

Hudson, N. Y.

Device for Overhead Drilling

The illustration shows a kink that I used for overhead drilling. I had more than a thousand holes to drill, and I found that this apparatus did the work very quickly. An old copying press was used; the plate was discarded and the screw and wheel reversed, as shown. At *A* a coupling sleeve was made to fit on the screw and the electric drill. After removing the breast plate, the sleeve was easily made to fit in its place. The press was placed on the stand when drilling.



RIG FOR OVERHEAD DRILLING

Pontiac, Ill. **FRANK GIFFORD.**

Where Should the Beginner Start?

On page 229 of the Aug. 10 issue of *Power* J. A. Lane has opened up an interesting subject in relation to where a beginner should start. But there is a question as to how many young men who, having spent their allotted time in the engine room, would go firing? Mr. Lane is correct in saying that they would be right in their glory to start in the engine room, but it is a safe bet that most of them when they see a fireman all black and sweaty, would say, "Not for mine." On the other hand, if all firemen knew as much about their boilers as engineers are supposed to know, there would be fewer accidents. I once had a fireman working for me who had been on that same job over twenty years and he could not put in a gage glass. He did not know what caused the draft, and he said that the ball on the safety valve lever weighs 300 pounds.

Where licenses for engineers and firemen are required, the young engineer and fireman must necessarily know their business, but in a no-license territory one finds some funny stunts. I live in a no-license district and once saw an engineer at a 550-volt direct-current switchboard close a main switch and then close the circuit breaker. It was just his bullheaded luck that the breaker stayed put.

I have been at the game less than four years and obtained my experience by traveling from plant to plant. Some say, stick to one plant. Very good, but in that case you know only what is in that plant. Outside of actual service, study and reading are the greatest help a young man can get. If the engineers of the present day were really engineers, they would use coal economically. You will see more economical operation in the one-man plants than you sometimes do in the plants carrying firemen. Why? Because where a man is his own engineer and fireman, he just naturally knows what he is doing.

It is a practice in some plants to employ illiterate and ignorant foreigners as firemen. This should be stopped. Why should an engineer be required to hold license and then have to be the brains of some foreigner fireman? There is no justice in it for the engineer.

Taking it all in all, the proper place to break in a beginner is in a power plant where he will eventually learn to do his own repair work. There are already too many plants sending outside for repairs when a really wise engineer could save that expense, provided the firm employing him supplied a few tools. C. F. **DEWEY.**

Sidney, Australia.

Coal Versus Oil Performance Chart

One of the first questions asked when it is suggested that a change in fuel be made from coal to oil or vice versa in a power plant, is whether it will pay to make the change or whether the cost of evaporation will go up or down. Calculations are usually made to determine the relation or relative value of the fuels in question, making use of the cost per ton of coal delivered at the plant, its heating value and the efficiency of the boiler plant when burning coal in the one case, in comparison with the results determined by making use of the density of the oil fuel, the heating value per barrel, the cost per barrel delivered and the efficiency when burning fuel.

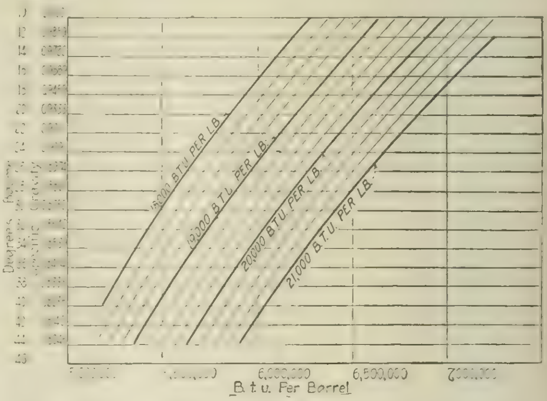


FIG. 1. HEAT CONTENT PER BARREL FOR VARIOUS GRADES OF FUEL OIL

Everything except the efficiency when burning either one or the other fuel is known. In burning coal the efficiency obtained is known while it is problematical just what the efficiency will be when changed to oil burning. With large boilers, properly equipped with well-designed furnaces and burners it is possible to obtain an efficiency of 82 per cent. This, of course, will not ordinarily be obtained under actual operating conditions, but during test conditions when the operation is very carefully watched. Poor furnace conditions and operation will reduce the efficiency of an oil-burning plant lower than if coal were used. So it can be said that under favorable conditions a higher efficiency can be obtained when burning oil than when burning coal, but it is unlikely in average plant operation that the efficiency when burning oil will be greater than while burning coal.

However, the matter of efficiency is one for each plant operator to decide for himself, as he is the one who knows what conditions are in his plant, and consequently can best say what efficiency may be expected.

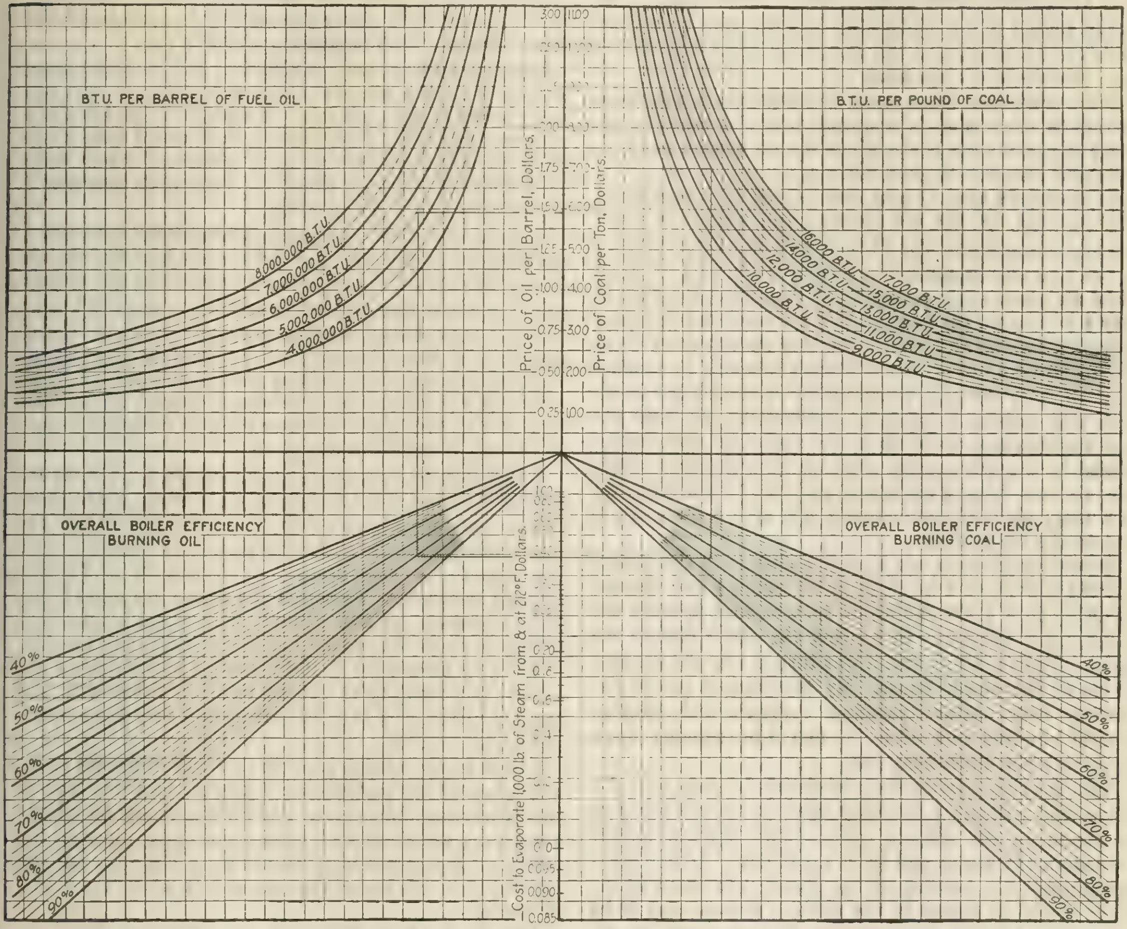


FIG. 2. COAL VERSUS OIL PERFORMANCE CHART

In making use of the accompanying chart, it is left to the operator himself to decide what efficiency he will get when changing from one fuel to the other. He should, however, be sure of his figures before making a change and also to be sure that an ample supply of fuel oil will be obtainable.

To make use of the chart, first determine the B.t.u. per barrel of the oil in question from the density-heat content chart, Fig. 1. Then referring to the coal vs. oil chart, Fig. 2, start at the cost per ton of coal and follow a horizontal line until an intersection is made with the B.t.u. per pound of coal; then follow a vertical line until intersecting the line representing the efficiency when burning coal; from this point proceed to the left, and the cost of evaporating 1,000 lb. of water from and at 212 deg. F. will be found. Proceed still farther to the left until intersecting the line representing the efficiency when burning oil; then follow a vertical line up until the curve representing the B.t.u. per barrel is reached; then follow a horizontal line to the right to the vertical line through the middle of the chart, and the cost per barrel of oil will be found which equals the cost of the performance using coal. The plotting line shown in Fig. 2 is made with the following assumption: Coal, $7 per ton; boiler efficiency, 70 per cent; B.t.u. per barrel of fuel, 5,500,000.

If the cost of oil is less than determined by the chart in the foregoing manner, it will pay to change to oil (not considering anything but cost of fuel). If not, it will, of course, be better to continue burning coal.

If burning oil, tracing lines around the chart in the opposite manner, starting with the cost per barrel of fuel and ending with the cost per ton of coal, will show what priced coal is equivalent to the oil being used.

L. C. Lichty,
Assist. Prof. Mechanical Engineering
University of Oklahoma.

Norman, Okla.

Practical Fuel-Conservation Methods

Some time ago I took charge of a small plant, and in order to show what a little attention to details will do the results obtained are herein related.

The boiler-grate area in this particular case was much greater than the load demanded. A convenient means of controlling the damper from the front of the boiler was the first thing to receive attention, which was accomplished by placing a notched plate in front of the boiler, the notches being spaced two inches apart. The fires are carried from three to four inches thick. The stoker engine is run slowly, the fires are kept free from clinkers and ashes, and the damper is about two inches open practically all the time.

Some engineers recommend, in cases where the grate surface is more than is required, that the ashes be allowed to accumulate part way up on the grates, but I do not think that this is good practice.

In March 68 tons of coal was burned in a new plant just starting up, but not running full time. In April the coal consumption was 70 tons, with but little increase in the load and production By the latter part of April I had all steam pipes covered, and beginning the first of May I instructed the firemen how I wanted the furnaces operated. During this month the coal consumption dropped to 60 tons, with a considerable increase in production. In June the coal consumption remained the same, with still greater increase in production. In July the coal consumption went up to 66 tons, but was accompanied by a much greater increase in production. This goes to show what a saving of coal can be accomplished in a large plant if the engineer will give a little attention to the boiler room.

A number of years ago I made a change in the steam-heating system of a large plant of which I had charge, resulting in a great saving of fuel, besides keeping the shops much warmer. In heating the shops during the night with live steam, steam was turned into the exhaust mains at the power house. By the time it got to the heating coils, after traveling through and heating several hundred feet of 5-, 7- and 8-in. exhaust lines, there was not much heat left.

This heating system had been run in this way for years, and without a reducing valve to control the flow of steam to the exhaust lines. The fireman simply turned on the steam and let it go at that. If the night fireman felt like keeping up the pressure to about 95 lb., there would be steam in the heating system, but if he got sleepy and let the pressure drop to about 50 lb., the shops would be cold the next morning.

All I did to remedy this was to run a 1-in. steam pipe from the line supplying the blower engine of the heating coils directly into the coils, with a reducing valve in this pipe. This required but little piping and we obtained excellent results, the shops being warm every morning. After piping all the heaters in this way, I made a rough two-hour test on a mild day in February, which was hardly long enough to tell anything about it, but it served to give a line on what was being accomplished. By turning the steam direct into the heating coils at about two pounds pressure, we burned 1,980 lb of coal with a feed-water temperature of 186 to 188 deg. F. By turning the steam into the exhaust mains at the power house at about three pounds pressure, we consumed 3,300 lb. of coal with a feed-water temperature of 202 to 204 deg. In two hours' run there was a saving of 1,320 lb. of coal and in a twelve-hour run at night, using live steam, there would be saved at the same rate about three and a half tons of coal. In zero weather the saving would be considerably greater.

Cincinnati, Ohio. **C. Mottern.**

Superheated Steam in Small Plants

About ten years ago the company by which I am employed built a new steam plant, and I was sent from the machine shop to erect and operate the plant, which was to run with 120 lb. steam pressure and superheated 125 deg., making a total temperature of 475 deg.

Superheat was a new one on me, and as there were no plants in the vicinity using superheat, it was not long before I was getting all kinds of advice from various engineers. I was told that it would take three times as much cylinder oil as if saturated steam were used, that soft packing would not hold at all and that I would have to use a special oil.

The engines were of the four-valve piston type and I surely did give those engines oil for the first few weeks. I took the cylinder heads off every other day for several weeks to see if they were getting enough oil, and I soon found that superheated steam was not as bad as it was supposed to be. The piston-valve engines have stood up very well and show just as good a diagram as when new. The plant has been enlarged several times with new boilers, but second-hand engines of different makes and types of valves were put in.

I expected to have some trouble with a 16 x 14-in. engine that had four flat balanced valves. The steam valves were operated by a Rites governor, and the exhaust valves by a separate eccentric; the engine ran at 250 r.p.m. and was directly connected to a 100-kw. 110-volt generator. Although the valves are quite large and I expected to have trouble with their lubrication, to my surprise the engine has never given any trouble.

We also have a 10 x 10-in. duplex steam-driven air compressor running at 175 r.p.m. It is fitted with the regular unbalanced D-slide valves, and they have never given any trouble.

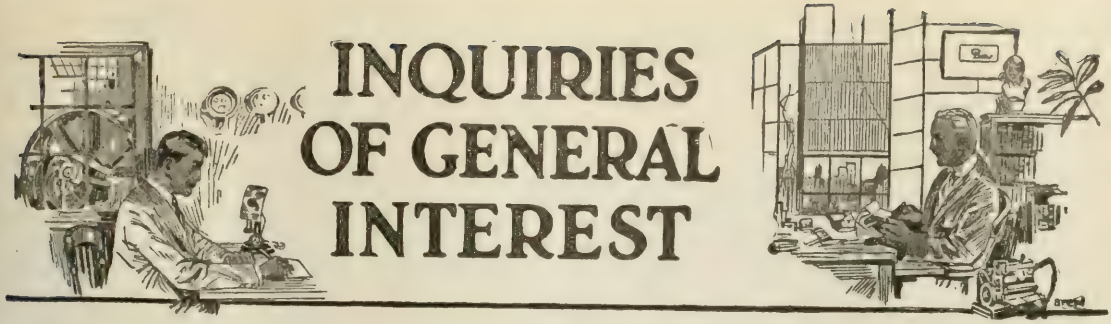
I have experimented considerably with different kinds and types of lubricators, and I prefer the force feed to the hydrostatic lubricator. The oil discharges on all our lubricators are fitted with home-made spray pipes on the inside of the steam pipe, to assist in breaking up the oil, and enter the steam pipe about 4 ft. above the throttle valve.

The 16 x 14-in. engine is the only one that uses metallic packing; all of the others are packed with asbestos piston-rod packing.

I think there are many engineers and small-plant owners who are in the same boat I was. When they think superheated steam they think of trouble, but I know from experience that the average slide-piston and Corliss-valve engine will stand 475 deg. heat with no more and perhaps with less trouble than would be experienced with saturated steam.

The first superheaters have been in use about ten years and have never cost one penny for repairs. The temperature is very uniform, never varying more than a few degrees. The dust or soot is blown off every other day with a steam lance, which takes only a few minutes for each boiler. **Joseph Gerber.**

Dansville, N. Y.



INQUIRIES OF GENERAL INTEREST

Solid Piston and Built-Up Piston—What is the difference between a solid piston and a built-up piston? W. E. T.

When a piston is of one piece, whether cast solid or hollow, it is usually termed a "solid piston." A built-up piston is one that is built up of a number of parts and usually with facility for adjustment at right angles to the cylinder center line.

Leakage of New Corliss Valves—After having valve seats of a Corliss engine rebored and new valves fitted, we are disappointed to find considerable leakage. How can the trouble be remedied? B. R. T.

The valves become warped from heat of the steam, and the high spots shown by the wear should be taken down by a good job of draw-filing. The valve should be examined after a few days' run and have any remaining high places removed with a smooth file or scraper and if the work has been carefully done the valves will soon come to a permanent good bearing.

Preference of Poppet Valves for Superheated Steam—Why are poppet valves used on engines intended to be supplied with superheated steam? M. F. J.

Poppet valves are preferred because large valves and valves with rubbing surfaces, such as slide valves and Corliss valves, do not work well with highly superheated steam as warping of the contact surface from high temperatures and lack of moisture, which acts as a seal with saturated steam, leads to excessive leakage and, in addition, more or less difficulty is experienced in lubricating the sliding surfaces.

Trouble from Crumbling Firebrick—We are experiencing considerable trouble with the firebrick of a boiler setting. When a brick is barely touched, it falls to pieces. Would operating conditions be the cause of this? J. B. S.

If the firebricks disintegrate from alternate heating and cooling with gradual changes of temperature, they may not be of high enough grade for the type of furnace, kind of fuel and intensity of firing that is practiced. But firebrick of most any grade is likely to spawl and crumble if the brickwork of the boiler setting was not thoroughly dried out before the boiler was put into service, or if the setting is alternately exposed to firing and moisture, whether derived from damp air, steam or direct wetting by water.

Power Factor of Induction Motors—What would be a conservative value for the full-load power factor and efficiency of a 60-cycle two-phase 220-volt 450-r.p.m 3¾-hp. squirrel-cage motor of modern design? H. N.

Both the power factor and efficiency of a squirrel-cage induction motor are affected to a greater or less extent by the frequency, number of poles and length of gap. Motors operating on 60 cycles have a higher efficiency than when designed for 25 cycles, whereas motors with a large number of poles operate at a slow speed and have a low efficiency and power factor. The motor in question runs 450 r.p.m. on 60 cycles. Consequently, it has 16 poles, which is an exceptionally large number for a motor of its size and frequency. Therefore, the full-load power factor and efficiency will probably not be more than 75 per cent for either factor.

Limitation of Cutoff with D Slide Valve—Why is it not practical to use a D slide for a steam engine to cut off earlier than ½ to ⅝ stroke? H. C. C.

For cutting off shorter than ½ to ⅝ of the stroke, the angle of advance of the eccentric, the amount of steam lap, and the size of the eccentric must all be made very large, resulting in increase of valve friction and also in very early release and excessive compression.

Leaving Current Transformer in Circuit—Will a current transformer that has been connected to an instrument be injured if it is disconnected and left in circuit indefinitely with its secondaries short-circuited? V. K. S.

The resistance of the current coil of an electrical instrument designed to connect to a current transformer is very low, therefore when the secondary terminals of the transformer are short-circuited the resistance of the secondary circuit is not materially changed. The standard current transformer is designed for 5 amperes in the secondary when the primary is carrying full load. Since the transformer is connected in series in the circuit, the secondary current is limited by the primary current; consequently, if the secondary is short-circuited, the current will not exceed the value determined by the ratio of the transformer and will not be burned out if the secondary terminals are short-circuited. On the other hand, if the secondary terminals are left open-circuited, when full load comes on there is danger of the transformer being destroyed, either from the high magnetic density in the core causing overheating, or the high voltage induced in the secondary may break the insulation down.

Sources of Engine Back Pressure—What are the causes of back pressure on an engine? R. G. L.

All conditions tending to raise the pressure of the exhaust steam, as by the addition of heat, compression, or obstruction to delivery into the atmosphere or condenser, are contributive to back pressure. Back pressure on the piston is increased by greater load on the engine, later release of steam after its expansion from tardiness in opening of the exhaust valves or earlier closing of the exhaust valve with increase of compression. Other causes contributive to back pressure are: Leakage of live steam past the piston or of the steam valve during the exhaust stroke; heat received by the exhaust steam from the cylinder walls; obstruction of the discharge through the exhaust port and passages, or connections and passages through an exhaust-steam feedwater heater; frictional resistance of the exhaust pipe due to bends and fittings and pipe friction that increases with the length and reduction in size of opening of the exhaust pipe; obstruction of the discharge by a condenser head or a back-pressure relief valve; and the pressure acquired for overcoming the pressure of the atmosphere or that of a condenser into which the exhaust is finally discharged and absorbed.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

American Chemical Society

In connection with the American Chemical Society meeting in Chicago the week of Sept. 6, an extended series of papers will be presented on fuel problems. The headquarters of the society will be the Congress Hotel, Chicago, but the Fuel Symposium will be held in the laboratories of the University of Chicago on Thursday afternoon, Sept. 9, under the chairmanship of A. C. Fieldner. The following papers will be presented: S. W. Parr, "Low Temperature Carbonization"; Edgar Stansfield, "Carbonization of Canadian Lignites"; Henry Kreisinger, "Byproduct Coke, Anthracite and Pennsylvania Coal as Fuel for Heating Houses"; F. W. Sperr, "Byproduct Coking"; G. A. Burrell and others, "The Charcoal Method of Gasoline Recovery"; S. E. Sheppard, "Colloidal Fuels—Their Preparation and Properties"; A. C. Fieldner and others, "Gasoline Losses due to Incomplete Combustion in Motor Vehicles"; J. B. Garner, "Enrichment of Artificial Gas with Natural Gas"; Harry A. Curtis, "Commercial Realization of Low-Temperature Carbonization of Coal"; H. C. Porter, "Fuel Conservation, Present and Future"; Alfred B. Powell, "Some Factors Affecting the Sulphur Content of Coke and Gas in Carbonization of Coal"; H. F. Yancey and others, "Distribution of the Forms of Sulphur in the Coal Bed."

Water-supply problems will also be considered by the society in connection with the meetings of the Division of Water, Sewage and Sanitation. A. S. Behrman will discuss the question of "Water Softening for the Manufacture of Raw Water Ice," and W. D. Collins will give a report from his work in the United States Geological Survey on the subject, "Hardness of Surface Waters in the United States."

The general sessions of the society will deal with the problem of increased production by industries. "The Relation of Educational Institutions to Industries" and "The Value of Technical Training in Reconstruction of Industries" will be discussed respectively by Prof. H. P. Talbot, of the Massachusetts Institute of Technology, and Thomas E. Wilson, president of Wilson & Co. of Chicago.

Westinghouse Scholarships

The War Memorial Scholarship Committee of the Westinghouse Electric and Manufacturing Co. has announced as the winners of the four scholarships for the coming college year, 1920-21; Alva C. Corrao, Small Motor Drafting Department; Henry Gardiner Symonds, son of N. G. Symonds, Manager Industrial Sales Division, Chicago Office; J. Dale Seabert, Transformer Engineering Department; and Herbert R. Hillman, son of William A. Hillman, who has been a machinist in the works of the R. D. Nuttall Co. for 27 years. These War Memorial Scholarships were established in 1919 as a means for perpetuating the memory of those employees of the Westinghouse Electric and Manufacturing Co. and its subsidiary companies, who took part in the World War. Each Scholarship carries with it an annual payment of $500 for a period not to exceed four years. The payment is to be applied toward an engineering education in any technical school or college selected by the successful candidate and approved by the Scholarship Committee. Scholarships are granted for one year only, but are continued for the full course provided the scholar maintains the academic and other standards required by the institution.

The average production for each underground worker employed in the coal mines of the United States during 1918 was 1,134 short tons according to statistics given out by the Bureau of Mines, Department of the Interior. The closest competitor of this country is New South Wales where each underground worker in 1918 produced 814 tons. British Columbia ranked third with 790 tons and Nova Scotia was fourth with 718 tons. The smallest individual output for recent years was that of Japan in 1917, when an average of 155 tons was mined by the underground employees.

Bituminous Prices Decline

The coal situation is better than it was a few weeks ago. More cars are available, production in most fields has been higher, and prices in some sections are lower. Of course there are exceptions, as in Cleveland, where the deadlock reached between operators and union heads has had an unfavorable effect upon mine labor, resulting in intermittent strikes and general dissatisfaction. In St. Louis the steam situation is fairly satisfactory, but stocks are on a day-to-day basis except in the case of a few big plants and the public utilities. The car scarcity seems to be most acute in the Birmingham district, the Southern Railway furnishing only 25 per cent of the number needed. The Louisville & Nashville R.R. on the other hand has been able to supply 100 per cent, while the Frisco is supplying 70 per cent of the cars required in the field it serves.

EASING UP ALONG ATLANTIC SEABOARD

The Boston market can be measured by the day-to-day quotations on spot coal. In the last week pool 11 grade declined $1.25, the last price offered being $9.50. Prices down to $7 at mines have been rumored on coal for shipment via Tidewater, but there appears to be very little buying interest owing to contracts that the manufacturers have with the mines. The only traffic restriction in effect at present is an embargo against coal moving via West Albany for B. & M. and N. Y., N. H. & H. destinations.

A better car supply has resulted in increased shipment and lower prices. Pool 10 was quoted at $9 to $10 at mines and about $16.50 alongside dock. For Pool 11 mine quotations ranged from $8.50 to $9 and $16 alongside.

Prices began to settle gradually in Philadelphia three weeks ago and the decline continues. Pennsylvania steam coal is available at about $11 at mines. Grades are again regrouping themselves, indicating that the market is becoming more regular.

A better run of cars and the curbing of speculation has produced a weaker market in Baltimore. Coal is selling at the mines at $9.50 to $10 per net ton for best fuels on the B. & O. R.R. Similar coals on the Pennsylvania R.R. delivery connections sell on a mine basis of $11 to $13.

INLAND PRICES ARE FIRM

The Chicago market is spotty. Some of the Franklin County operators have raised prices, one firm selling Franklin County prepared coal through its regular channels on the basis of $5.50 f.o.b. mines, which is about $1 higher than the price asked by other Franklin County operators. Southern Illinois open-market prices are much higher. The car supply is much improved as is also the time in transit of coal from mines through to destination. Eastern coals are coming into the Chicago market in greater volume than expected. Pocahontas coals sell at retail for $12 to $15.

Cincinnati coal companies that receive their fuel by boat have not increased prices. The net increase in the rail freight from the West Virginia mines to Cincinnati is 61c. per ton, and on anthracite $1.73 per ton There are ample stocks and no complaints from industries or public utilities.

Reports from Columbus state that production has increased in all districts owing to an improved car supply. On the Hocking Valley R.R. the supply was almost 100 per cent; on the Toledo & Ohio R.R. the supply also was good, while Eastern Ohio is credited with about 64 per cent, which is a marked improvement. The advanced freight rates were expected to have some influence on prices, the increases being 40c. from the Hocking Valley and 66c. from the Kanawha field.

In the Middle West prices are as follows: Franklin County and Southern Illinois prepared coals, $4.75 to $8.50; Springfield District, $6.25 to $8.50; Northern Illinois thin vein coal, $5.75 to $7.50; Clinton Fourth Vein from Indiana, $4.50 to $8; Indiana Fifth Vein, $4.25 to $7.25.

Difficulties with mine labor in the Middle West have been settled for the present, and early last week the men began going back to work both in Illinois and Indiana. On Aug. 25 practically all the larger mines were working The demand for coal in the Middle West is as heavy as ever and the market prices on all grades are reported erratic.

Obituary

Professor John Perry—The death of Professor John Perry in his seventieth year, on Aug. 4, recorded the passing of one of England's foremost engineers and authors. His books, papers and lectures on engineering subjects have been widely read, and he contributed during his long period of service in no small measure to the advancement of engineering knowledge. Professor Perry was born in Ulster, in 1850, and received his technical education at Queen's College, Belfast. From 1870 to 1874 he was assistant master in Clifton College. He resigned and became professor of engineering in Japan, where he remained until 1879. Between the years 1879 and 1895 he accepted the position of professor of engineering and mathematics, City and Guild of the London Technical College, and later professor of mechanics and mathematics in the Royal College of Science, South Kensington. He was actively associated with many engineering societies. He was a past president of the Institution of Electrical Engineering and past treasurer of the British Association. He was the author of a number of books, including "The Steam Engine," Practical Mechanics," "Hydraulics," "Applied Mechanics" and many others.

Personals

Irving C. Baker is now plant engineer for the Maryland Motors Corporation, Laurel, Md.

The Charles T. Main organization includes in its personnel William Frank Uhl, as hydraulic engineer, and Charles R. Main, as special assistant.

Herman B. Scharnberg has resigned his position with the Haitian American Corporation and has taken the position of chief engineer with the Palma Sugar Co., Central Palma, Oriente, Cuba.

Louis H. Blood has resigned as chief engineer of The Oesterlein Machine Co., and has opened an office in Cincinnati as designing engineer, specializing on the design of standard and special machine tools.

Walter Rautenstauch, professor of mechanical engineering, Colubia University, has recently joined the J. C. White organizations as vice president of The Management Corporation, in charge of Industrial properties.

Milton C. Stuart, formerly senior mechanical engineer at U. S. Naval Engineering Experiment Station, Annapolis, Md., has been appointed professor of mechanical and marine engineering at the Naval Postgraduate School, Annapolis, Md.

Wallace E. Tillinghast, managing owner. Massachusetts Steam Specialty Co., will be in direct control and supervision of the department of diplomatic and advisory engineering which that company has recently organized.

William D. Ennis announces his resignation as professor of mechanical and marine engineering in the Postgraduate School of the U. S. Naval Academy to become vice president of the Technical Advisory Corporation of New York. Mr. Ennis has been associated with the latter corporation since its organization and will hereafter be located at its general offices in New York City

C. W. Willette, after many years of investigation and study of the requirements on the Pacific Coast, has brought out an entirely new type of sawmill machinery, and has concluded a contract with the Puget Sound Machinery Depot, of Seattle, Wash., for the manufacture of this machinery, in connection with their own, under his personal supervision as chief engineer of the milling department. Mr. Willette is located in Portland, Ore.

General George H. Harries and **Samuel E. Doane** are among the newly elected officers of the Illuminating Engineering Society, who will assume office in October. General Harries has been prominent in the electrical field for over twenty-five years, engaging in electrical engineering and construction. Mr. Doane is also well known in the electrical field, having specialized in standardization work, one of his papers on this work being instrumental in the establishment of the Bureau of Standards. General Harries, as new president of the Illuminating Engineering Society, and Mr. Doane, as junior past-president, will both serve on the Council of the Society for the coming year.

Charles Whiting Baker, for many years editor-in-chief of *Engineering News* and since 1917 consulting editor of *Engineering News-Record*, announces his resignation and the establishment under his direction of The Engineering Business Exchange, 31 Nassau St., New York. The new firm will act as a clearing house for those having an engineering or technical business for sale, and others who are interested in considering an investment in such properties. Mr. Baker is a graduate of the University of Vermont, class of 1866. After graduating, he became an associate editor of *Engineering News*. In 1895 he became editor-in-chief, acting as such until 1917, when he was made consulting editor of *Engineering News-Record*. He is a member of the American Society of Mechanical Engineers, of which he was vice president from 1909 until 1911; American Society of Terminal Engineers, vice president, 1919-1920; Engineering Council since organization in 1917, representing A. S. M. E., Chairman Committee on Public Affairs; secretary, Council's Committee on Classification and Compensation of Engineers and of the Executive Committee National Public Works Department Association.

Society Affairs

The New England Section of the National Electric Light Association will hold its annual convention at Kineo, Maine, Sept. 13 to 16 inclusive.

The Association of Edison Electric Illuminating Companies will hold its annual convention at the Hotel Griswold, New London, Conn., Sept. 13 to 16 inclusive.

The Illuminating Engineering Society, fourteenth annual convention will be held at Cleveland, Ohio, Oct. 4 to 7. A number of interesting papers will be read including, "Central Station Methods for Securing High Lighting Standards in Stores and Homes," and "Central Station Experience in the improvement of Factory Lighting."

The Pennsylvania Electric Association will hold its annual convention at Bedford Springs, Pa., Sept. 8 to 11. At the technical session on Sept. 10 the following addresses and papers will be delivered: "Coal Sunply and Distribution," address by J. D. A. Morrow; abstract of the report on Power Factor, as prepared by representatives of the Philadelphia Electric Co., "Coal Storage," address by O. P. Hood, Chief Engineer, Bureau of Mines, Washington, D. C.

The American Association of Engineers, in continuation of plans inaugurated last year by a number of chapters, is planning educational courses, which will place at the disposal of members a variety of courses not usually accessible to engineers. The Twin City Chapter has arranged with the general extension division of the University of Minnesota to form evening classes in various subjects. The classes will be instructed by members of the faculty of the university and by the leaders in professional practice outside the university. Courses are offered in the following technical subjects: Architectural history, architectural design, freehand drawing, map drawing, surveying, railroad engineering, structural design, reinforced concrete, elementary electricity, direct and alternating current machinery, power-plant design, shop mathematics, applied mechanics, heating and ventilating, water power, municipal engineering and highway engineering.

The Sixth National Exposition of Chemical Industries will be held in Grand Central Palace, New York City, Sept. 20-25. On the afternoon of Thursday, Sept. 23, the Chemical Engineering symposium will take place. The American Institute of Chemical Engineers will hold a meeting in the Palace in the afternoon, and papers will be read. In the evening the engineers will have a dinner at the Technology Club. Three other symposiums will be held during the week. One will be on "Fuel Economy," one on "Materials Handling," and one on "Industrial Management." The Fuel Handling Division and the Material Handling Division have developed such progress that it is necessary to give each a separate section at the coming exposition. Important topics will be discussed on the days these two divisions meet.

Miscellaneous News

The Shipping Board announces that it has entered into a contract with the Atlantic Gulf Oil Corporation for supplying crude and fuel oil to be delivered over a period of one year beginning on or about Jan. 1, 1921, in cargo lots at the supplier's terminal, Tecomate, Mexico, as follows: 6,000,000 bbl. of fuel oil at $1.25 per bbl., including taxes; 9,000,000 bbl. of crude petroleum at $1.25 per bbl., including taxes. The Shipping Board is to provide the tank steamers to transport the oil.

The Narragansett Electric Lighting Co., of Providence, R. I., is planning to install a 45,000-kw. two element cross-compound Westinghouse turbine-generator. This unit will be operated at 210 lb. pressure, 125 deg. superheat and 28½ in. vacuum. The generator will be three phase 60 cycle 11,000 volts. To go with the generating unit, 36,000-g.p.m. twin jet condensers will be installed. These condensers will be steam-turbine and gear driven. The installation is interesting because the unit now installed is the largest generating unit in the world which is equipped with jet condensers. It will be remembered that the 45,000-kw. unit now installed at this station recently completed what is thought to be the world's record for a continuous run of large triple-expansion cross-compound turbine-generators. In fact, it has operated 84 days without being shut down.

New Construction

PROPOSED WORK

Mass., Cambridge—The A. R. Hyde Co., 432 Columbia St. had plans prepared for a 1 story, 20 x 40 ft. power house at its factory. Estimated cost about $20,000. Tuck & Gilman, 34 School St., Boston, Engr.

Conn., Middletown—A. Brazos & Sons, Inc., 68 Oak St., is in the market for a 50 or 60 hp. mounted boiler and an engine.

N. Y, Richmond—The Dept. Pub Welfare, Municipal Bldg, New York City, will soon receive bids for the installation of boilers in the present boiler house at Sea View Hospital, here. Former bids recalled.

Md., Baltimore—The American Can Co., 120 B'way, is having plans prepared for a factory including a steam heating system. About $500,000.

Md., Baltimore—Samuel T. Williams, 223 North Calvert St., is in the market for a steam heating boiler rating from 2100 to 2,500 sq.ft. capacity and a 2 stage, duplex, belt-driven air compressor, 270 to 400 cu.ft. of free air per minute to 100 lb. pressure.

Va, Fort Monroe—The U. S. Army, Construction Div., Wash., D. C. plans to build a new booster pump house here.

Va., Richmond—The Pearl Laundry, 6 South 12th St. is in the market for a 25 to 30 hp. new or used motor.

Va., Richmond—J. E. Candle, 316 North 3rd St., is in the market for one motor.

Va., Richmond—W. H. Sickel, 409 West Broad St., is in the market for electric motors.

Va., Richmond—D. Heyward, 715 West Broad St., is in the market for a 30 or 40 ton ice plant.

S. C. Charleston—The Bureau of Yards and Docks, Navy Dept., Wash., D. C. plans to make improvements to boiler plant here.

Fla., Jacksonville—The Florida Christian Home is having plans prepared for alteration of present buildings, installation of new heating plant, etc. About $50,000. J. H. Lynch & Son, Dolf Bldg., St. Louis, Mo., Archts. and Engrs.

O., Akron—The Loew Theatrical Enterprises, 1493 B'way, New York, N. Y. will soon award the contract for a theatre and arcade on South Main St., including steam heating system. About $500,000. C. Howard Crane, 2325 Dime Bk. Bldg., Detroit, Mich., Archt. and Engr.

O., Bellaire—The City plans to issue $30,000 in bonds to improve the waterworks system and purchase pumping machinery.

O., Carey—The city council plans to reconstruct the distribution system here. Plans will include either a power plant or the erection of transmission lines. About $90,000. Froehlich & Emery, 2nd Nat'l Bank Bldg., Toledo, Engrs.

O., Cleveland—J. H. Rooke, 507 Williamson Bldg., had plans prepared by W. W. Hodges, Archt. and Engr., Lennox Bldg., for a 4 story, 200 x 280 ft. factory, including steam heating system. About $250,000.

O., Cleveland—The City, care of G. Beck with City Hall will purchase wire, cables, transformers and equipment, meters and service equipment for the municipal electric light plant. About $100,000.

O., Columbus—The Cotter Warehouse Co., Schultz Bldg., is in the market for conveyors, portable elevators, etc., for its plant here. About $30,000. W. L. Cotter, Pres.

O., Lorain—The Bd. Educ. is planning to build a 3 story high school including steam heating system at East 31st St. and Seneca Ave. About $300,000. F. C. Warner, Hippodrome Annex Bldg., Cleveland, Archt.

Mich., Detroit—The Bd. Educ., 50 B'way, received bids for heating, ventilating and plumbing systems in the Leland School addition from the Drake Avery Co., 40 State St., at $91,915; for the Carstens School from W. J. Rewoldt, 506 Owen Bldg., $62,108, Irvine & Meier, 3289 Woodward Ave., $64,389; Copper School from J. W. Partlan, 51 Park Pl., $93,800; Crossman School addition from Drake Avery Co., 40 State St., $51,821, J. W. Partlan, 51 Park Pl., $53,886, O'Connor Bros., Owen Bldg., $54,195. Noted July 13.

Mich., Detroit—The city council has ordered estimates to be prepared for a proposed 2 story, 250 x 600 ft. memorial building, including steam heating equipment. John A. Kronk, City Hall, Chmn. of Comm.

Mich., Detroit—The Ft. Shelby Garage, care of John Gillespie, Ft. Shelby Hotel, plans to build a 4 story, 130 x 150 ft. garage on Howard and 1st Sts. Steam heating system, boiler, ash handling equipment, etc. will be installed. Albert Kahn, Marquette Building, Archt.

Ill., Granite City—The Bd. Educ. will receive bids until October 1 for a 3 story high school. Power plant for heating will be installed in same. About $225,000. William B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archt. Noted August 10.

Ill., Roscoe—The Rockford & Interurban Ry., Rockford, plans to install a transformer, here. About $4,500.

Minn., Bemidji—The Bd. Educ. plans to build a 3 story high school including steam heating system. About $500,000.

Minn., Minneapolis—The Franklin Co-operative Creamery Co., 26th St. and Franklin Ave., care of Edward Solem, 11½ Western Ave., has plans under way for a 1 story, 64 x 85 ft. creamery. About $25,000 to be expended on power and refrigerating equipment.

Kan., Dodge City—The Midland Ice & Light Co. will soon receive bids for a 1 story, 56 x 62 ft. boiler house. Mann & Gerow, Hutchinson Archts. H. A. Noble, 411 Reliance Bldg., Kansas City, Mo., Structural Engr.

Kan., Wakeeney—H. Long, city clk. will receive bids until September 17 for power plant, for providing necessary equipment including generators, exciters, etc. and furnishing labor. Black & Veach, Mutual Bldg., Kansas City, Mo., Engrs.

Mo., Kansas City—The Ford Motor Co., Highland Park, Mich. will soon award contract for a 1 story, 175 x 535 tractor assembly plant. Steam heating system will be installed. Albert Kahn, 58 Lafayette St., Detroit, Mich., Archt.

Mo., St. Louis—The Bowen Motor Railway Co., Title Guaranty Bldg., plans to build a factory and power house. About $385,000. O. J. Popp, Odd Fellows' Bldg., Archt.

Okla., Purcell—The city will hold an election soon to vote on $382,000 bonds for new water supply and filtration plant, improvements to the electric light plant, etc. Johnson & Benham, Firestone Bldg., Kansas city, Mo., Engrs.

Idaho, Boise—The Idaho Power Co. has been requested by residents of Wilder and Homedale to extend its transmission lines from here. Plans include sub-station, distribution system, 7.5 miles volt line, etc. Estimated cost about $51,000.

Utah, Brigham—The city plans an election on September 10 to vote $250,000 bonds for addition to municipal electric plant to increase capacity to 1,500 hp. C. O. Roskelly, Engr. Noted May 3.

Ore., Salem—R. B. Goodwin, Secy. Oregon State Board of Control, will soon award the contract for labor and materials for heating and plumbing systems in the 2 story dormitory to be built near here, for the State Institution for Feeble-Minded.

Ore., Salem—M. J. Anderson of Portland has applied to the state engineer for permission to divert water for the development of 13,000 hp. on the south fork of the Coquille River. Estimated cost of project about $750,000.

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received bids for cold storage plant at Marine Base here, from C. M. Gay Co., 2650 Sante Fe Ave., Los Angeles, $24,000; T. Haverty, 801 Maple St., Los Angeles, $44,000. Noted June 8.

N. B., St. John—The Dept. Pub. Wks., Ottawa, Ont. will soon award the contract for alterations and additions to the steam heating apparatus in the Immigration Building here.

Ont., London—Frank W. Ruggles, Alma, Mich. will soon award the contract for the first of a series of buildings for the manufacture of auto trucks to be built on East London St., here. Steam heating system will be installed in same. About $2,000,000.

Ont., London—The Utilities Commissioners are in the market for one electrically driven waterworks pump, capacity of 500,000 Imp. gal. per day. E. V. Buchanan, Hydro Bldg., Gen. Mgr.

Ont., London—Watt & Blackwell, Archts., Bank of Toronto, will soon award the contract for the construction of a 3 story, 55 x 165 ft. children's hospital for the Daughters of the Empire. Hot water system, 3 boilers, pumps, motors, etc. will be installed. About $250,000.

Ont., Newbury—The City Council plans to construct an electric light and power distribution system here and is in the market for material and equipment. About $10,000. Chas. Tucker, Engr.

Ont., Toronto—Mayor T. L. Church, room 12, City Hall, will receive bids until September 14 for two 300,000 Imp. gal. per day, vertical centrifugal pumps with electric motors against 320 ft. head.

Ont., Welland—The Joseph Stokes Rubber Co., Broad St. Bank, Trenton, N. J., plans to build a 120 x 160 ft. factory and a 50 x 50 ft. power house, here. Plans include installation of two 150 hp. boilers, 2 pumps, air compressor, etc. About $100,000. Karno-Smith Co., Broad St. Bank, Trenton, N. J., Engrs.

CONTRACTS AWARDED

N. H., Winchester—The Winchester Tannery Co. has awarded the contract for a 1 story, 40 x 52 ft. boiler plant to Robt. F. Carroll, Keene, N. H. About $20,000.

Mass., Westfield—The Certified Food, Inc., plans to build a 1 story, 50 x 100 ft. cold storage plant. About $30,000. Work will be done by day labor.

Conn., Bridgeport—The United Illuminating Co., 84 Temple St., New Haven, has awarded the contract for the superstructure of a 1 story, 140 x 150 ft. power plant on East Main St., here, to Casey & Hurley, 120 Pequonnock St. Total est. cost $1,500,000.

Conn., Middletown—The Goodyear Rubber Co., 114 Church St., has awarded the contract for a boiler house to D. O'Brien & Sons Co., Inc., 118 Asylum St., Hartford. About $50,000.

Conn., New Britain—The Connecticut Light & Power Co., 111 West Main St., Waterbury, has awarded the contract for a 1 story, 45 x 90 ft. sub-station on Church St. here, to Wm. E. Burk, 76 Robbins Ave. About $40,000.

N. Y., New York—The Menbridge Realty Co., care of Gronenberg & Leuchtag, Archts., 303 5th Ave., will build a 2 story, 100 x 115 ft. theater and showroom building, including steam heating system. About $250,000. Work will be done by day labor.

N. Y., New York—M. Klaw, Commercial Trust Bldg., has awarded the contract for a theater building on 45th St. between B'way and 8th Ave. to Jardin Co., Inc., 507 5th Ave. Steam heating system will be installed in same. About $300,000. Noted June 1.

N. Y., New York—The Lawyers' Mortgage Co., 59 Liberty St., has awarded the contract for an office building at Maiden Lane and Nassau St., including steam heating system, to Cauldwell-Wingate Co., 381 4th Ave. About $1,500,000.

N. J., Camden—The Victor Talking Machine Co., Front and Cooper Sts., has awarded the contract for a 1 story, 53 x 200 ft. power house to the White Construction Co., 95 Madison Ave., New York, N. Y. Noted Aug. 10.

N. J., Trenton—The Mutual Pottery Co., Clinton Ave., has awarded the contract for buildings from 1 story to 5 stories including power house to Stone & Webster, 120 B'way, New York, N. Y. About $500,000.

Md., Baltimore—The Coca-Cola Co., care of S. L. Willard, resident manager, Pratt St. and Market Pl., has awarded the contract for a 4 story 196 x 584 ft. coca-cola factory and cooperage plant, to A. Tufts Co., Chandler Annex, Atlanta, Ga. Steam or hot water heating system will be installed in same. About $1,250,000.

Tenn., Jacksonville—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for the removal of boilers from here and the re-erection of same at Portsmouth, Va., to Clarence J. Eisinger, 141 7th Ave., Brooklyn, N. Y., $33,136, 150 days.

Ky., Covington—The City Ice Co., 3210 Jefferson Ave., Cincinnati, O., has awarded the contract for a 42 x 136 ft. ice factory on 2nd and Scott Sts., here, to Wisenall & Bell, Covington. About $30,000.

O., Cleveland—The American Stove Co., Perkins Ave., has awarded the contract for a 1 story, 21 x 35 ft. boiler room at 43 Hough Ave. to the Boldt Constr. Co., 6110 Euclid Ave. About $10,000.

O., Cleveland—K. V. Painter, 6523 Euclid Ave., has awarded the contract for an 8 story commercial building on East 30th St. and Euclid Ave. to A. W. Kilbourne Co., 6523 Euclid Ave. Steam heating system will be installed in same. About $1,000,000.

O., Columbus—The Columbus Die, Tool & Machine Co., 955 Cleveland Ave., has awarded the contract for a 36 x 36 ft. boiler house to Chas. Snyder, 2535 Findlay Ave. Estimated cost $8,000.

Ind., Evansville—The Vendome Theater Co. has awarded the contract for a 2 story 145 x 190 ft. theater building on 3rd and Sycamore Sts. to M. J. Hoffman Constr. Co., Furniture Bldg. Steam heating plant will be installed in same. About $500,000.

Ind., Evansville—The Standard Realty Co. has awarded the contract for a 3 story, 110 x 180 ft. theater and hotel on 6th and Main Sts., to M., J. Hoffman Constr. Co., Furniture Bldg., $692,000. Steam heating plant will be installed in same. Noted August 10.

Ind., Indianapolis—The Methodist Hospital has awarded the contract for a 6 story, 80 x 170 ft. hospital addition on 16th St. to J. G. Karstedt Constr. Co., Lemcke Bldg. A vapor steam heating system will be installed. About $300,000.

Minn., Minneapolis—The Bd. Educ. has awarded the general contract for a 2 story, 8 room building of the Eugene Field School to F. N. Hegg, 2942 Nicollet Ave., at $76,995 and for heating, plumbing and ventilating to the Western Heating Co., 13 East 36th St., at $21,453.

N. M., Fort Stanton—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., has awarded the contract for the installation of a boiler and new system of piping, here, to Chris Irving, 1525 Larimer St., Denver, Col., at $12,584. Noted August 3.

Ont., London—The Benson Hines Hotel Co. has awarded the contract for an 11 story hotel including steam heating system on Richmond St. to George A. Fuller Co., 45 St. Alexander St. About $1,500,000.

PRICES-MATERIALS-SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire		50-Ft. Lengths
Underwriters' 2½-in.		85c per ft
Common, 2½-in.		30%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.60	$0.40	$0 30

Steam—Discounts from List

First grade	20%	Second grade	30%	Third grade	45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	30–10%		

LEATHER BELTING—Present discounts from list in fair quantities (½ doz. rolls):

Light Grade	Medium Grade	Heavy Grade
30%	25%	20%

RAWHIDE LACING
For cut, best grade, 25%, 2nd grade, 30%.
For laces in sides, best, 79c per sq. ft.; 2nd, 75c.
Semi-tanned: cut, 20%; sides, 83c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	1 70
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1 70
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1.50
Rubber sheet	50
Rubber sheet, wire insertion	70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0 27
2-in.	36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1 05

85% magnesia high pressure		List +5%
For low-pressure heating and return lines	4-ply	50% off
	3-ply	52% off
	2-ply	54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	8½	6.6	8@ 9	8½	13¼
Fiber or sponge	8½	8.6	12@ 15	8½	20
Transmission	10	8.1	12@ 15	8½	20
Axle	...	4.8	6@ 6½	5¼	7¼
Gear	6½	6.1	8@ 9	5¼	8½
Car journal	12(gal.)	4.7	23@ 25	8½	8½

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
White	15.00@ 17.00	13 00	16 00	11.00 to 14 00
Colored mixed	9.00@ 14.00	9.00 to 12.00	12.00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13¼	13¼ x 20½
Cleveland	$55.00	$65.00
Chicago	41.00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$1.25	$2.25	$1.67	$2.10
5-gal. cans	1.40	2.40	1.92	2.30

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	15.50	17 00	13 00	14 50	15 50	13 00
25- and 50-lb. kegs	15.75	17 25	13 25	14 75	15 75	13.25
12½-lb. keg	16.00	17 50	13.50	15.00	16 00	13 50
1-lb. cans	18 50	20.00	15 00	16 50	15 00	15 00
5-lb. cans	20 50	22 00	16 00	17 50	16 00	16 00

500 lb. lots less 10% discount: 2000 lb. lots less 10–2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	List net	40%	30%
Tinned	List net	40%	30%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$6 00	Chicago	$5.62	Pittsburgh	$4 50

Structual rivets, same sizes:

New York	$7 10	Chicago	$5.72	Pittsburgh	$4 60

REFRACTORIES—Following prices are f. o. b. works,

Bauxite brick, 56% alumina, f.o.b. Pittsburgh	M.	$160
Chrome brick, f.o.b. Chester, Pa., carlots	net ton	100– 110
Chrome brick, 9 in. strs. and sizes, f.o.b. Baltimore	net ton	90– 95
Fire clay brick, 1st quality, 9 in. shapes. f.o.b. Pennsylvania, Ohio and Kentucky works	M.	55– 60
Fire clay brick, 1st quality, f.o.b. St. Louis	M.	45– ...
Fire clay brick, 1st quality, f.o.b. New Jersey	M.	75– ...
Fire clay brick, 2d quality, 9 in. shapes. f.o.b. Pennsylvania, Ohio and Kentucky works	M.	50– .55
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	110– 120
Magnesite brick, 9 in. sizes and shapes larger than 9 in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	110– 120
Silica brick, 9 in. and 9 in. sizes, f.o.b. works, Chicago district	M.	65– ..
Silica brick, f.o.b. Birmingham	M.	56– 61
Silica brick, f.o.b. Mt. Union, Pa	M.	55– .60

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90 00	87.00	60.50	79.00	60.00	75.00
Commercial	50 00	42.00	21.00	17.50	15.00	15.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$20.00	25.50–30.00
Cleveland	20.00	20.00
Chicago	21 00	16.50

In coils an advance of 50c. usually is charged
Domestic iron (Swedish analysis) is selling at 12c. per lb.

SHEETS—Quotations are in cents per pound in various cities from warehoues also the base quotations from mill:

	Large Mill Lots			San	New York	
Blue Annealed	Pittsburgh	St. Louis	Chicago	Francisco	Current	One Yr. Ago
No. 10	$3.55@ $7.50	$7.09	$7.02	$8.65	$7.12@ $8.00	$4.57
No. 12	3.60@ 7.55	7.09	7.07	8.70	7.27@ 8.05	4.62
No. 14	3.65@ 7.60	7.09	7.12	8.75	7.22@ 8.10	4.67
No. 16	3.75@ 7.70	7.09	7.17	8.85	7.32@ 8.20	4.77
Black						
*Nos. 18 and 20	4.15@ 8.30	8.10	7.80	10.60	8.30@ 9.80	5.30
*Nos. 22 and 24	4.20@ 8.35	8 10	7.85	10.65	8 35@ 9.85	5 35
*No. 26	4.25@ 8.40	8.10	7.90	10 70	8 40@ 9 90	5 40
*No. 28	4.35@ 8.50	8.10	8.00	10.80	8.50@ 10.00	5.50
Galvanized						
No. 10	4.70@ 8.50	9.60	8.50	....	8.80@ 11.50	6.20
No. 12	4.80@ 8.60	9.60	8.60	11.35	8.90@ 11.50	6.25
No. 14	4.80@ 8.60	9.60	8.60	11.35	8.90@ 11.50	6.30
Nos. 18 and 20	5.10@ 8.90	9 60	8 90	11 65	9 15@ 11.90	6.60
Nos. 22 and 24	5.25@ 9.05	9.60	9.05	11.80	9.30@ 12.05	6.75
*No. 26	5.40@ 9.20	9.60	9.20	11.95	9.45@ 12.20	6.90
†No. 28	5.70@ 9.50	9.60	9.50	12.25	9.75@ 12.50	7.20

*For painted corrugated sheets add 30c. per 1000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages, for galvanized corrugated sheets add 15c., all gages.

WROUGHT PIPE —The following discounts are to jobbers for carload lots on the Pittsburgh basing card

BUTT WELD

Steel			Iron		
Inches	Black	Galv.	Inches	Black	Galv.
¾ to 3	45 to 57½	41½ to 44	⅜	15½ to 25½	+1½ to 11
			½	19½ to 29½	1½ to 11½
			¾ to 1½	24½ to 34½	8 to 18½

LAP WELD

2	47 to 50½	34½ to 38	2	20½ to 28½	6½ to 14½
2½ to 6	50 to 53½	37½ to 41	2½ to 6	22½ to 30½	9½ to 17½
7 to 12	47 to 50½	33½ to 37	7 to 12	19½ to 27½	6½ to 14½
13 and 14	37½ to 41				
15	35 to 38½				

BUTT WELD, EXTRA STRONG, PLAIN ENDS

¾ to 1½	52 to 55½	39½ to 43	¾ to 1½	24½ to 34½	9½ to 19½
2 to 3	53 to 56½	40½ to 44			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	45 to 48½	33½ to 37	2	21½ to 29½	8½ to 16½
2½ to 4	48 to 51½	36½ to 40	2½ to 4	23½ to 31½	11½ to 19
4½ to 6	47 to 50½	35½ to 39	4½ to 6	22½ to 30½	10½ to 18
7 to 8	43 to 46½	29½ to 33	7 to 8	14½ to 22½	2½ to 10
9 to 12	38 to 41½	24½ to 28	9 to 12	9½ to 17½	5½ to+2½

BOILER TUBES—The following are the prices for carload lots f. o. b. Pittsburgh

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	15 to 40½	1¾ and 1⅞ in	+20
2½ to 3¼ in	10 to 30½	2 and 2¼ in	+10
2¼ in	4 to 24	2½ and 2¾ in	+1
1¾ to 2 in.	+½ to 19½	3 and 3¼ in	1½
		3½, 4 and 4½ in	8

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in.	$327	1¾ in	$207
1¼ in	267	2 to 2¼ in	177
2½ in.	257	2½ to 3¼ in.	167
1½ in	207	4 in	187
		4½ to 5 in	207

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond. M Ft	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$104 00(net)	$138 00	$164 00	$210 00
No. 12 solid	135 00	170 00	225 00	265 00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400 00	500.00	560.00	......

From the above lists discounts are

Less than coil lots	+ 5%	+15%
Coils to 1,000 ft	5%	List Net
1,000 ft. and over	−10%	7%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever-Ready:

	Each, Net
Less than 12	$0.45
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUIT. ELBOWS AND COUPLINGS—These prices are in 100-lb. lots, f. o. b. New York, with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
Size, In.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.
½	85 00	93.50	22.00	524.60	6.65	7.30
¾	11.50	126.50	29 00	32.00	11.25	12 37
1	170.00	187.00	41 00	45 00	15.50	17.00
1¼	230.00	253.00	52 00	57 00	20 70	23.60
1½	275 00	302 50	70 05	78 00	25.00	27.50
2	375 00	403 00	130 00	145 09	33.70	37 00
2½	585.00	613 80	210 00	235.00	47.50	53 00
3	765.00	841.50	560 00	620 00	70 00	78 00
3½	920.00	1,012.00	1,350 00	1,485.00	92 00	114 00
4	1,170.00	1,287.00	1,469.00	1,617.00	115.00	140 00

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
7/32	250	$0.05½	Coils......40% off Less coils, 25% off
¼	250	.06	
5/16	250	.09	
⅜	200	.12	
½	200	.15	
¾	150	.18	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0 12	D. P. D. B.	$0.43
D. P. M. L.	.21	T. P. to D. P. S. B.	.26
T. P. M. L.	.33	T. P. S. B.	.38
D. P. S. B.	.23	T. P. D. B.	.64

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.50	$1.30	$1.68
T. P. M. L.	.70	1.70	2.40
D. P. S. B.	.63	1.60	.....
T. P. S. B.	1.15	2.40	.....
D. P. D. B.	1.10	3.00	....
T. P. D. B.	1.90	5.40	.
T. P. to D. P. D. B.	1.30	3.80	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$23.00
No. 16 cotton twisted	27.50
No. 18 cotton parallel	26.50
No. 16 cotton parallel	34 50
No. 18 cotton reinforced heavy	38 00
No. 16 cotton reinforced heavy	45 00
No. 18 cotton reinforced light	33 50
No. 16 cotton reinforced light	39 50
No. 18 cotton Canvasite cord	30 00
No. 16 cotton Canvasite cord	33.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp	100	$0.25
35-amp. to 60-amp	100	.35
65-amp. to 100-amp	50	.90
110-amp. to 200-amp	25	2.00
225-amp. to 400-amp	25	3.60
425-amp. to 600-amp	10	5.50

600-Volt	Std. Pkg.	List
3 amp to 30 amp	100	$0 40
35 amp to 60 amp	100	60
65 amp to 100 amp	50	1 50
110 amp to 200 amp	25	2 50
225 amp to 400 amp	25	5 50
450 amp to 600 amp	10	8 00

Discount	
Less 1-5th standard package	15%
1-5th to standard package	28%
Standard package	45%

FUSE PLUGS, MICA CAP—

0 30 ampere, standard package	$5 25
0 30 ampere, less than standard package	6 00

LAMPS—Below are present quotations in less than standard package quantities

Straight Side Bulbs Mazda B				Pear-Shaped Bulbs Mazda C			
Watts	Plain	Frosted	No. in Package	Watts	Clear	Frosted	No. in Package
10	$0 40	$0 45	100	75	$0 75	$0 80	50
15	40	.45	100	100	1.10	1 25	24
25	40	45	100	150	1 55	1 70	24
40	40	45	100	200	2.10	2 30	24
50	40	45	100	300	3.15	3 40	24
60	45	50	100				12
				500	4.60	4.90	12
				750	6.50	6.90	8
				1,000	7.50	7.95	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.24
Composition 2-piece attachment plug	.32
Swivel attachment plug	.20
Current taps	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12 50	$15.50	$17 00	$28 50
12	14.96	18.50	21.45	35.00
10	20.62	24.75	28.05	46.00
8	28.90	33.30	38.50	66.00
6	......	......	58.75	......
4	......	......	80 75	......
2	......	......	111.00	......
1	......	......	154.00	......
0	......	......	181.50	......
00	......	......	220 00	......
000	......	......	265 00	......
0000	......	......	330 00	......

Prices per 1000 ft. for Rubber-Covered Wire in Following Cities:

	Denver			Birmingham			St. Louis		
	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$15.64	......	$38.45	$12.23	....	$38.64	$15.64	.....	$38.45
10	24 50		...	27.60	....	65.57	24.50	.....	58.70
8	33.48	$56 81	..	38.64	....	87.33	33.48	....	.....
6	.	77 17	....	69.12	......	.....	......	56.81	....
4	......	108 10	.....	.....	$107.42	.....	...	77.17	....
2	......	142 00	.....	......	138.46		......	108 10	....
1	......	167 70	......	......	178.52	......	......	142.00	....
0	......	198 20	......	......	217.09	......	......	167 70	....
00	....	234 60	......	......	263 57	......	......	198.20	...
000		279.60	......	......	320.44	......	......	234.60	......
0000	..	..	......	......	389.17	......	......	279.60	......

Pittsburg—23c. base; discount 50%. St. Louis—30c. base.

SOCKETS, BRASS SHELL—

⅜ In. or Pendant Cap			⅜ In. Cap		
Key Each	Keyless Each	Pull Each	Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	+50%
1-5th to standard package	+20%
Standard package	−10%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	55c. lb
No. 18 B. & S. regular 1-lb. coils	56c. lb

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 60c. lb., 100 lb. lots	55c. lb
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c. lb
Wire solder, less 100 lb. 47c. lb., 100 lb. lots	42c. lb
Soldering paste, 2 oz. cans	$1.20 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+5%
$50 to $200 list value	−10%
$200 list value or over	−15%

POWER

Volume 52 New York, September 14, 1920 Number 11

THE KNOCKER

By RUFUS T STROHM

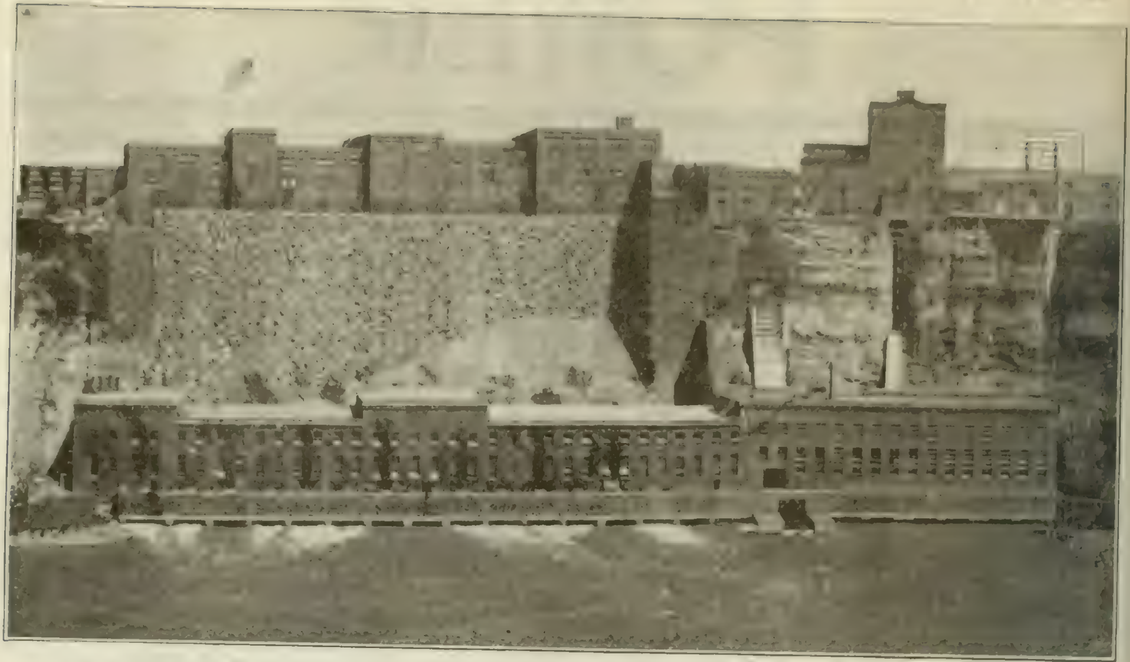
In every power house you'll find
The chap that wields the hammer;
He's everlastingly inclined
To discontent and clamor.
He knocks the men in places high,
He knocks the meek and lowly,
And while he knocks, his reddened eye
Emits a gleam unholy.

He loves to seize an honored name
And tear it into tatters,
Or desecrate some snowy fame
With nasty, muddy spatters.
He does his best to show the flaws
In every fellow-creature,
And thus ignores the moral laws
Delivered by the preacher.

The layout of the plant is bad,
According to his dictum;
The plant designer is a shad,
The owner is the victim;
The whole equipment is a mass
Of jumbled apparatus
That doesn't have a grain of class
Or engineering status.

He ridicules with caustic voice
The kind and make of stoker,
And looks upon the boiler choice
As worse than mediocre.
The type of turbine's wholly wrong,
He states to everybody,
And pipes and valves that should be strong
He vows are only shoddy.

Although he loves to swank and strut
Like some triumphant Pharaoh,
The truth is this—he's off his nut
And talks through his sombrero.
Such rant as his you're apt to meet
In any ten-cent shocker,
But still, it feeds his self-conceit,
And that's what charms the knocker.



World's Largest Hydro-Electric Units

Three 37,500-Hp. Hydro-Electric Units Installed by The Niagara Falls Power Company—Each One of These Units Has Carried Over 40,000-Hp. Load—More Than 90 Per Cent of the Total Energy in the Water Is Delivered at the Generator Terminals—Load on Thrust Bearings Approximately 500,000 Lb., with Only a 26-Hp. Friction Loss—Project Cost Approximately $8,000,000

By F. A. Annett
Associate Editor, *Power*

ELECTRICAL development at Niagara Falls began early and, like most of the early electrical undertakings, was a humble one as we see these projects today. In 1879 the first machine, a Brush arc dynamo, was installed to light Prospect Park at the Falls. This machine had a capacity equivalent to about 36 hp. From this 36-hp. machine the size of hydro-electric units has increased until, in the latter part of 1919, the largest hydro-electric generator in the world was put into successful operation — a machine having over one thousand times the capacity of the first unit, or 37,500 hp. Starting with this first electrical system, the size of electric-power projects has increased until today that of The Niagara Falls Power Co. has a total connected capacity of 498,000 hp. and hydro-electric development at Niagara Falls has expanded until at present there is a total connected capacity of over 850,000 hp. installed in the plants on the American and Canadian sides of the river, all driven from the same source —Niagara Falls. As a result of this phenomenal development industries have grown up, at and around the Falls, of such vital importance to this country and Canada that, if Niagara Falls was to fail for only a few weeks, our whole industrial structure would be seriously handicapped. The present hydro-electric power development is represented in seven plants, four on the American side and three on the Canadian, having an operating

> *The ultimate development of Niagara Falls will have a 300-foot head, when each cubic foot of water will produce an amount of power capable of lifting a 100-ton burden one inch from the tired shoulders of man.*
>
> *Engineering thought blazes the trail to the most efficacious use of Niagara's waters. This thought now takes form in action, and action removes the doubt that theory could not solve. Results exceed the vision and now Niagara, more than ever, supplies the material wants of man. With equal vision, courage and skill must engineering control that part of the water which may be set aside for esthetic purposes. Engineering must shape its turbulence and so direct its cataract-forming currents that the maximum grandeur may obtain.*
>
> *Engineering has made it possible to convert 90 per cent. of the stored energy of Niagara's water into useful forms of electrical power. Engineering can, and will, take but half the river's natural flow and raise its esthetic values to a level with the hydro-electric efficiency now obtaining. With half the water engineering will enhance the natural beauty and render a more sublime spectacle than nature, uncontrolled, now furnishes with all the water.—John Lyell Harper.*

capacity of approximately 750,000 hp. These various plants are located as indicated on the map, Fig. 1, which also shows their capacities. Interconnected in one system are the four plants on the American side, with the plant of the Canadian Niagara Power Co. on the Canadian side, making a total operating capacity of 450,000 hp. In operation on this system are the machines that represent the earliest attempt to develop Niagara Falls power on a large scale and also the most recent. The initial installation in the first development consisted of three 5,500-hp. units, in plant No. 1 of The Niagara Falls Power Co., Fig. 1. The latest installation has three 37,500-hp. machines, in an extension to what used to be plant No. 3 of the Hydraulic Power Company of Niagara Falls. The first installation had a total capacity of 16,500 hp.; the latest has 112,500. In the headpiece, at the foot of the cliff, is shown plant No. 3 on the left extending about two-thirds of the way across the picture; on the right is extension No. 3. At the top of the cliff are located the offices, buildings of the company, the headworks buildings and control room, etc.

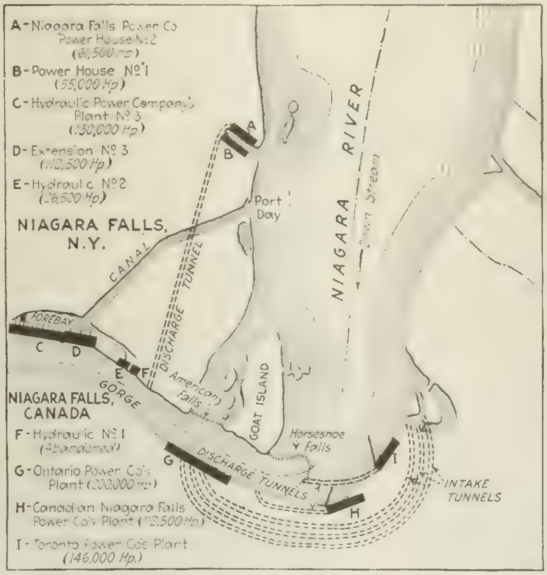

A-Niagara Falls Power Co Power House No 2 (61,500 Hp)
B-Power House No 1 (55,000 Hp)
C-Hydraulic Power Company's Plant No 3 (130,000 Hp)
D-Extension No 3 (112,500 Hp)
E-Hydraulic No 2 (26,500 Hp)
NIAGARA FALLS, N.Y.
NIAGARA FALLS, CANADA
F-Hydraulic No 1 (Abandoned)
G-Ontario Power Co's Plant (200,000 Hp)
H-Canadian Niagara Falls Power Co's Plant (72,500 Hp)
I-Toronto Power Co's Plant (146,000 Hp.)
A
B
C
D
E
F
G
H
I
Port Day
CANAL
FOREBAY
DISCHARGE TUNNEL
GORGE
American Falls
GOAT ISLAND
NIAGARA RIVER
Horseshoe Falls
DISCHARGE TUNNELS
INTAKE TUNNELS

FIG. 1. MAP SHOWING GENERAL LOCATION OF POWER PLANTS AT NIAGARA FALLS

Power plants Nos. 1 and 2, Fig. 1, were the first installed by The Niagara Falls Power Co. and are on the river about one mile above the American Falls. At these plants the water is deflected into a forebay and passes through steel-plate penstocks, 7.5 ft. in diameter, to the turbines. As indicated in Fig. 3, the generators are located on an approximate level with the surface of the forebay and connect through a long shaft to the turbines placed near the bottom of the wheelpit. The water from the turbine is conducted through a tunnel, 7,481 ft. long, and discharged into the river about 2,000 ft. below the Falls. In these two plants the twenty-one turbines operate under an average effective head of 140 ft. and develop 10.8 hp. per cubic-foot second of water delivered to the turbine. Water for what used to be plant No. 3 of the Hydraulic Power Company of Niagara Falls, but is now plant No. 3 of The Niagara Falls Power Co., is carried through an open canal from the river, at Port Day, below plants Nos. 1 and 2, Fig. 1, to the top of the cliff about 4,400 ft. below the Falls. In 1852 the Porter family, whose estates consisted of a large farm

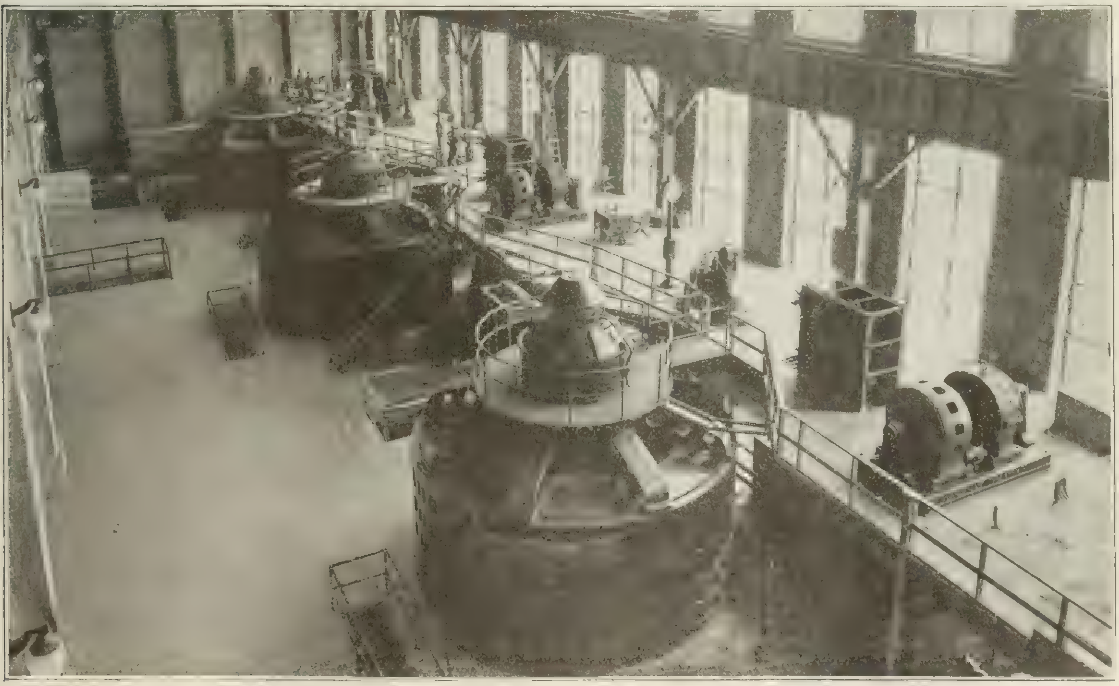


FIG. 2. INTERIOR OF GENERATOR ROOM AND OPERATING GALLERY OF NO. 3 EXTENSION

at Niagara Falls donated a strip of land 100 ft. wide for the construction of a canal, beginning at a point about one-half mile above the Falls and ending about 4,000 ft below, which is the site of the present canal. The genius of foresight that dominated the Porters in making this grant is well demonstrated in the fact that the water carried in the canal on this site today develops over 200,000 hp. under the most efficient head of all schemes so far put into effect for generating power from the Falls. This canal was first built by Horace H. Day during the period from 1852 to 1860 and was 8 ft. deep and 35 ft. wide. But the first attempt to utilize the full head of water was not undertaken until 1895, when the Hydraulic Power Co. completed a plant of 6,850-hp. at the water's edge on the lower river. This plant, shown in Fig. 1 at *F*, is now abandoned. A second plant *E* was built by this company, of 26,500 hp. capacity, but it is now used as a reserve only. A third plant, *C*, of a total capacity of 130,000 hp. containing thirteen 10,000-hp. units, was installed between 1907 and 1913, and this constituted the maximum diversion of water that would be allowed until the power demands for manufacturing war materials created a very serious power shortage in the manufacturing district located around the Falls.

Confronted with this serious shortage of power and consequently a restriction in the production of war materials, the War Department requested all parties interested to submit plans for the development of the remaining water available for diversion, 4,400 cubic feet seconds, allowed by the treaty with Great Britain.

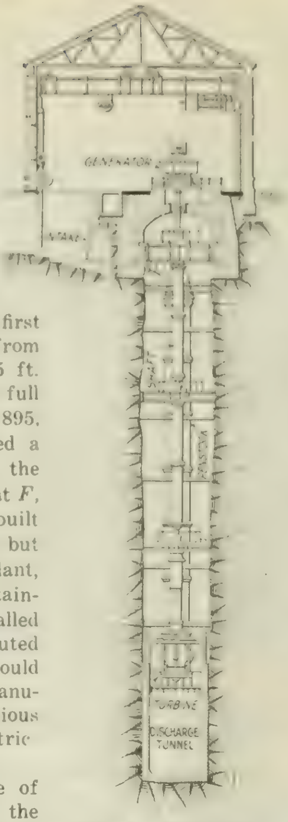


FIG. 3. SECTIONAL VIEW NO. 1 POWER HOUSE

As a result, the plan submitted by the, at that time, Hydraulic Power Company of Niagara Falls, was accepted as the one that would utilize the water most economically. The plan consisted of installing three 37,500-hp. units in an extension to be built to the Hydraulic Power Co.'s plant No. 3, and an enlargement of the canal that supplied this plant with water. To better utilize all the water at Niagara to which the various companies had property rights, it was suggested by the War Department that they consolidate into one company, as a result of which The Niagara Falls Power Co., Hydraulic Power Company of Niagara Falls and the Cliff Electrical Distributing Co. were consolidated under the name of The Niagara Falls Power Company.

In May, 1918, authority was granted by the War Department for carrying out the plan submitted by the Hydraulic Power Co. Nineteen months later, Dec. 20, 1919, the first unit was put into operation. If the progress of the work had not been slackened on account of the signing of the armistice, the first unit in this plant would have been ready for operation approximately twelve months after the work was started.

Ice had been giving considerable trouble and not infrequently restricted the capacity of the various power plants on the American side of the Falls. Therefore the successful operation of this new development required, among many other features, that an unobstructed flow of water be assured.

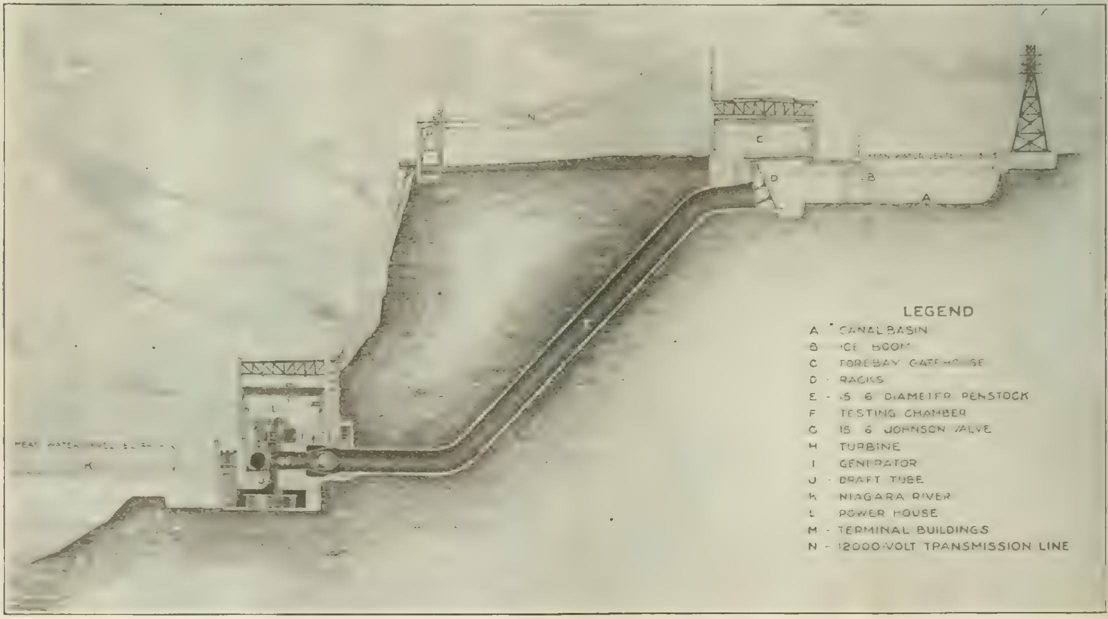


FIG. 4. SECTIONAL VIEW THROUGH POWER PLANT, ONE PENSTOCK AND FOREBAY OF NO. 3 EXTENSION

To accomplish this necessitated the cutting of a channel, 150 ft. wide, 20 ft. deep and over one-half mile long, curving from the intake at the canal at Port Day up the stream, in the bed of the river, which is solid rock. The object of this understream channel was to allow sufficient water to flow under the ice no matter how much the latter might pile up back of the ice booms. The canal, which was 100 ft. wide, was also deepened to 14 feet.

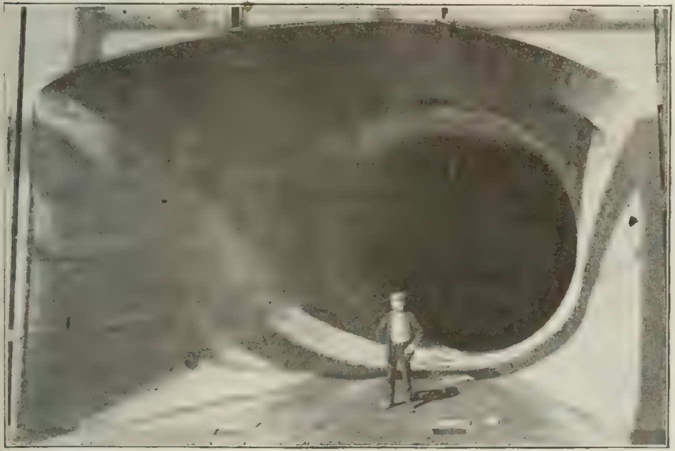


FIG. 5. BELL MOUTH OF ONE PENSTOCK

To supply the three new units with water from the present canal also required the construction of a new forebay 176 ft. long, 74 ft. wide by 28 ft. deep. All the work had to be done in a current that varies from one to six feet per second. Construction of the forebay necessitated the building of a cofferdam. This dam was built of Lackawanna sheet-steel piles on solid rock and so constructed as to allow pumping out the water back of it to a depth of 35 ft., and it is the only cofferdam that has ever been so constructed.

Ice apron *B*, Fig. 4, on the front of the forebay deflects the ice which continues down to the end of the canal, where a drag operated by two men and a 10-hp. motor takes it out and dumps it down over the cliff to the river below. If water was used to carry the ice away, sufficient to develop 500 to 600 hp. would be required, therefore the ice run is used only in exceptionally bad cases. It has not been necessary to use water to carry away the ice since the completion of the understream canal at Port Day. Last winter was the most severe winter in a decade, yet the ice that reached the forebay was successfully handled with the present equipment, therefore, it is doubtful if much water will ever again be required to handle it. Racks *D* are located in the forebay to catch any ice that may get by the apron. Very little débris comes down in the water, consequently no trouble is experienced from this source. Since the bottom and sides of the canal as well as the river bottom are solid rock, no difficulties are experienced with sand.

The entrance to the three penstocks, for No. 3 extension, from the forebay are bell mouths, Fig. 5, 28 ft. wide by 20 ft. high and gradually taper down to a true circle 15.5 ft. in diameter. From the bell mouth the penstocks curve to an angle of 45 deg. and extend down to a level with the wheels (see Fig. 4) where they make another easy curve and extend out 90 ft. to the face of the cliff. These penstocks are 350 ft. long, cut in solid rock, and are lined with concrete throughout their entire length. The horizontal section, in addition to having a concrete lining, is also lined with 1⅛-in. boiler plate, which acts as an anchor for the turbine casings to the penstocks. The general arrangement is clearly indicated in the sectional view, Fig. 4.

Steel-plate gates are located in the intake to the penstocks. These gates are handled by cranes and slide down on racks placed about 30 deg. to the vertical. In each gate is a trap to bypass water and fill the penstocks before the gates can be opened. This trap is open during the closing of these gates, so that the pressure of the water will not prevent the gates from seating.

Each of the three turbine casings is connected to its penstock through a valve, *G*, Fig. 4, hydraulically operated and electrically controlled. These valves, which are the largest in the world, were furnished by the Larner-Johnson Valve and Engineering Co. Fig. 7 shows one of them with the penstock end of the casing removed. The control gear is clearly indicated on the side of the valve. The outer valve housing is of cast steel and steel plate and is 17 ft. inside diameter through the body of the valve and tapers to 10 ft. 6 in. diameter at the outlet end. The entrance end to the valve housing is made of steel plate forming a flaring extension of the 15-ft. 6-in. penstock. Throughout the total length of the valve, approximately 24 ft., the area of the water passage is reduced without abrupt changes or sharp curves, and the stream-line shape of the valve parts renders the hydraulic losses practically negligible.

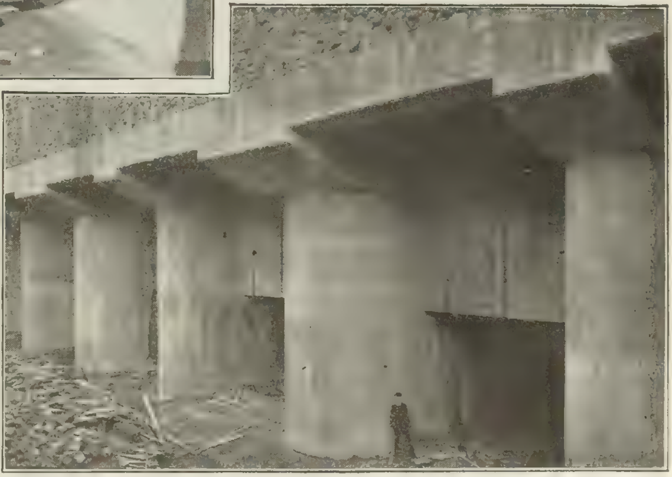


FIG. 6. TAILRACE END OF DISCHARGE, SHOWING CONCRETE PIERS SUPPORTING TURBINE FOUNDATIONS

The valves are of the balanced needle type, having a movable plunger sliding in an internal cylinder see Fig. 8). An internal cylinder *C* is supported from the valve housing, and the movable plunger *P* is arranged so that it works within cylinder *C*. When the valve is open, as in the figure, hydraulic pressure from the penstock is applied not only to the outside of the plunger, but also to the inside of chambers *A* and *B*. This creates a state of hydrostatic equilibrium in all parts of the plunger. To close the valve, pressure in chamber *B* is reduced by discharging water from it into the tailrace and allowing the pressure to be applied in chamber *A*. This pushes plunger *P* forward until it seats at *S*. During the opening operation chamber *A* is allowed to discharge into the tailrace and pressure from the penstock is applied within chamber *B*. Operation of the plunger is accomplished entirely by the hydraulic pressure in the penstock, no external force or pressure being required. The mechanism that controls the movement of the needle plunger is shown in place on the side of the housing, Fig. 7. The valve may be manually controlled locally, or electrically controlled from a switch station on a pedestal (shown back of the governors in Figs. 18 and 21), near the generating units. A solenoid actuates a pilot valve, and the pilot valve controls a relay valve which regulates the flow of water to and from the main valve for its operation. The valve does not operate with change of load on the turbine, all the fluctuations being taken care of by the governor operating twenty radial vanes that control the amount of water reaching the runner. As shown in Figs. 18 and 21, indicators with illuminated dials mounted on top of the pedestals that the Johnson valves are controlled from show the position of the turbine gates.

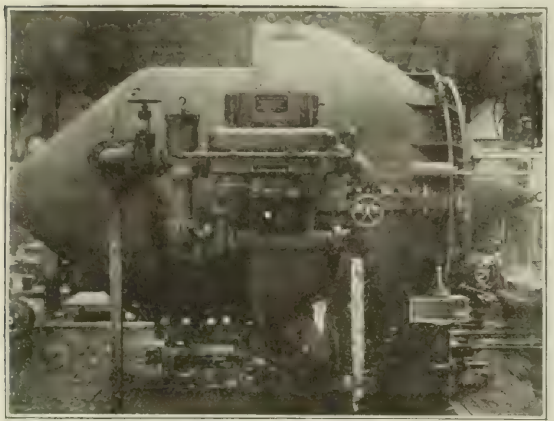


FIG. 7. JOHNSON VALVE WITH CONTROL GEAR

The rate of the valve stroke may be regulated to suit the conditions and may be set for any time up to a minimum of 30 sec. for a complete stroke in either direction. The valve is so designed that it will close automatically in case of a serious break in the wheel casing.

Exclusive of the steel-plate housing at the upstream end, the complete valve weighs approximately 200,000 lb., and the plunger or moving element, 52,000 lb. The force required to move the plunger is extremely small, as no sliding surfaces are subjected to a difference of hydraulic pressure and only the friction of the plunger moving in the internal cylinder must be overcome. To unseat the plunger and fill the wheel casing, a force of 520,000 lb. is available, and to complete the opening stroke the available force is 2,000,000 lb. To close the plunger in dead water, the available force is 415,000 lb., and this is greater in moving water. A force of 1,560,000 lb. is applied on the plunger to hold it against its seat. In spite of the enormous size of the valve and forces for operation, the operator has absolute control of the stroke at all times and may stop the plunger immediately at any intermediate point.

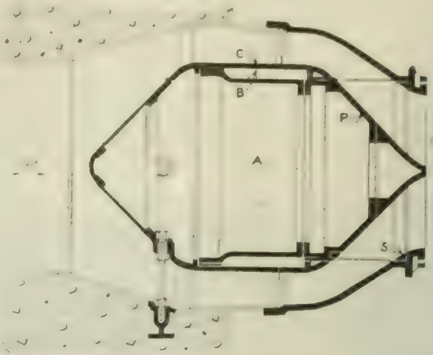


FIG. 8. SCHEMATIC DIAGRAM OF JOHNSON VALVE

No provision was necessary to take care of the surges in the penstock, for being hewn through solid rock the penstock itself provides sufficient strength to withstand any force that may be set up, due to suddenly shutting down a machine.

In the design and building of the units four manufacturing companies are represented. One complete unit—generator and turbine—was designed and built by the Allis-Chalmers Manufacturing Co., one generator each by the General Electric Co. and the Westinghouse Electric and Manufacturing Co., and the turbines for these two generators by the I. P. Morris Co. Each turbine is of the vertical shaft, single-runner, Francis

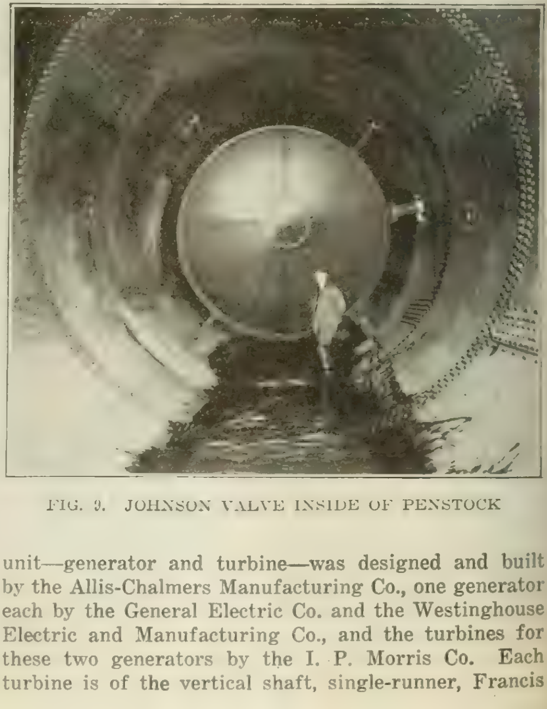
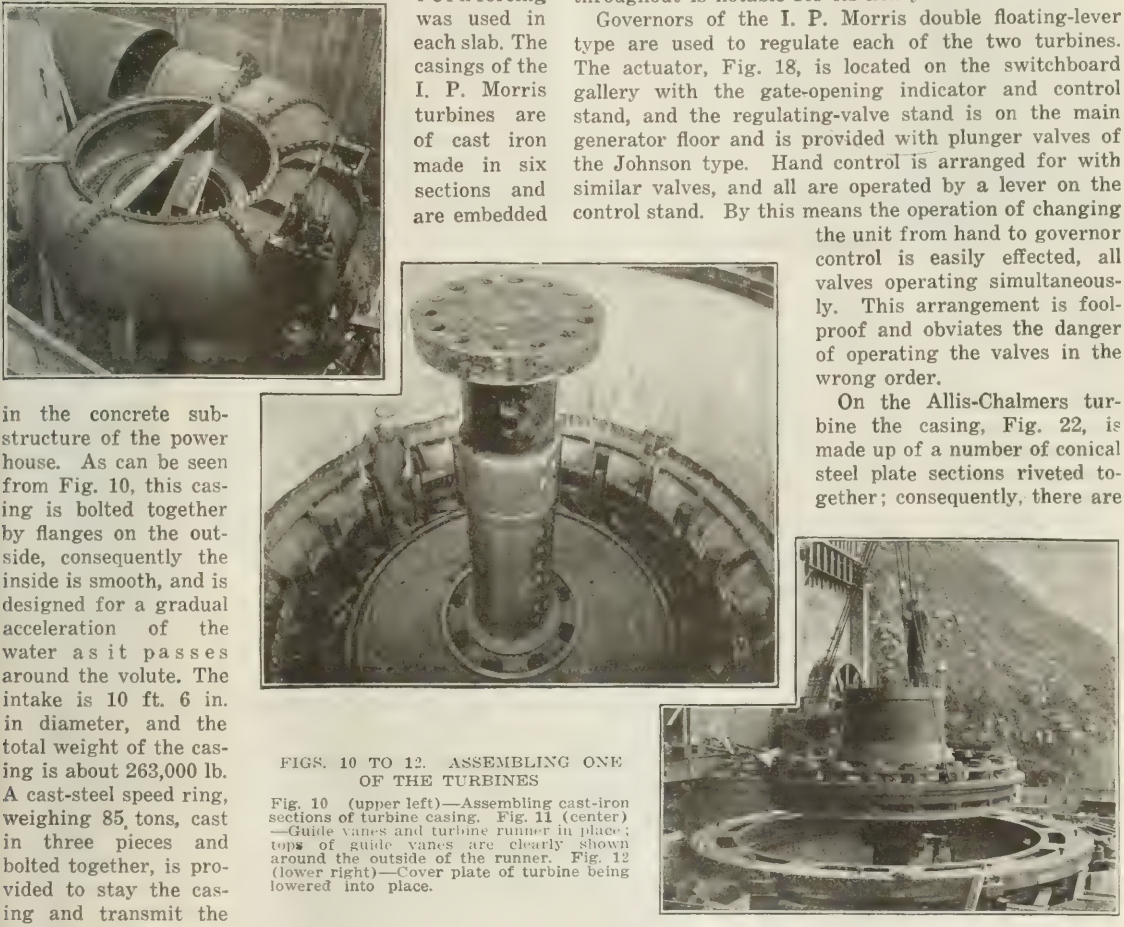


FIG. 9. JOHNSON VALVE INSIDE OF PENSTOCK

type, operating under a head of 215 ft. at a speed of 150 r.p.m. and is rated at 37,500 hp., although each has already carried more than 40,000 hp. load. The three units were designed to develop an average working load of 100,000 hp. This load is being carried continuously and with ease. Taking all frictional and other losses, from forebay to switchboard, into consideration, these units are securing 90 per cent of the potential energy in the water used.

Each complete unit—generator, turbine and casing—weighs approximately 1,000 tons and is set on a reinforced-concrete slab, 11 ft. thick, 53 ft. wide and 55 ft. long, resting on reinforced-concrete piers, Fig. 6; 46 tons of steel reinforcing was used in each slab. The casings of the I. P. Morris turbines are of cast iron made in six sections and are embedded in the concrete substructure of the power house. As can be seen from Fig. 10, this casing is bolted together by flanges on the outside, consequently the inside is smooth, and is designed for a gradual acceleration of the water as it passes around the volute. The intake is 10 ft. 6 in. in diameter, and the total weight of the casing is about 263,000 lb. A cast-steel speed ring, weighing 85 tons, cast in three pieces and bolted together, is provided to stay the casing and transmit the weight of generator and floor to the foundations. Cast-steel guide vanes with polished surfaces are used, and the lubrication of all guide-vane bearings is effected by means of a central grease gun. The guide vanes may be clearly seen in Fig. 11. With the grease gun it is possible to supply any bearing on any guide vane with a definite amount of lubricant. The runner is of cast iron, in one piece, having a maximum diameter of 10 ft. 6 in. and a total weight of 27,000 lb., and the weight supported by the thrust bearing is about 500,000 lb. The shaft is 25 in. in diameter and is provided with a lignum-vitæ guide bearing at the turbine and a babbitted guide bearing on top of the generator.



FIGS. 10 TO 12. ASSEMBLING ONE OF THE TURBINES

Fig. 10 (upper left)—Assembling cast-iron sections of turbine casing. Fig. 11 (center)—Guide vanes and turbine runner in place; tops of guide vanes are clearly shown around the outside of the runner. Fig. 12 (lower right)—Cover plate of turbine being lowered into place.

The draft tube is of the Moody spreading type and is of special value in that it regains the whirl component as well as the axial component of the velocity of the water leaving the runner. This results in higher efficiency than the old type of curved draft tube, which does not regain the whirl. The spreading tube also eliminates surging and water hammer, which so often occurs with curved draft tubes. These draft tubes are shown in section in Figs. 13 and 14.

A renewable ring is provided in the draft tube just below the runner, and the upper section of the draft tube is furnished with manholes for the inspection of tube and runner discharge. The total weight of each turbine is about 765,000 lb., and the installation throughout is notable for its heavy construction.

Governors of the I. P. Morris double floating-lever type are used to regulate each of the two turbines. The actuator, Fig. 18, is located on the switchboard gallery with the gate-opening indicator and control stand, and the regulating-valve stand is on the main generator floor and is provided with plunger valves of the Johnson type. Hand control is arranged for with similar valves, and all are operated by a lever on the control stand. By this means the operation of changing the unit from hand to governor control is easily effected, all valves operating simultaneously. This arrangement is foolproof and obviates the danger of operating the valves in the wrong order.

On the Allis-Chalmers turbine the casing, Fig. 22, is made up of a number of conical steel plate sections riveted together; consequently, there are both girth and longitudinal seams. All rivets are countersunk on the inside of the casing. Where the penstock connects to the Larner-Johnson valve on the forebay end, it is 15 ft. 6 in. in diameter, and tapers down to 10 ft. 6 in. on the turbine end, at which diameter it connects to the turbine casing. As can be seen from Fig. 15, a straight connection is used from the Johnson valve to the casing on the two units to the left where the connection of the machine to the right increases from a diameter of 10 ft. 6 in. at the valve to 11 ft. 6 in. at the entrance to the spiral. The plates are $\frac{7}{8}$ in. thick at the entrance to the casing and $\frac{1}{2}$ in. thick at the small end of the volute. The casing is riveted to a cast-steel speed ring, weighing 85,000 lb. Twenty cast-steel guide vanes control the water from the casing to the runner. These vanes are connected to the shifting ring through adjustable links so proportioned that they will fail before a guide vane or its shaft is injured if any obstruction should lodge between vanes. The runner is of cast-iron bolted to a cast-iron hub keyed to the tapered end of the shaft, as indicated in Fig. 20. A lignum-vitæ guide bearing, Fig. 19, is mounted directly above the turbine, the lignum-vitæ being set with its end grain toward the shaft, and is lubricated with water from the headrace supplied through a fine strainer. Lubrication of the guide-vane bearings is accomplished by using a pressure grease cup on each bearing.

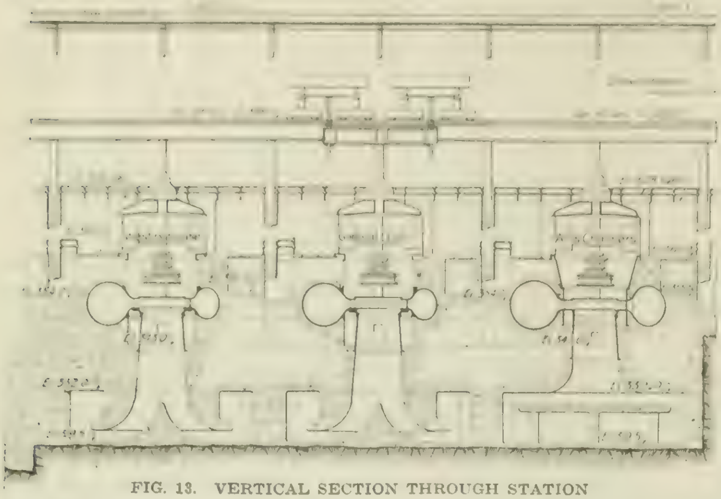


FIG. 13. VERTICAL SECTION THROUGH STATION

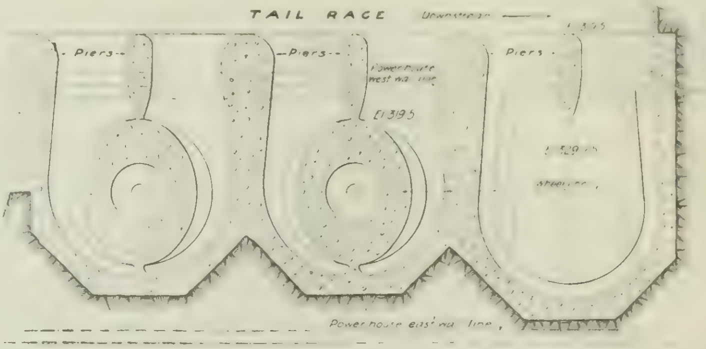


FIG. 14. HORIZONTAL SECTION THROUGH DRAFT TUBES

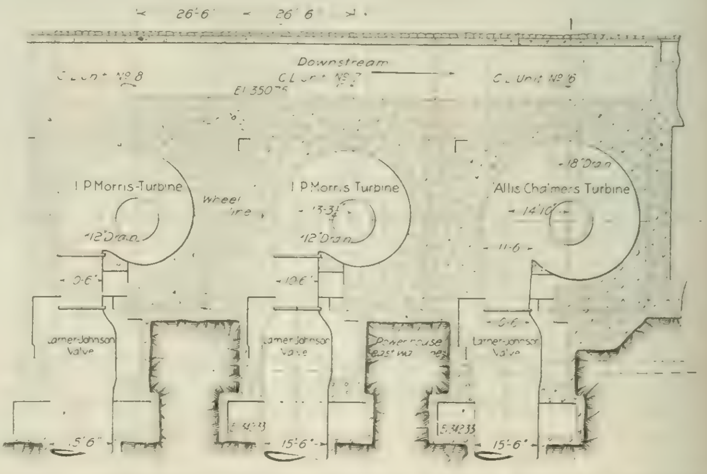


FIG. 15. HORIZONTAL SECTION THROUGH STATION, SHOWING PENSTOCK VALVES AND TURBINE CASINGS

The turbine discharges into a single draft tube of the White hydraucone regainer type. Reference to Figs. 13, 14 and 20 will make the construction clear. In the hydraucone regainer, a straight bell-mouth tube is used; mounted directly below the mouth of this tube is a concrete slab supported on piers. The discharge toward the river goes directly to the tailrace, and the discharge toward the penstock drops down and goes under the concrete slab to the river. In the divided draft tube, instead of the discharge being out under a concrete slab, after it leaves the draft tube the flow is upward and around the lower end of the draft tube. The chief result accomplished is, the water does not turn on itself, either axially or radially until it discharges; thus a large percentage of the velocity energy in the discharge is regained. By the use of the hydraucone or spreading draft tube about 80 per cent of the velocity head in the discharge is recovered, whereas with the old type of curved draft tube a large proportion of this velocity head is always lost. Apparently, one device is as efficient as the other. Tests show that over 90 per cent of the total energy in the water is delivered at the generator terminals and the turbines themselves have an efficiency of 93 per cent.

The effectiveness of the hydraucone regainer and divided draft tube is illustrated in the headpiece. On the right it is seen that the tailwater from extension No. 3 is practically smooth, while from plant No. 3, on the left, the discharge gives evidence, by the whiteness of its surface, of considerable velocity. By looking at the discharge of No. 3 extension with all three machines operating under normal full load, it never would be suspected by the current that it represented a flow of some 4,500 cubic-foot seconds. In this machine the governor flyballs are mounted directly on the turbine shaft and are connected to the governor mechanism through rods and bell cranks, as indicated in Fig.

20. In the governor stand, Fig. 21, are three piston valves—the pilot valve, intermediate valve and main valve. The motion of the flyballs operates the ⅞-in. pilot valve, which in turn operates a 3¼-in. four-ported intermediate valve, and the motion of the latter varies the pressure on either end of the four-ported main valve, which is 12 in. in diameter. A motion of only one-half inch of this main valve is all that is required to pass sufficient fluid to cause the operating pistons to move from one end of their cylinders to the other in two seconds. As is clearly indicated in Fig. 20, the fluid pipes, which are 6 in. in diameter, from the governor stand connect to the operating cylinders outside the pit liner. These operating cylinders are so located as to allow removing the turbine cover plate without distributing the governor piping on cylinders. Fluid use in the governors is about 99 per cent water and 1 per cent oil, supplied from a central pressure system. Three governor fluid pumps of the centrifugal type are provided. Two of the pumps are driven by 75-hp. induction motors and the third by a direct-current motor. One of the alternating-current motors is started from a manually operated starter on the operating galley. The other alternating-current motor is equipped to start automatically by a float switch in the sump tank. The direct-current motor is also arranged to start automatically from a float switch adjusted to follow the alternating-current motor-driven pump. This arrangement makes it practically impossible for the governor-fluid supply to fail. Pressure of 115 for operating the governors is obtained by static tanks at the top of the cliff. Should for any reason the fluid supply to the governors fail, which, as previously stated, is practically impossible, they may be operated with water taken from the penstocks. The governors on all machines will close the gates from full opening in three seconds. In case of an interruption of the load on any one of the units or an interruption of the exciter circuit, the governors will completely close the gates and shut the machine down. Each of the three generators is designed for a capacity of 32,500 kva. and generates 12,000-volt three-phase 25-cycle current when operating at 150 r.p.m. Although designed and built by different companies, each machine has about the same external appearance, and to this end the manufacturers co-operated, so that the installation presents a uniform appearance, Fig. 2. The weight of the Allis-Chalmers generator is supported by a cast-iron pit liner, which in turn rests upon the turbine casing and speed ring, thus making the generator and turbine one composite unit, Figs. 13 and 20. This pit liner is also shown in Fig. 22, located within the spiral casing. A cast-iron ring grouted into the building structure and supported from the turbine casing and speed ring is used as a foundation for the other two generators, Fig. 17. A comparison of these details can be seen in Fig. 13.

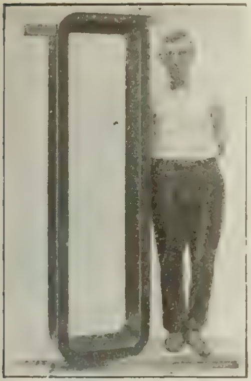


FIG. 16. GENERATOR FIELD COIL

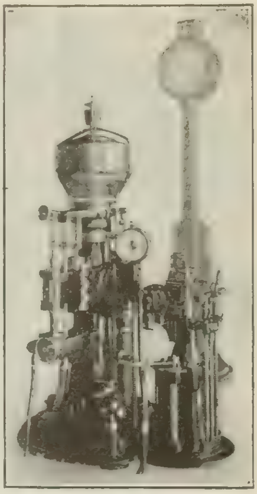


FIG. 18. I. P. MORRIS GOVERNOR AND ACTUATOR AND GATE-OPENING INDICATOR

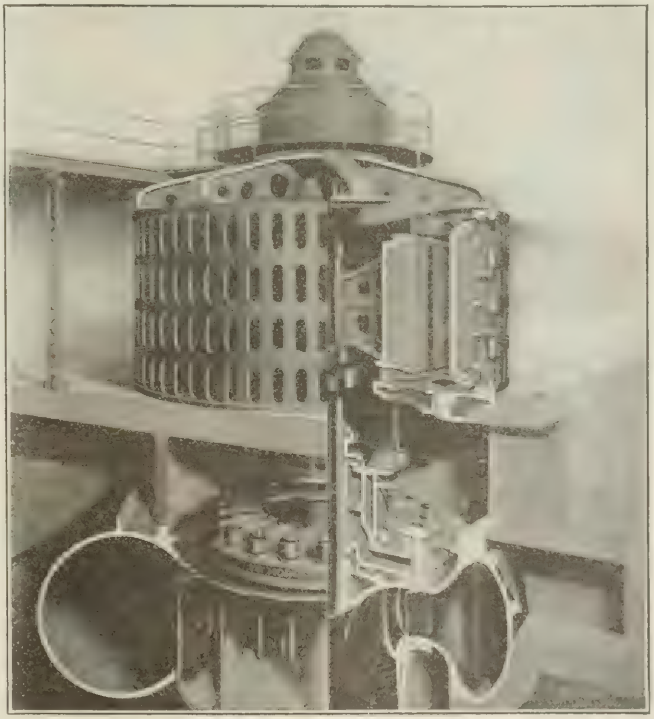


FIG. 17 SECTIONAL VIEW THROUGH UNIT ON LEFT IN FIG 13.

As to the internal construction of the generators the engineers of the manufacturing companies were left at liberty to follow their own ideas regarding details, the main restriction being that the electrical characteristics of the three machines must be such that they would operate satisfactorily in parallel. A box frame of usual design, 21 ft. outside diameter, cast in four sections, is used for the stator. On account of the larger size of the units the stator cores were stacked and the machines wound when they were installed. Both ends of each phase winding are brought out so that a balance system of relay protection can be used. The windings are connected in star and the neutral grounded through a resistance of approximately 5 ohms, obtained by using a water rheostat. One of the distinguishing features in the internal construction of the machine is found in the rotor. In the Allis-Chalmers machine the rotor consists of two cast-steel field rings, machined on all surfaces and shrunk onto a cast-steel spider. The field poles are made in two sections, each section being dovetailed to the field ring. In the General Electric machine, the spider consists of six cast-steel wheels, with spaces between them for the circulation of air. These wheels are rabbeted together at the hubs and held together by bolts through the arms of the spider. The polepieces are in one section and held to the rotor by two dovetails. A ring built up of $\frac{1}{8}$-in. laminations on a cast-steel spider is the rotor construction used in the Westinghouse machine. One-section polepieces held to the rotor with a single dovetail are used. An idea of the size of the generators is given in Fig. 16, which shows a man standing alongside of a field coil.

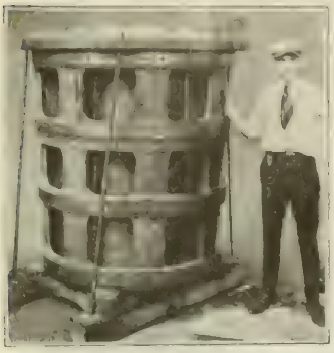


FIG. 19. TURBINE-GUIDE BEARING, UNIT FIG. 20

The shafts are 27 in. in diameter below the rotor and are fitted with a 45-in. forged-on steel flange, for bolting to a corresponding flange of the turbine shaft. On the upper end of the shaft is the Kingsbury thrust bearing, carried on a bridge having eight radial arms. This bridge is of cast-steel in two parts. Each bearing is 49 in. outside diameter and capable of carrying a suspended load of approximately 500,000 lb., which is ample to carry the weight of the rotating element and downward thrust of the water. A total downward load of approximately 470,000 lb. is caried on the thrust bearing, 100,000 lb. of which is due to the water thrust on the turbine runner. Directly under the thrust bearing is the upper guide bearing, which is 26 in. in diameter and 36 in. in length. The thrust bearing runs in a bath of oil supplied from a central system. No oil-cooling coils are provided in the thrust-bearing housing, the oil being cooled and filtered in the central system.

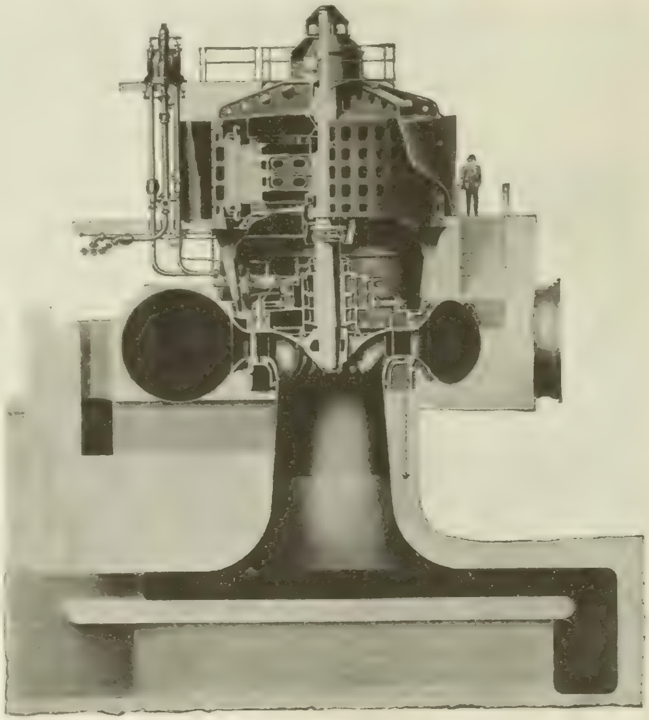


FIG. 20. SECTIONAL VIEW THROUGH UNIT NO. 16

Special care has been taken in the design of the oiling system to make it as simple as possible. Oil from the central system, after passing through a duplex strainer, flows into two feed pipes, one leading to the thrust bearing and one to the guide bearings. Each of the pipes is provided with sight-flow indicators and regulating valves.

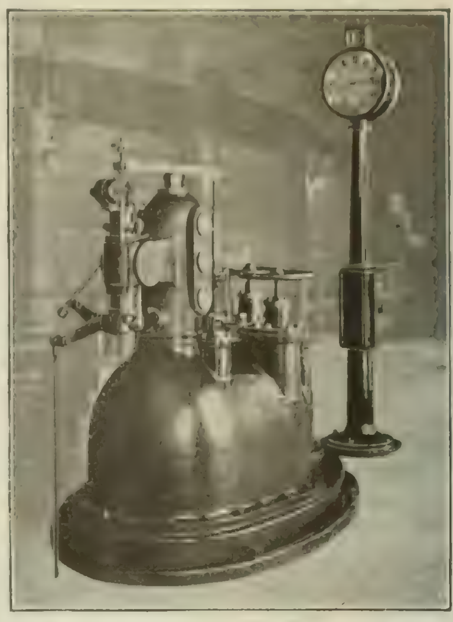


FIG. 21. ALLIS-CHALMERS GOVERNOR STAND AND GATE-OPENING INDICATOR

An oil meter is installed in the thrust-bearing feed line, and the circulation of the oil is regulated to about 35 gal. per min. As previously stated, the load on the thrust bearings is approximately 470,000 lb., nevertheless the friction loss in the bearings is only about 26 hp. The machines from standstill will begin revolving on one per cent gate opening. To bring the rotating element to rest after the gates have been closed, and also to prevent the rotor from turning in case of leaks through the gates, brakes are installed on the generators. These brakes are operated by compressed air, from a cock mounted near the hand-control stand located near the governor, and are capable of bringing the generator to rest from full speed, in four minutes. Ventilating air for the generators is taken into the top of the machine from the generator room and also from the pit under the machine. The amount of air required by the different machines to carry off the heat varies from 70,000 to 90,000 cu.ft. per min. This air is forced over the windings and through the ventilating ducts in the cores by steel-plate centrifugal fans mounted on the ends of the rotor. The field poles and ventilating openings in the rotor rims also set up a strong blowing action. At present the air discharges through the stator yoke into the generator room. Provisions have been made to surround each generator with a steel-plate housing as indicated in Fig. 20. This housing will be connected to a duct system, so that the ventilating air can be disposed of in several ways, by auxiliary fans, one for each generator. In the summer months the ventilating air can be discharged outside the station. In the winter months part of it will discharge into the station and control room for heating, and the remainder will go to the ice runs. Of interest is the large crane, one end of which is shown in Fig. 23, at the top of the cliff for handling all materials for the plant at the lower river's edge. This crane is capable of lifting a modern freight car and its load off the track, carrying it in over the edge of the cliff and lowering it down to the plant below. The figure shows the crane raising an empty flat car after it has been unloaded in the plant.

One of the unique features of the station is the simplicity of the control. The leads from the generators go to an oil switch and then directly to a six-circuit transmission line carried on steel towers that run to the Echota substation, three miles away. This transmission line is designed to have, eventually, a capacity of 400,000 kw. All circuits are carried on the same towers. Most of the towers are built on concrete foundations, but a number of them have foundations built on the cantilever principle and extend out over the canal. From station No. 3 power is transmitted by underground cable, but when duct capacity for the new development was considered, which it is expected will eventually reach 400,000 kw., it was found practically impossible to obtain this on account of street limitations, therefore overhead transmission was adopted. The generator oil switches are automatically tripped by inverse-time-limit relays, set for 3 sec., when overloads occur outside the generators. In case of trouble within these generators the switches are opened instantaneously and the field circuit is killed by a balanced relay system of protection operated from current transformers in the generator leads differentially connected. To give this system of protection maximum reliability, the relays are placed near the generators. This avoids the long leads that would be required if these relays were in the control room at the top of the cliff, and the wiring of this system is also made independent of all other circuits. Two current transformers and two inverse-time-limit relays, both connected open delta, protect each generator from overloads. The neutrals of both the current transformers and relays are grounded. In the ground connection of the transformers is connected a relay, which trips the generator switch when the current to ground reaches approximately full-load value. The inverse-time-limit relays are rated at 5-ampere where the ground relay is only 2.5-ampere capacity.

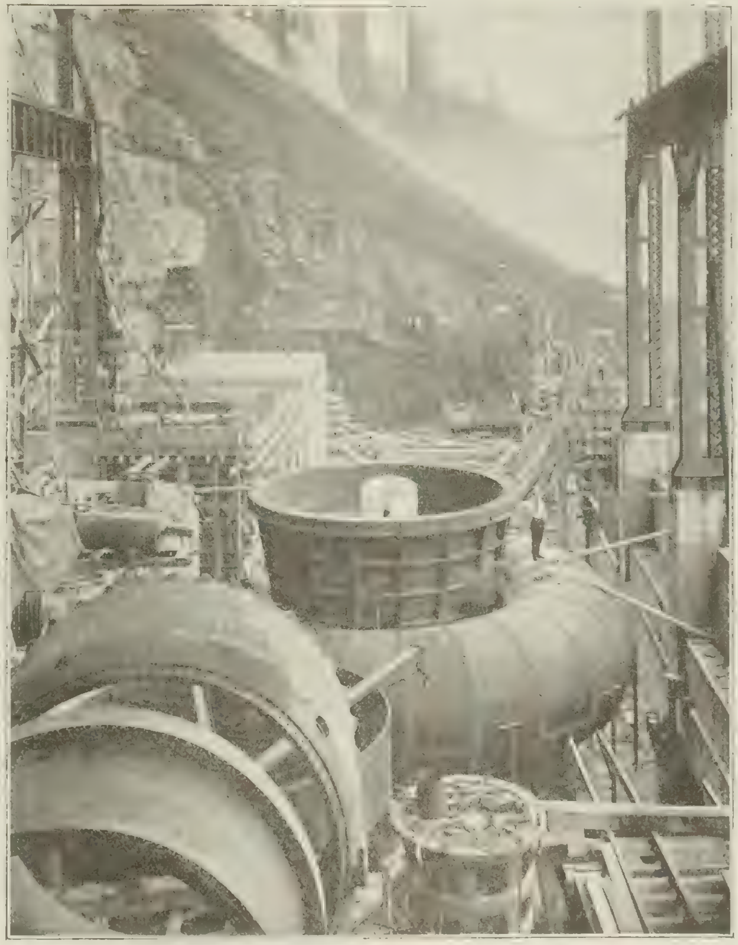


FIG. 22. INSTALLATION OF UNIT NO. 16 TURBINE CASING AND PIT LINES IN PLACE

At the top of the cliff above the main generator station is the control room. On account of the simplicity of the switching arrangement the control is greatly simplified, as is clearly indicated in Fig. 24. When a switch is opened, an annunciator on the control board shows the relay that operates it, thus indicating the source of the trouble. In each of two of the generators are 18 temperature coils, the third machine has 18 thermocouples located at different parts of the stator windings. Six of these in each machine, that show the highest temperatures, are connected up to an indicator in the control room.

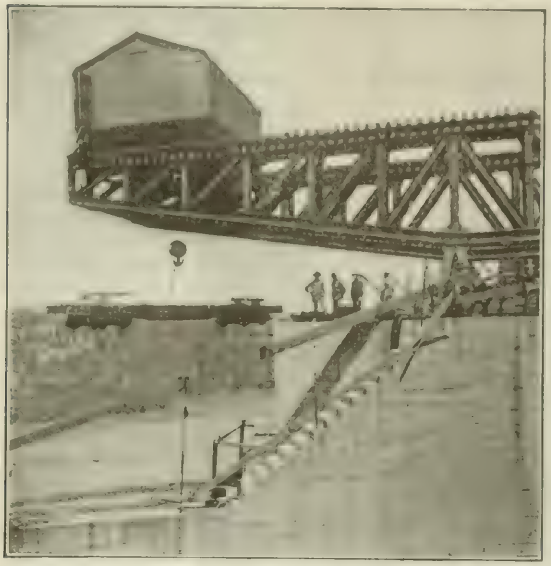


FIG. 23. LARGE CRANE AT TOP OF CLIFF

Excitation for the alternators is obtained from 2,200-volt induction-motor, direct-current generator sets. Each exciter is of 225-kw. capacity, shunt wound with interpoles, and generates 220 volts. The induction motors can be supplied from three sources: Transforming the 12,000-volt current from the main generators down to 2,200-volts; 2,200-volt current from No. 3 station, and also from a 2,200-volt substation in No. 3 gatehouse. Any one of these three sources can be connected to a duplicate set of busses, and the 2,200-volt induction motor, driving the exciters, connected to these busses through selector oil switches. An emergency source of excitation may be obtained from No. 3 station's direct-current busbars. This circuit is connected through a field rheostat located near the main units and connected to a busbar. To this busbar the field coils of any one of the alternators may be connected in case of failure of its motor-generator exciter. Although all three machines are connected to the emergency excitation source, the switches are so interlocked that only the field coils of one machine can be connected to this circuit at one time.

In laying out the station effort was made to divide the electrical and mechanical operating functions. Electrical operation is centered in the control room and the mechanical in the station. How well the designing engineers have succeeded in their efforts to simplify operation is evidenced by the fact that a station of a normal operating capacity of 100,000 kw. is being operated by three men on a shift, or a total of nine men on the three shifts. One man is located in the control room and two in the station. Although these units are the largest in the world, no failure of any part of the equipment has been experienced since the machines were put in service. This is very remarkable since the design and construction of the plant represents a distinct forward step in hydro-electric development. In carrying out this project, it was necessary for the engineering staff to make the plans as the work progressed. Nevertheless, less than $1,000 was expended in changing plans. This, it must be admitted, is a remarkable record in engineering work involving an expenditure of approximately $8,000,000. The project, although carried out by Government sanction for war work, was financed entirely by The Niagara Falls Power Co. Exhaustive tests are being made on these units, the results of which will be available for publication at a future date.

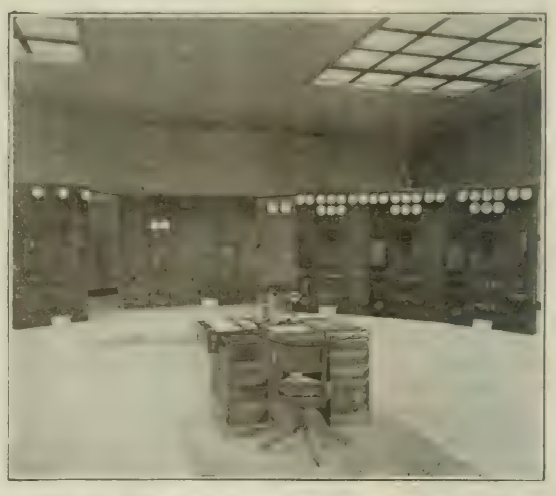


FIG. 24. MAIN SWITCHBOARD IN CONTROL ROOM

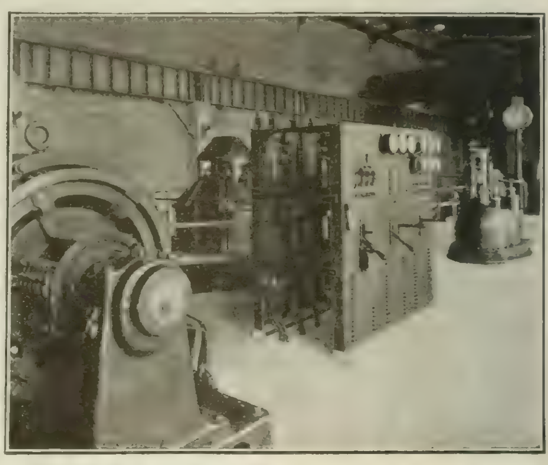


FIG. 25. VIEW OF OPERATING GALLERY IN MAIN STATION

Motor generator exciter in foreground, control switchboard for auxiliary electrical equipment in center, governor stand and gate-opening indicator on the right for unit No. 16.

The author of this article wishes to acknowledge the assistance and co-operation rendered, in the preparation of this story, by John L. Harper, vice president and chief engineer of The Niagara Falls Power Co., and his engineering staff, also by engineers of the companies supplying the hydraulic and electrical machinery.

John Lyell Harper

Chief Engineer and Vice President, The Niagara Falls Power Company

Two billion, thirty-four million kilowatt-hours output and eighty-four per cent load factor is the 1919 record of the Niagara Falls Power Company, which claims John Lyell Harper as its chief engineer and vice president. He never bosses his "boys." Yet all the engineering science, art and skill that so freely abound in this great organization pay tribute to his kindly, friendly direction and control.

That Niagara leads America in electrical output and load factor is due largely to the genius of this man, whose closest associates are never sure whether his seriousness is facetious, or his facetiousness is serious.

During the war, when there was a serious shortage of power at Niagara Falls and the War Department requested plans for the most economical development to utilize the remaining water available for diversion, it was the Hydraulic Power Company, of which Mr. Harper was chief engineer, that supplied the plan. Again, when all the power companies on the American side of the Falls were consolidated into The Niagara Falls Power Company, it was John L. Harper who was chosen chief engineer and vice president of this great organization. Mr. Harper's plan for the future development of Niagara Falls, whereby 60 per cent of the total flow of the river may be used for power development and the remaining 40 per cent so utilized as to give the Falls an esthetic value equal to or even greater than the present spectacle, has made this man a national figure.

Like all such men, he loves the soil. By vocation an engineer, he is a farmer by avocation. And so he supports a fruit farm, bordering the lower Niagara River, and peopled by little Harpers. His love of harmony is nicely exemplified by the color scheme that obtains on the farm. *Any* color is a good color, provided it is *buff!* From sleek Jerseys to rooting porkers, from Airedale dog to downy ducklings, buff is the color.

The Limitations of Efficiency in a Steam Engine

Why It Is Necessary To Throw Away Part of the Heat Supplied to It

BY DEWITT M. TAYLOR

A HEAT engine may be defined as a machine for transforming heat energy into mechanical work. Under this definition the word heat engine includes not only what is ordinarily called an engine, but in a steam plant it includes boiler, piping, engine, condenser, air pump and feed pump. All these are parts of the apparatus which transmit the energy from the furnace to the engine or turbine shaft.

The simplest conceivable heat engine requires four parts: A source of heat, a working substance that can be acted on by the heat and by its changes produce work, an engine proper in which the working substance acts, and a refrigerator to which the heat not used in producing work may be rejected.

The necessity for the first part is obvious—you must have a source of heat to run a heat engine. The necessity for a working substance may not be so obvious at first thought, but a very little study will make it clear. The technical definition of work is sometimes given as the action of a force through a distance. A more popular definition is that work consists of moving something against a resistance. Now the heat in the furnace of a steam plant, of itself, cannot move anything. If it is transmitted to the water, the latter expands in the formation of steam and will move the engine piston or turbine blade. In this case the water or steam is the working substance. It might be said that the heat will expand the parts of the boiler shell and so do some work. In this case the steel is the working substance and does work on the setting it displaces or on the atmosphere it pushes back as it grows larger. There have been engines built which developed power by alternately heating and cooling a metal bar, the movement of the ends of the bar being transmitted through ratchets to a rotating shaft. Of course such an engine develops very small amounts of power owing to the small changes in the metal bar, but it illustrates the fact that while a working substance is necessary, it need not be a liquid or a gas. Liquids, vapors and gases are generally used, however, because of their convenience.

Every engineer knows that a very large proportion of the heat of the steam used in an engine or turbine is thrown away in the condenser cooling water. Any suggestion that this heat be turned into power is met by the statement that this is impossible, that even in a perfect heat engine only a part of the heat can be used in the generation of power and that the remainder must be wasted. It is proposed here to explain the reasons for this statement and to show that it is true so that the nontechnical man may appreciate just what are the limits of efficiency in a heat engine.

The need of an "engine proper" in which the working substance can act is also obvious. Its real function is to transmit the movement of the working substance to the point where we want the force to act.

The necessity for the fourth part of the heat engine, a refrigerator, or as it has been called, a waste basket for the unused heat, is not so clear. It is convenient here to consider another requirement of a heat engine. This is, that for continuous operation the working substance must go through a cycle. It must pass through various changes, but must be returned to its original condition and continue to pass through the same change over and over again.

As an example, consider a condensing steam-turbine plant. The feed water in the boiler is made into steam, passes through the turbine, is condensed in the condenser and is pumped back into the boiler ready to go around the circle again. A non-condensing plant which exhausts to the atmosphere may seem to depart from this cycle requirement. Consider a pound of feed water entering the boiler and follow it through the plant until it is blown out through the exhaust head on the roof. Now if the plant is to continue to run, another pound of water must be fed to the boiler. Suppose the original pound of water came from a near-by river and the second pound is taken from the same place. The boiler does not know whether it has a new, strange pound of water or whether the original pound was condensed as rain, fell back into the river and was drawn into the suction pipe. The important point to consider is that from a thermal standpoint the effect is the same whether we return the identical pound of water to the boiler or use a different pound. Someone may insist that we can have no real cycle unless the original pound of water is returned to the boiler and, further, that we have no assurance that this original pound does get back. Assume for the sake of argument that the second pound is not identical with the first and that a third different pound takes the place of the second, etc. If we keep this up long enough, all the water in the universe may have passed through our plant and we will either have to stop or use some of the water a second time. This simply means that we have enlarged our system until it includes the universe instead of confining it to the four simple parts we started with.

Let us now see just how the steam does work on the piston. Fig. 1 shows the section of an imaginary steam plant. *A* represents a boiler connected to the cylinder *B* by the steam pipe *C*. Assume that the cylinder has a cross-section area of 2 sq.ft. and a stroke of 5 ft. and that the steam pressure is 1,000 lb. per sq.ft. If the piston is in the head end of the cylinder, the volume of the steam and water in the system is equal to the volume of the boiler and steam pipe. Suppose now that the piston travels to the other end of the cylinder, the volume of the steam is increased by the area of the cylinder multiplied by the stroke, or $2 \times 5 = 10$ cu.ft. If during this time the fire under the boiler has been kept just right, the pressure will have remained constant at 1,000 lb. per sq.ft. and the total force acting on the piston was $1,000 \times 2 = 2,000$ lb. This has acted through a distance of 5 ft., so that the work done was

2,000 × 5 = 10,000 ft.-lb. This might have been written all together as 1,000 × 2 × 5 = 10,000 ft.-lb. If we multiply the increase in volume, 10 cu.ft., by the pressure in pounds per square foot, 1,000, we get the same result. To express it in general terms, the work in foot-pounds is the pressure in pounds per square foot multiplied by the area of the piston in square feet and the length of the stroke in feet. If these last three quantities are represented by P, A and L respectively, we may write:

$$\text{Work done} = P \times A \times L$$

The product of A and L, however, is equal to the increase in volume, so that the work done is $P(V_2 - V_1)$ where V_1 is the volume of the boiler and steam pipe and V_2 is the volume of boiler pipe and cylinder combined.

Now if we are willing to stop, we have put some heat into the water, the engine has done some work and the piston reached the end of its stroke. If, however, we want to continue to run the engine, the piston must be pushed back to the head end of the cylinder and this may be done under various conditions.

Assume first that the fire is kept burning and the piston forced back. Heat is being added by the fire, and at the same time the volume of the steam is being decreased so that the pressure must be increased. Under these conditions it is obvious that it will take more work to force the piston back than was done by the steam on the piston during the forward stroke.

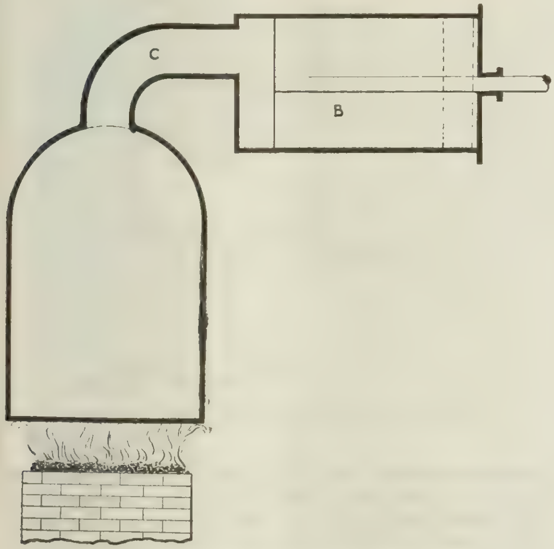


FIG. 1. IMAGINARY STEAM POWER PLANT

Suppose, now, that the fire is put out, but that the boiler, cylinder and piping are covered so that no heat is gained or lost. If the piston is now forced back, it is obvious that the pressure must rise, owing to the decrease in volume, although not so much as in the previous case. Under these conditions also the return stroke absorbs more work than the forward stroke produced.

It is obvious, then, that if the return stroke is to require less work than the forward stroke furnished, some heat must be taken out of the steam, or as it is usually expressed, some heat must be rejected. The rejection of heat necessarily implies some body to receive the heat, and it is this body which is referred to as the refrigerator in thermodynamic discussions.

In the actual steam engine steam is not admitted during the full stroke as in the imaginary engine just described. During admission the pressure remains practically constant and the steam in boiler and engine cylinder expands as in the case already described. After cutoff the steam in the boiler can no longer expand and as heat continues to be supplied, the pressure rises. The time until the engine valve opens for the next stroke, however, is so short and the amount of water in the boiler so large that the increase in pressure is in most cases unnoticeable.

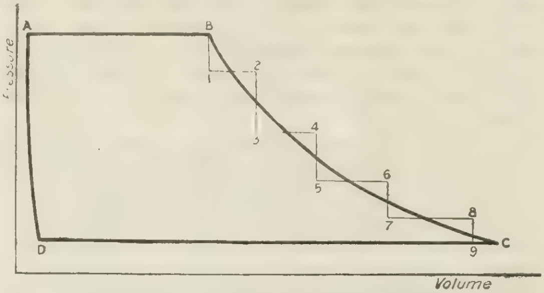


FIG. 2. PRESSURE-VOLUME DIAGRAM SHOWING STEAM CHANGES DURING A WORKING CYCLE

Meanwhile, the steam in the cylinder is increasing in volume and decreasing in pressure. The work done during this part of the stroke may be computed by assuming a number of constant pressure changes at intervals. Referring to Fig. 2, the line AB will represent the changes during admission and the curve BC the expansion. The work done may be approximately found by considering the broken line $B,1,2,3,4,5,6,7,8,9,C$ instead of the curve, and the greater the number of steps taken the greater will be the accuracy. The work done on any "step" is of course the pressure multiplied by the change in volume for that "step," and the sum of all these products is the total work.

This steam must be put back into the boiler if the engine is to continue in operation, and the amount of work required to put it there depends on the conditions under which the pumping takes place. If we leave it in the engine cylinder and force the piston back without cooling the steam, the relations between pressure and volume will be the same as during expansion and we have to put back all the work we got out of the steam. Suppose, now, that the steam is left in the cylinder, but that it is cooled by some means so that, as the piston moves back, the pressure remains constant at the pressure existing at the end of expansion. This process is represented by the line CD in Fig. 2, and the work done is equal to the pressure multiplied by the change in volume between C and D. This of course will be much less than the work done when passing from A to B and then to C. If all the steam has been condensed at D, the volume at that point represents that of the water, which of course, is very small as compared to that of the steam. To get the water back to the condition at A, the volume will decrease very little as the pressure rises to A and the curve DA represents this change.

The same thermal effect may be obtained by condensing the steam in a condenser outside the cylinder.

The idea of condensing the steam inside the cylinder was used in the first engines and was not abandoned until Watt showed that a separate condenser was possible and an improvement.

A similar study of any other form of heat engine—a gas engine, an oil engine or a hot-air engine, for example—will show that in all cases the working substance must pass through a cycle or a continuous round of operations. This study will also show that it is necessary to throw away some of the heat supplied by the fuel. The first problem of engine design, then, is to select a cycle which will result in wasting the minimum amount of heat. In the year 1824 a French engineer named Sadi Carnot devised a cycle which is still known as the Carnot cycle.

Carnot showed that if an engine could be built to work on this cycle, the proportion of the heat that must be wasted would depend only on the temperature of the source of heat and the temperature of the refrigerator. He further showed that for any given values of these two temperatures, no engine could operate at a greater efficiency than one working on the Carnot cycle. If we let T_1 be the absolute temperature of the source of heat and T_2 the absolute temperature of the refrigerator (absolute temperature is the temperature read on a Fahrenheit thermometer plus 460), then the efficiency of an engine operating on this cycle will be $\frac{T_1 - T_2}{T_1}$, or as it is sometimes written, $1 - \frac{T_2}{T_1}$.

No engine can ever be built to equal this efficiency because of the limitations of the properties of materials, etc. The Carnot efficiency does, however, set a standard toward which we can work and to which we can compare all engines. It also indicates the limit beyond which it is impossible to go under any given set of temperature conditions.

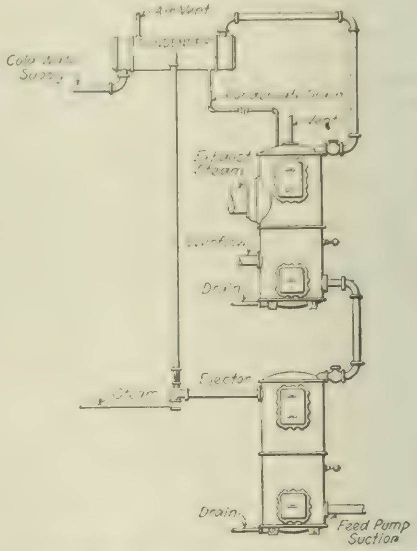
Air-Separating Process

Natural water as it is fed to boilers contains three classes of impurities—dissolved gases, dissolved solids and suspended matter. The purpose of this air-separation process is to remove the dissolved gases, but it also removes one class of the dissolved solids as well. Fundamentally, the process consists of heating the water to its approximate boiling point and then injecting it into a chamber under vacuum. The vacuum is maintained by an air pump with a condenser or heat exchanger in series, so that all the heat from the vapor exhausted from the region of vacuum is returned to the feed-water heater through the heat exchanger. The process operates at 100 per cent efficiency thermally, but thermodynamically the energy loss due to pumping from the region of vacuum slightly lowers the over-all efficiency.

Referring to the illustration, which is a diagrammatic layout of the system, which is manufactured by the Elliott Co., Pittsburgh, Pa., the sequence of the process is as follows: Water enters from the supply mains and passes through one side of the circulating system of the heat exchanger, from which it passes, still under supply pressure, to the inlet valve of the heater and is admitted to the heater under the control of a water-level float valve. Having been heated to the operating temperature of the heater, it passes under gravity head to a float-control valve of the separator. In proper time it passes into the separator, gives up its dissolved air, and the major part of the water passes through the separator to the pumps that supply the boilers. A small portion of it, however, is evaporated under vacuum conditions of the separator and is withdrawn mixed with air from the water by the air ejector producing the vacuum.

The mixture of air, vapor and ejector steam passes to the other side of the circulating system of the heat exchanger; the heat of the mixture is absorbed by the flow of the incoming supply water; the air escapes through the vent, and the condensate returns by gravity to the heater. The process has, therefore, lost no heat and no water, and only the air has escaped. This perfect head balance and the practically complete elimination of the air are the characteristics of the process. No heat as such is wasted, although some energy is consumed in pumping out the air and in overcoming the additional suction head on the boiler-feed pumps.

Irrespective of the arrangement of the auxiliary apparatus such as ejectors, heat exchanges, etc., the separating process may be applied to several conditions that are in line with rational practice. The separator may draw water from a heater and deliver the processed water to boiler-feed pumps for direct feeding to boilers. The separator may draw its hot water from a heater and deliver it through feed pumps to an economizer, or the separator may draw hot water from one section of an economizer and deliver it to another section.



DIAGRAMMATIC LAYOUT OF THE SYSTEM

The separation process removes nitrogen, hydrogen, oxygen and free carbon dioxide from the water. The first two of these are relatively inert, but the second two, oxygen and free or half-bound carbon dioxide, are responsible for the internal corrosion, which can be safely avoided by keeping the temperature of the water above the dew point of the flue gases. Under these conditions, the dew point being about 130 deg. F., there will be no condensation of acids from the gases and there will be no internal or external corrosion and no heat loss or operating charges.

Maintenance and Operation of Government Fuel Yard

THE responsibility for the purchase and distribution of fuel to Federal and municipal plants in the District of Columbia and surrounding territory, with the exception of the Navy Yard, has been vested in a Government fuel yard, provision for the establishment of which was made in the Sundry Civil Bill for the fiscal year 1918.

This yard is operated to insure the centralization of the purchase and distribution of Government fuel. Purchases are made at the mines. The object of the Government-operated yard is twofold—namely, to avoid the repetition of a coal shortage such as was experienced during the winter of 1917-18 and to provide facilities for taking coal into storage in the summer months as a protection to plants having but little storage space available.

The installation of a permanent yard was started in the winter of 1918-19, but was not completed until the present fiscal year. In the study of different types of equipment consideration was given to the difference in summer and winter requirements as affecting the demands of motor equipment and labor, and to meet the situation an effort was made to so design the yard that the trucks could be loaded in a minimum length of time as well as with a minimum amount of labor. Consideration was given only to types of coal-handling equipment which provided for the unloading of incoming coal independently of delivery operations and, conversely, for delivery operations to be equally independent of the labor force engaged in unloading.

A conveyor system of handling was installed. Coal arriving on the main line of the railroad is switched to one of two spurs. Each spur has a capacity of 16 cars, 8 in the unloading space and 8 in the space for empties, beyond the hoppers. As the spur track has a down grade of 1½ per cent away from the main line, the cars are easily moved.

The coal descends through the hopper upon the conveyor running beneath it, which has a capacity of 250 tons per hour. In passing over the conveyor, it is automatically weighed by an electric conveyor scale after which it is delivered by the conveyors either direct to the loading bins or else to the storage spaces.

STORAGE SPACE FOR COAL IN GOVERNMENT FUEL YARD

Contracts were given out for storage. The award was made on the basis of 69c. per ton for coal and $1.50 per cord for wood. The amount expended for this type of labor under the contract was $27,813.54. Believing that this cost was excessive, steps were taken to have the fuel yard's organization handle this phase of the work, with the result that a saving of $9,000 over the previous year was effected.

During the year 266,942.39 tons of coal, 689 cords of wood, 1,122.2 bushels of charcoal and 22.9 tons of coke were handled. All but 73,463.58 tons was delivered by truck at an average handling cost of $1.138 per ton. In this cost is embraced the expense of rehandling, incident to the reclaiming from storage of 17,562.32 tons. The total cost of this fuel to the departments was $1,904,071.41. The basic cost to the fuel yard was $1,674,147.14, leaving a margin of gross profit of $229,924.37 for the total cost of operation.

The average cost per ton for the yard was 26.6c.; for the garage, 65c.; for overhead, 9.4c.; and for household improvements and depreciation of equipment other than motor equipment, 15.8 cents.

The expense of the yard and garage operations for nine months (October 1 to June 30) was as follows: Stacker and conveyor, $4,061.75; unloading cars (3.009), $6,409.05; reclaiming coal, $3,306.75; loading and weighing trucks, $2,096.15; overhead, $19,720.29. The overhead embraces such charges as rental ($9,250 per annum), power and light current ($3,243) and salaries of supervising employers and watchmen.

Spontaneous Combustion of Coal in "Silo" Bunkers

In the April 6, 1920, issue of *Power* was published an article dealing with the completed improvements of the coal-handling facilities at the Cos Cob plant of the New York, New Haven & Hartford R.R. The completed part of the system consisted of two cylindrical concrete storage bunkers (silo type) 40 ft. in diameter and 46 ft. high, each having a capacity of about 1,000 tons of coal.

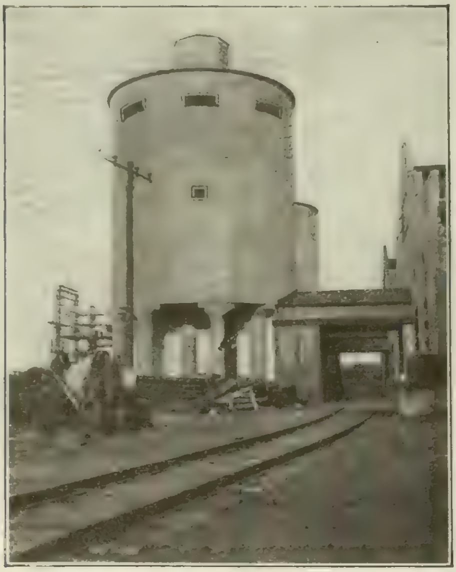


FIG. 1. COAL SILOS AT COS COB

Since these bunkers were put in use, trouble has developed from spontaneous combustion. This has given rise to considerable apprehension because of the possibility of the gases rising from the coal becoming ignited and causing an explosion that might wreck the bunkers.

Spontaneous combustion with Pennsylvania run-of-mine was caused by masses of coal becoming packed around the bottom edge and between the outlets in the bottoms of the bunkers. When fresh coal was delivered to the bunkers, this solid mass remained in a packed condition and therefore did not move out to be replaced by the newly received coal.

It is understood that the storage bunkers were originally constructed with flat bottoms. In order to facilitate the outflow of coal, sloping concrete deflectors extending from the outside wall toward the outlet gates were put in each, also an inverted V-shaped deflector running across the bottom of each bunker between the six outlets (see Fig. 2). All these deflectors have a slope of 45 degrees.

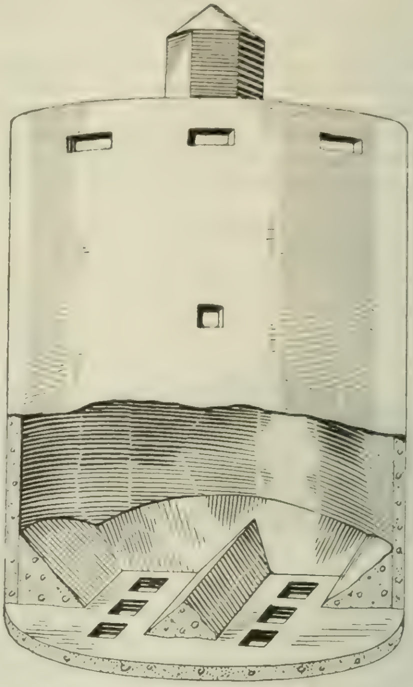


FIG. 2. SHOWING SLOPING-BOTTOM DEFLECTORS

Even with this bottom construction the trouble from packing coal has not been entirely removed, and it is proposed, if it becomes necessary, to replace these concrete deflectors with iron ones set at an angle of 60 deg. In order to remove the packed coal from the center deflector, an 18 x 18-in. poke hole has been cut in the side of the bunker about 20 ft. from the bottom. This is to permit of loosening the coal with a bar from a platform on the outside.

In case of the coal catching fire, there is the danger of an explosion of the confined gases. The method adopted to clear the bunkers of these gases consists of a series of ventilating openings, each 18 by 36 in., cut at intervals around the top of the bunkers, so that no matter in what direction the wind may blow there will be a current of air flowing across the top of the coal and out through the opposite vent hole. It is thought that this will remove sufficient gases to prevent an explosion and to permit of men getting into the bunkers when necessary.

"Y"-Box Resistors and Their Uses

By H. C. YEATON

If it should be required to reduce the voltage of a three-phase three-wire circuit when transformers are not available, a "Y"-box resistor may be used to advantage in many cases. Fig. 1 shows a "Y"-box resistor connected to a three-phase three-wire circuit. The voltage across each of the lines *AB*, *BC* and *CA* is 220 volts. A line is brought out from the neutral point *N* of the "Y"-box resistor, the voltage being reduced in the ratio of 1.73:1 or to 220 ÷ 1.73 = 127.2 volts between A_1N, B_1N, and C_1N. A_1N, B_1N, and C_1N have the same phase relations, respectively, as the legs in the main circuit *AO*, *BO* and *CO*. The amount of resistance in each leg of the "Y"-box resistor should be equal and should be designed so as to withstand, without overheating, any load to which it might be subjected. An experiment indicated in Fig. 2 might readily be performed to make the subject more clear. Take three ordinary lamps, rated at approximately 120 volts, and connect a terminal of each at a common point *O*. From the other terminal of each lamp connect a lead to each line of a 220-volt three-phase three-wire circuit. When connected in this manner, each lamp will have 127.2 volts impressed upon it, and all three lamps will burn at full brilliancy. Now disconnect one lamp lead from one line, and it is obvious that the remaining two lamps will be connected in series across 220 volts and the brilliancy of the two lamps will diminish. A "Y"-box resistor is used quite frequently with a single-phase indicating wattmeter when it is required to measure the power of a balanced three-phase, three-wire circuit as shown in Fig. 3. There are two resistance legs in the "Y"-box resistor, and the resistance of the potential circuit in the wattmeter forms the third leg of the "Y". The resistance in each leg of the "Y"-box is the same as that of the wattmeter's potential circuit.

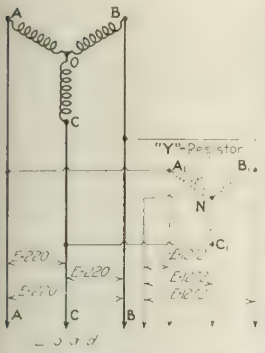


FIG. 1. "Y" RESISTOR CONNECTED ON A THREE-PHASE CIRCUIT

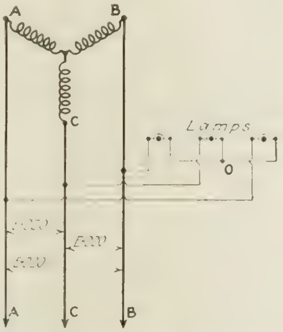


FIG. 2. THREE LAMPS CONNECTED TO FORM "Y" RESISTOR

The particular object of the "Y"-box, when used in connection with a single-phase wattmeter to measure the power of a balanced three-phase three-wire circuit, is to obtain the same phase relation between both the current and potential circuits in the wattmeter, as that of the phase in which the power is measured. In Fig. 3 the potential circuit from O_1 through the wattmeter has the same phase relation with the current circuit *C′* as the voltage and current of circuit *OC*. It is obvious that the wattmeter measures the current in the leg *OC*, and is connected across a voltage on the "Y"-box, which is the equivalent to the voltage across *OC*. This therefore measures the power in the *C* phase of the circuit, and as there are three phases, the scale reading on the single-phase wattmeter should be multiplied by 3 to obtain the total power of the circuit.

Frequently, it is desired to use a single-phase wattmeter to measure the power of a balanced three-phase three-wire system, when the voltage of the circuit is in excess of the voltage rating of the wattmeter. This can be accomplished by means of a "Y"-box multiplier, as shown in Fig. 4. Assume that a 2 : 1 multiplier is required to adapt the single-phase wattmeter to measure the power of a circuit of which the line voltage is twice that of the meter. The resistance in the "Y"-box multiplier from O_1 to *X* should be equal to the resistance of the wattmeter potential circuit, and the resistance in each leg of the "Y"-box multiplier from O_1 to A_1 and from O_1 to B_1 should be equal to two times the resistance of the circuit O_1X. To obtain the correct power in the three-phase three-wire circuit, the single-phase wattmeter readings should be multiplied by 3, the same as described in Fig. 3, and also by 2, since the multiplier has a ratio of 2 : 1.

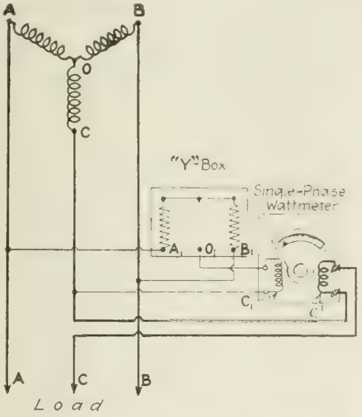


FIG. 3. SINGLE-PHASE WATTMETER CONNECTED THROUGH "Y" RESISTOR

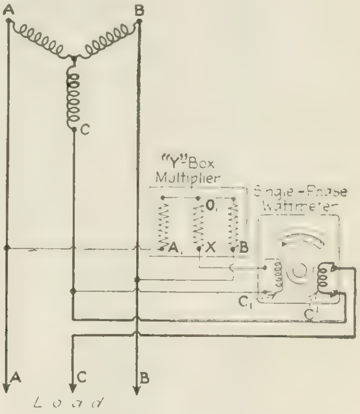


FIG. 4. SINGLE-PHASE WATTMETER CONNECTED THROUGH "Y"-BOX MULTIPLIER

"Y"-box multipliers, for other capacities, for use with a single-phase wattmeter to measure the power of a three-phase three-wire circuit can be calculated in the same way as described. Like all electrical resistances, "Y"-box multipliers should be so selected or designed as to withstand the watt load to which they will be subjected, without overheating.

Refrigeration Study Course—XV*
The Absorption Machine

By H. J. MACINTIRE
Professor of Mechanical Engineering, University of Idaho

SO FAR in this study course little has been said of the absorption refrigerating system, the type of machine that is least understood in refrigerating circles. However, this machine is important, is adapted to certain kinds of work and will continue to be sold and used for many years. It has, however, its particular sphere, and the future will see it more particularly confined to these limitations. For example, it cannot be operated with success without steam. But the high steam-pressure absorption machine is seldom used now, because as a rule the same result may be obtained much more economically by use of low-pressure (exhaust) steam or by the use of a steam-driven compressor.

Using exhaust steam in the absorption machine, a ton of refrigeration may be obtained for about 30-35 lb. of steam, or about the rate required in certain types of steam-driven compressors. In other words, we can practically double the tonnage, using the same steam, by the addition of the absorption machine. Is this a case of "getting something for nothing"? The answer is, no. We simply employ another machine, more investment and much more engine-room space to the purpose of securing greater economy. But are there any other advantages besides the use of exhaust steam (like exhaust-steam heating) for the production of refrigeration?

Yes, the one other great advantage of the absorption machine lies in its ability to secure a low temperature with slight increase of expenditure of power. As has been pointed out a number of times in this study course, the compressor gives the maximum economy with the highest possible suction pressure. This is because the tonnage varies directly as the number of pounds of ammonia condensed and later evaporated in the expansion coils. But this number of pounds varies with the so-called specific volume of saturated ammonia, which in turn varies indirectly as the absolute pressure. At low pressure this specific volume (the volume in cubic feet occupied by one pound) is so great that the standard compressor is frequently expressed as being only "fanning a vacuum." The standard compressor is unsuited for such service, as it has greatly reduced capacity and tends to overheat the ammonia on discharge. As has been considered already, for low temperatures use should be made of compound compression and not of the standard form of compressor. But how about the absorption machine? How does it work to secure economy at low refrigeration temperatures?

THE ABSORPTION MACHINE IN ACTION

The absorption machine is not a displacement pump in the sense of the compressor. The gas is carried over from the low-pressure side to the high-pressure side in the form of a solution at much reduced volume. For example, 5, 10 or 15 lb. of solution will carry with it a pound of anhydrous ammonia. This aqua (solution of water and ammonia) occupies $\frac{1}{12}$ to $\frac{1}{4}$ cu.ft. of space per pound of ammonia delivered irrespective of the pressure on the low side, which might be (for the one pound) 15, 20 or even more cubic feet. This peculiarity of forming a solution (weak aqua) is not absolutely liquefaction. It is simply a fact that water has the ability to dissolve a large amount of ammonia, say 500 to 1,000 volumes.

The result of the cycle of operations is that the ammonia may be boiled at any temperature, practically, and the gas formed will be conveyed to a so-called absorber. In the absorber the gas enters solution and the aqua formed in the process is pumped back into the "still" again, which is arranged for suitable heating by means of exhaust-steam piping (see Fig. 1). The exhaust steam heats the aqua (so-called strong aqua) in the still or generator and drives off a vapor mixture of steam and ammonia, the steam being almost entirely separated from the ammonia before condensation occurs in the ordinary type of ammonia condenser. This action is similar to that taking place with ordinary distilled water, oil refineries and in other industries. The idea is simply that a certain *concentration* of aqua —when heat is applied—will boil ammonia gas, and the boiling pressure is the vapor pressure in the condenser. Also, that boiling will continue until a certain concentration is obtained of solution in the still, unless the temperature of the aqua in the still is increased, in which event boiling will continue. As the temperature of the still is held constant, then to have continuity of boiling it is necessary to keep up a steady addition of strong aqua and allow the weak aqua (the strong aqua after boiling away the ammonia gas) to pass out of the still (also called a generator).

THE WEAK AQUA ABSORBS THE GASEOUS AMMONIA

The weak aqua from the still is made to go into the absorber, where it meets the gas produced by the action of boiling in the refrigerating coils (see Fig. 2). The gas comes into the absorber and is thoroughly mixed with the liquid weak aqua in a manner similar to the steam-jet condenser; that is, the gas is apparently condensed and carried away. There is, however, no real analogy between the absorber and other steam-power-plant equipment. The weak aqua does actually condense the gaseous ammonia and then absorbs it, forming thereby a stronger solution or concentration. This strong solution is called the strong aqua, and it leaves the absorber at a low pressure (the pressure in the refrigerating coils), a low temperature, but a strong concentration. It is the difference in the concentrations of the weak and strong aqua which materially affects the economy of the absorption refrigerating machine.

In a heating plant it is usual to see the boiler and steam distributing systems, the condensate return and the hotwell or tank, but there is always a boiler-feed pump to return the condensate from the hotwell to the boiler again. This is because the condensate line is at or near atmospheric pressure and the condensed steam

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*"The Refrigeration Study Course" article in the August 24 issue should have been numbered XIV instead of XVI.—EDITOR.

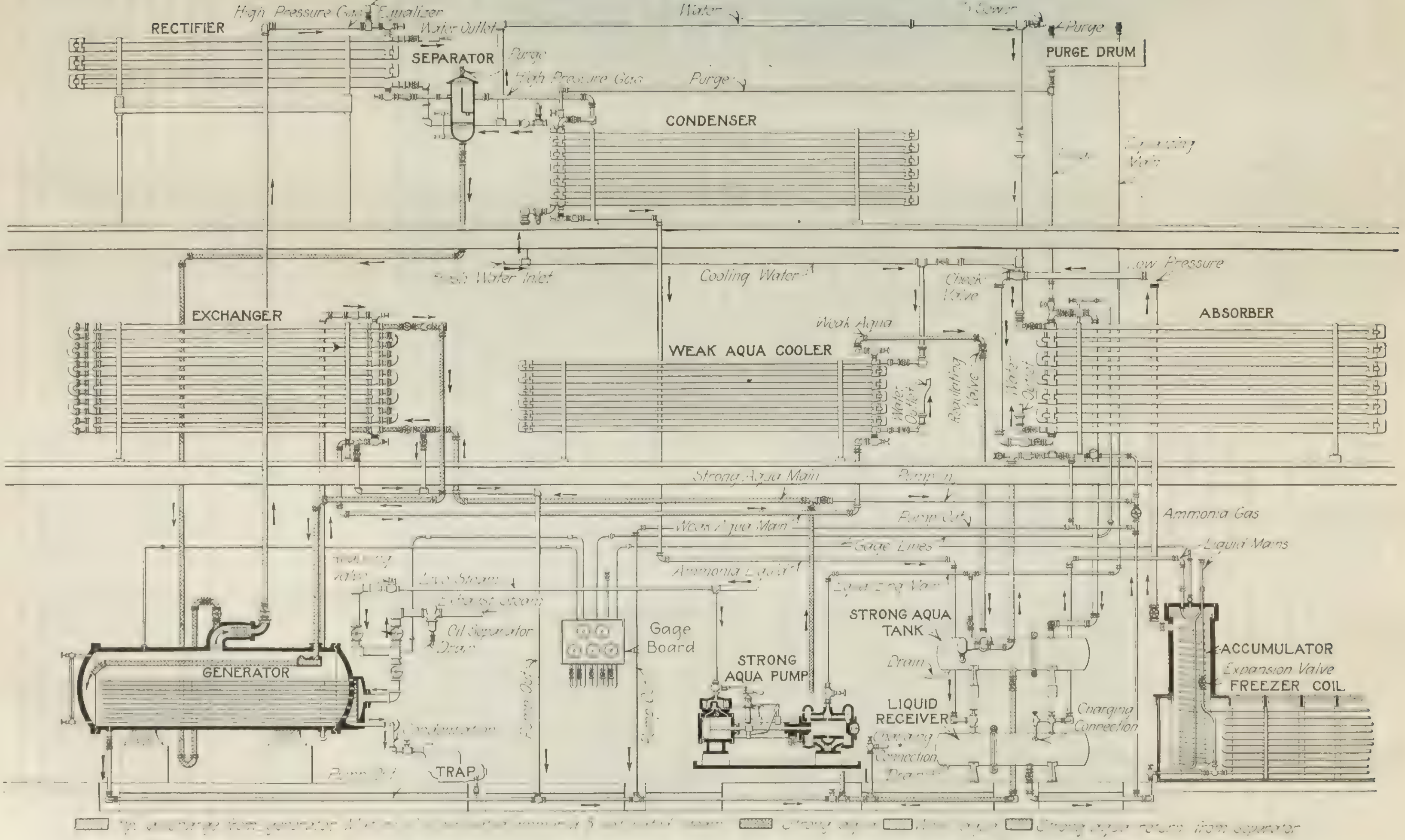


FIG. 1. LAYOUT OF TYPICAL ABSORPTION REFRIGERATING SYSTEM

and makeup cannot of itself return to the boiler. The same is true of the strong aqua of the absorption system, which is subject to the pressure of the low side and naturally cannot return to the still without assistance. This end is achieved by means of a strong-aqua pump, designed especially to handle a liquid which is readily volatile.

The strong-aqua pump returns the strong aqua to the top of the still, but in between the pump and the still is the so-called exchanger. The exchanger is usually a double-pipe apparatus designed to improve the economy of the plant. If one examines into the case, it is seen that the weak aqua leaves the still in a very hot condition. The strong aqua leaves the absorber in a relatively very cool condition. The exchanger is simply a counterflow set of piping arranged to cool the weak and heat the strong aqua. The strong aqua returns to the still with a temperature not much below that of the aqua in the still. Incidentally, the weak aqua has to be cool (like steam condensing water) to enable it to absorb more gas. The exchanger also aids in providing better economy by requiring less cooling water to be supplied to the absorber.

The only other special piece of apparatus in the absorption system is the device placed between the still and the condenser. This is a water-cooled rectifier, or dehydrator, used to remove the greater part of the steam in the gas from the still. It seems that during operation the gas leaving the still is superheated in the same manner as the discharge gas of the compression machine. It contains also some 10 to 20 per cent steam. To separate the steam from the ammonia, it is usual to pass the mixture through a system of piping which is water-cooled and to cool the gas to a point some 15 to 20 deg. above the point of saturation (the temperature corresponding to that of the condenser pressure). During the cooling process most of the steam is condensed and returns as a strong aqua to the still again by gravity (see Fig. 3).

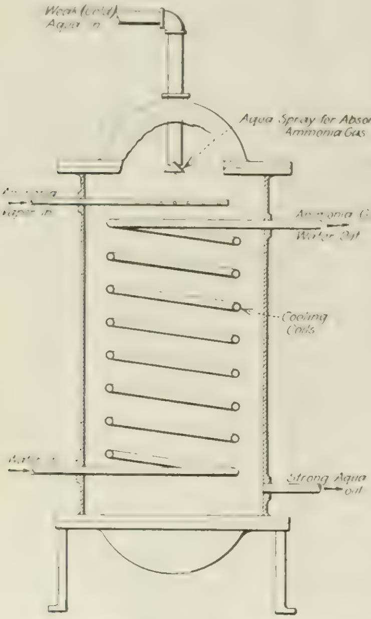


FIG. 2. CONSTRUCTION OF AN ABSORBER SIMPLIFIED. NOTE SIMILARITY TO JET STEAM CONDENSER

It is therefore seen that the absorption refrigerating system is more like a steam-heating plant except for the addition of certain special pieces of apparatus. The plant has a single moving machine, namely, the strong-aqua pump (provided the cooling and condensing water does not require pumping). The plant is also like a distilling system and, when understood, will give satisfaction. However, the amount of useful refrigeration performed is directly proportional to the difference in the concentrations of the weak and strong aqua. Also, the amount of liquid ammonia condensed in the condenser is directly influenced by the concentration, steam pressure and ammonia pressure in the still. It may be necessary to increase the concentration or the steam pressure (or reduce the condenser pressure) to get proper results, but when properly installed and maintained, the absorption machine gives excellent results. The machine is bulky, expensive in first cost and requires more water for cooling purposes. The absorption machine requires cooling water on the condenser, the absorber, the weak-aqua cooler and the rectifier. Whereas at times it is possible to use the cooling water successively in a number of these portions of the machine, yet sometimes two or more times as much water is required as for a compression plant of similar size where cooling water is required on the condenser and the compressor jackets only.

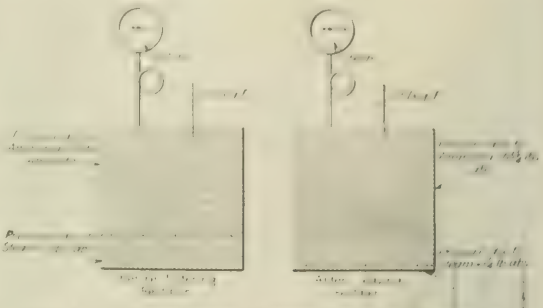


FIG. 3. ILLUSTRATING ACTION OF THE RECTIFIER

The particular advantages in the use of the absorption machine lie in the relative ease in securing low temperatures and in the ready use of exhaust steam after use for power purposes. Where high-pressure steam has already been used and is available as exhaust steam in sufficient quantities at nominal book value (or as a waste product) the absorption machine is readily applicable. The economy of operation must, however, overbalance the increased first cost, additional engine-room space and the occasional difficulty in securing efficient operating engineers.

It is natural to expect the absorption machine to be found in combination plants of all sorts, where, instead of running the steam engine condensing, the exhaust is sent through the coils of the generator. In general it does not pay to operate small steam engines condensing, and *no single-acting steam engine* of standard make should be so operated except as a means of securing condensed steam. The reason for this is because the so-called cylinder condensation becomes excessive where the range of temperature in the cylinder is large.

Therefore compounding should be employed when a condenser is used. And, therefore, engines of about 100 hp. and under should be simple engines and should not be run at a vacuum—here the absorption combination plant will fit.

In plants using considerable auxiliary steam-driven machinery the exhaust of which is not needed for boiler feed, the absorption machine may be used to advantage. And most certainly where low temperatures are desired, as in sharp freezers or in any industrial plant where brine at zero degrees F. is specified, the absorption may readily find its place. *Power* readers have noted the description of the Quincy Market Cold Storage and Warehouse Co.'s plants, and that it has been possible to work in the absorption machine to advantage. Also it will be remembered that the oil refineries are strong for this machine because of the low-temperature brine which they think they have to employ. The author believes that the absorption machine is valuable in special and particular cases.

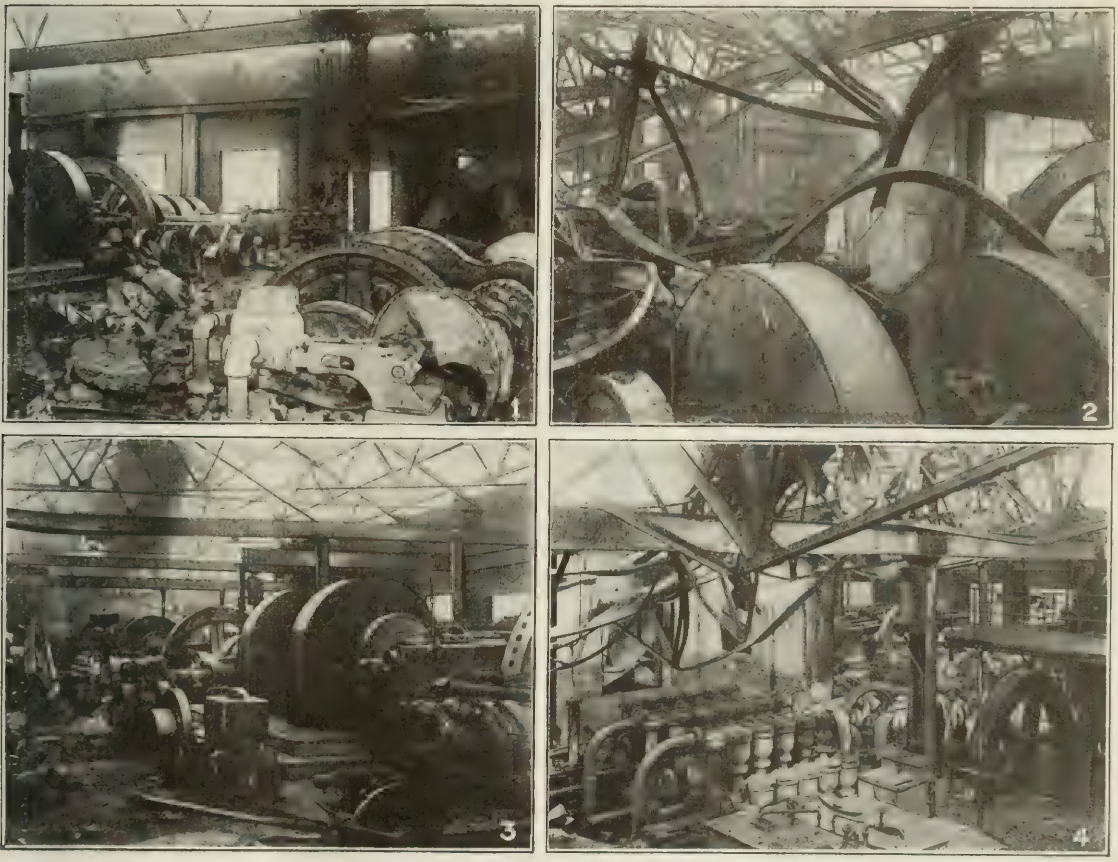


FIG. 1. GREELEY STATION FOUNDATION PLAN. FIG. 2. NO. 2 McINTOSH & SEYMOUR AND NO. 3 SNOW. FIG. 3. NO. 1 AND NO. 2 McINTOSH & SEYMOUR ENGINES. FIG. 4. McINTOSH & SEYMOUR ENGINE WITH PUMP

Show This to Your Coal Dealer

"This award . . . offers no justification for any advance in the retail price of coal, but on the other hand is consistent with a decline in prices."—*Report of the Anthracite Coal Commission.*

Diesel Pipe-Line Station Fire

On June 2 the destruction by fire of the Greeley (Kansas) pumping station of the Prairie Pipe Line entailed a loss of $1,250,000. Viewed from the standpoint of the Diesel-engine manufacturer, the loss is far greater, since the fire has caused this particular pipe-line company to abandon the proposed plan of replacing all the present steam plants with the Diesel units.

The Greeley station was a combined steam and Diesel plant, although the steam unit was not in use at the time of the fire. The engine house contained one triple-expansion National Transit steam unit, two 450-hp. Snow Diesel units, two 650-hp. McIntosh & Seymour Diesels and one 600-hp. Snow which had not been entirely installed. The National Transit steam cylinders formerly had been connected to the pump, which was being driven by a No. 3 Snow Diesel.

It will be seen from Figs. 1 to 4 that the fire destroyed the entire engine room. The boiler house, which appears at the left in Fig. 5, was entirely separate from the engine room and so escaped destruction. In addition to the loss of the plant a vast amount of oil was burned. The discharge lines from the several pumps passed through a valvehouse where the various gate valves were located. The fire was so intense that the valvehouse was destroyed. The discharge lines from Greeley to Osawatomie, Kan., are on a rising grade; the contents of eighteen miles of six 6-in. lines flowed back into the engine room and increased the loss. The oil flow was finally stopped by cutting into the lines. The flow of oil continued for about seventy-two hours.

The immediate cause of the fire has not been fully determined as there were apparently two possible ways whereby the initial explosion could have been produced.

The pumps are rated at 2,000 bbl. of oil per twenty-four hours and have a discharge pressure of about 700 lb. A flow developed in one of the discharge manifolds of the pump geared to the No. 1 McIntosh & Seymour engine. The oil, as it issued from the fracture, was broken up into a fine mist by the high pressure. The air within the building imemdiately became saturated with oil particles. As soon as the break occurred, the engineer stopped the Snow engines and the No. 2 McIntosh. It was impossible to get to the No. 1 engine, and the engineer left the building. He was joined by the oiler, and the two then started away from the structure. They had gained only a few yards before the explosion occurred. After the fire the No. 1 engine throttle lever was found in the "stop" position, both men disclaim recollection of having stopped this engine. As soon as the explosion occurred, the roof fell in and the whole building became a mass of flames.

Several features of the plant layout constituted fire hazards, and it is impossible to determine with any degree of exactness where the fault lay. The oil-pipe lines within the building were placed in pipe chases or trenches which communicated with the trenches containing the exhaust pipes of the Snow engines. These exhaust lines were not water-cooled and were protected by asbestos lagging, which was somewhat broken in several places. The McIntosh & Seymour exhaust lines were water-cooled and ran across the building on a level with the cylinder heads. The air-suction lines for the working cylinders and air compressors of the Snow engines had their intakes outside the building. The McIntosh & Seymour engines secured their air from within.

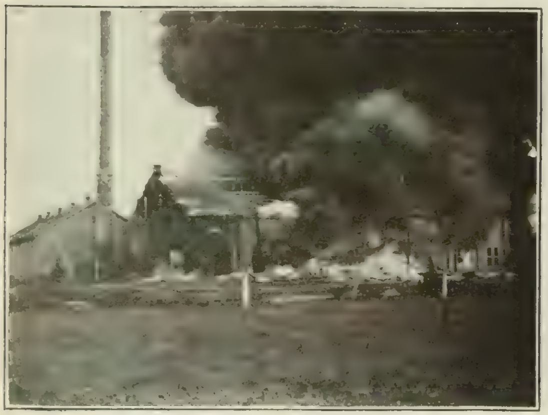


FIG. 5. PRAIRIE PIPE LINE STATION FIRE, GREELEY, KANSAS

It is claimed by some of the Prairie officials that the oil which saturated the air inside the building was drawn into the McIntosh air compressor and that as soon as it reached the high-pressure stage the temperature was high enough to ignite the oil. On the other hand, it is claimed by some, more familiar with the actual working conditions in this plant, that on several occasions oil had gotten into the pipe trenches and had ignited on coming into contact with the Snow exhaust pipes. Furthermore, the fire at the Buckner (Missouri) pumping station was caused by hot exhaust pipes. The Greeley station engineers claim that two explosions occurred; that the first was heavy, while the second, which quickly followed, was comparatively light. The latter was probably the explosion in the McIntosh air compressor, which was totally destroyed.

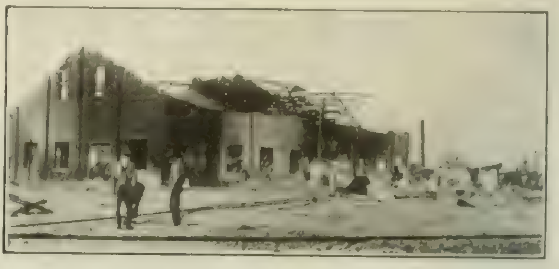


FIG. 6. PLANT AFTER THE FIRE

As already stated, this fire has had a very detrimental effect on the Diesel-engine industry. To an impartial observer it appears that there is no excuse for the condemnation of the Diesel engine; indeed, it should not even be on trial. Certainly, the method of installation rather than the engine is the underlying cause of the disaster. Formerly, it was the general practice to place fire walls between the oil pump and the source of power. It is to be regretted that this wise precaution was abandoned in many of the later oil-engined stations. At present many of the pipe-line companies are building these fire walls in their unprotected plants. No Diesel engine should be installed without provision for water-cooling the exhaust lines. More fires are caused by neglect in this matter than by anything else. Similarly, good engineering practice dictates the location of the air supply for both the working cylinder and the air compressor outside the building. If oil engines are installed properly, there is no danger of fire.

According to the *Electrical Review*, London, the paper mill and sulphite factory at Vargo, Sweden, which were destroyed by fire in 1918, have been rebuilt and again set in operation. Owing to the difficulty experienced in obtaining coal the directors of the Vargo company, in connection with the work of reconstruction decided to adopt electricity throughout, including the use of electrical boilers in the steam plant, and the works now consume no coal, whereas 20,000 tons per annum would be needed under former conditions. The boiler house contains seven "electric" boilers, each of 3,000 hp. Current is used in the boilers at 10,000 volts. Each boiler is provided with three electrodes, and the connection arrangements are such that steam generation can be regulated within 5 per cent. It is stated that full steam pressure can be raised in from five to ten minutes after switching on the current, and considerable economy in attendance is obtained, as compared with coal firing.

EDITORIALS

Power Development at Niagara Falls

NIAGARA FALLS has become practically synonymous with power and scenic beauty. One can hardly be considered without bringing the other to mind. There are few of nature's spectacles that surpass or even equal the esthetic grandeur of Niagara Falls, as there are also few sites in the world that can compare with it in hydro-electric power-development possibilities. Approximately, one million people visit Niagara Falls each year to view the beauty of the falling water, and each year there are billions of kilowatt-hours generated from the potential energy stored in this water. Intelligently controlled and utilized, Niagara Falls is capable of developing millions of horsepower instead of a few hundred thousand at present, and still retain its present natural beauty.

In this issue the leading article deals with power development at Niagara Falls, especially the most recent, which consists of three 37,500-horsepower units. This installation has many features of particular interest. It represents a distinct advance in hydro-electric engineering. This is all the more worthy of notice, since the project was conceived under the stress of war and a considerable portion of the work was carried to completion under these conditions. This development may be considered as one of the benefits coming to this country as a result of the war, since it was brought about by a serious shortage of power for the industries at Niagara Falls, vital in the production of war materials. This shortage made it imperative that the War Department do something to relieve the situation and sanction the utilization of the remaining water allowed to be diverted for power development by the treaty with Great Britain. As a result we have one of the most efficient water-power developments in the world today—a development that is not only of paramount importance to our industrial progress, but also makes possible a saving of approximately five hundred thousand tons of coal per year.

The efficiency of these machines is higher than that ever attained before for units of this type, ninety per cent of the total energy in the water being delivered at the generator terminals. A feature that contributes considerably to the efficiency is the two types of draft tubes used—one the White hydraucone regainer and the other the Moody spreading type. These tubes make it possible to recover approximately eighty per cent of the velocity head in the discharge. From the results obtained by the use of these draft tubes so far, it is apparent that they make possible far-reaching developments in hydro-electric engineering.

When the first plant was built that may be considered an attempt to develop power from Niagara Falls on a large scale, it was an undertaking that taxed the engineering talent of both America and Europe as well as the manufacturing facilities. From first breaking ground for the plant in 1890 five years was required before the first unit was put into operation—one of three 5,500-horsepower machines. In the latest development, nineteen months after permission to go ahead with the work was granted by the War Department, the first unit was put into operation and a month or so after the two other machines were put into service. In this case the three machines have a capacity of seven times that of the first units, and develop twenty-two horsepower per cubic-foot-second where the former developed only approximately eleven horsepower. The latest development is the work of the engineers of one company, and the machinery was designed, built and installed by American manufacturers. This achievement in itself shows the progress made in hydro-electric engineering in this country in the last thirty years.

Although this new development involves the design and construction of the largest hydro-electric units in the world and the whole project all the way through has proved to be one of the most successful pieces of engineering work of its kind ever undertaken, it nevertheless can hardly be compared with the project started in 1890. One was strictly the blazing of a trail into an unexplored region, the other the crowning achievement of thirty years' experience in the field.

Securing Maximum Efficiency from Oil Engines

THE Diesel and semi-Diesel oil-engine market is somewhat disturbed by the soaring price of fuel oil. The oil which could be purchased for two and one-half cents per gallon a year ago is now being quoted at eight to ten cents. This increase, while startling, would not be of any general importance if the oil engines now in operation were being run at their maximum efficiencies. Any modern Diesel can deliver a horsepower-hour on four-tenths of a pound of fuel. Unfortunately, only a handful of stations attain a fuel consumption of less than one hundred and fifty per cent of this amount. With two hundred and fifty thousand horsepower of Diesels in operation the fuel lost in one year due to inefficient operation amounts to some fifty million gallons. This represents a considerable loss of money. Of more moment, however, is this waste when considered as an unnecessary destruction of natural resources. The loss due to inefficient operation of the semi-Diesel engine is of equal if not greater amount.

It is useless to ask the operator of the average oil-engine plant to adopt more efficient methods. He is not equipped with the means of checking the results he does obtain. In the modern steam plant the engineer has coal and water weighers, indicators, CO_2 recorders and numerous other instruments to reveal losses. In the oil-engine station even an indicator is seldom seen and less often is it used. There is every argument in favor of efficiency instruments, and it happens that with the Diesel plant only a few are required. An indicator is especially required and should be used at least once a week to check valve settings. A CO_2 recorder should be attached to the exhaust lines. One of the recording type is desirable. Furthermore, pyrometers should be used on the exhaust lines from each engine. With such an equipment and imperfect combustion in the engine cylinders would be revealed by the lowering of the CO percentage in the exhaust. A variation in the reading of the pyrometers would at once indicate an unbalancing of the cylinders. Proper means could then be taken to secure an even distribution of the work in the engine cylinders.

If the power-plant owner hopes to secure the efficiency which he has been led to believe the Diesel possesses, such accessories are necessities. The oil-engine manufacturer can assist the Diesel to attain the popularity it deserves if he will see that each plant sold is completely equipped with efficiency instruments.

Supply and Demand and Coal Prices

THE price of coal is high, we are told, because the demand exceeds the production. Stocks have been drawn down far below the safety limit, and consumers know it. Production, although gaining, is at too low a rate to assure us of reaching a safe level of reserves before winter.

And so, in obedience to the implacable, the inviolable, the sacrosanct law of supply and demand, the price goes up and it is almost impious to complain.

But in the summer of 1919 the mines were idle a great part of the time for lack of orders. Plenty of railroad cars were on the tracks empty, waiting for loads of coal. Buyers knew this, and they knew that in obedience to the high and holy law of supply and demand the price of coal ought to drop.

But it did not!

Prices were kept up to the war level, and the public was beseeched in flaring advertisements, in newspaper interviews and in pronouncements by those in high places, to buy early and avoid the rush.

Now the consumer is told that the present shortage is his own fault; that he used up his reserves instead of buying when plenty of coal could have been had—at a price—and provoked the big coal strikes by forcing the miners to idleness.

Can it be that somebody has hitched a pawl-and-ratchet attachment to the implacable law?

Coal Storage and Mechanical Coal Handling

SECURITY in power-plant operation, whether private or public utility in nature, demands greater coal storage these days than in the days when railroad transportation was almost always adequate. The power-plant executive is, therefore, today confronted with a new problem in coal handling on a large scale. This comes most unfortunately at a time when every effort is being made to cut down the amount of labor required. However, the engineer has available many mechanical facilities for coal handling that are proving most efficient in practical operation. The report of the chief engineer of the Government Fuel Yards in Washington on the operations for the fiscal year ended July 1, 1920, give additional encouragement in this direction. These yards, handling over 250,000 tons of coal per year, have been operated with unexpectedly low costs, especially when one considers the conditions under which official work of this sort must be maintained. The chief engineer reports a total of 23.6 cents per ton as the yard operating expense for handling this fuel. This includes unloading from the cars, delivery either to trucks, truck bunkers or stock piles, reclaiming from stock and all related expenses. The total expense reported, $1.13 per ton, embraced not only these yard operations, but also the total garage and the trucking expense of sixty-five cents per ton, the overhead expenses of about nine cents per ton and depreciation and leasehold improvements, sixteen cents per ton.

Engineers confronted with the problem of irregular fuel deliveries—and what engineer is not so bothered?—can well consider whether machinery does not hustle better than men and whether some mechanical stocking and reclaiming systems, even one operating on a small scale, will not be essential in the future. This situation, of course, is further aggravated when high demurrage rates are imposed and the one-day rule prevails with respect to unloading coal cars. It seems that the problem will be important to everyone, regardless of whether he is confident the coal situation is going to be worse or better.

Respect for the Man Who Knows How

WISE indeed is the engineer who organizes his men to care for all unusual situations, even to emergencies. Unfortunately, some men do not and cannot keep from elbowing their way into jobs which their crews are doing well. If the chief "drops in" just to see how things are going and departs when he finds them satisfactory or after giving directions, his men not only do the work better, but have a higher regard for him than if he rolled up his sleeves and did the job himself.

There are times, however, usually emergencies, when the chief can endear himself to his men and command their undying respect and admiration. Of course he must be capable and unhesitatingly sure that he knows how to do the job or meet the situation before he "jumps into it" himself. The bluffer has no place here; such occasions demand a thoroughly practical knowledge of the fundamentals involved, plus a sureness of action that puts confidence into the frightened or puzzled crew that called on the chief when their combined ingenuity and knowledge failed.

Some men give considerable thought about just what to do and in what sequence, should this or that accident or emergency happen. Such a habit of thought leads to preventive measures to lessen the possibilities of accidents and emergency. It is a good habit to encourage.

The American Society of Mechanical Engineers has added a commendable feature to its election machinery in a pamphlet giving pictures and biographical sketches of the nominees for the several offices. The membership, even in a year when there is no contest, is given in this way a new interest in the personnel of the executive organization and an indication to which it is entitled of the probable attitude of the candidates upon policies in which the members may be interested.

The coal users of the country cannot individually protect themselves from the extortion which they are suffering at the hands of the coal dealers, but when united action by the people as a whole, governmental action, is urged, there goes up a wail of "Government interference."

CORRESPONDENCE

Why Not a License Law?

In reference to the letter by Mr. Webber on page 147 of the July 27 issue, I wish to say that New York has as good a law as any state in the Union, as regards the manufacture and inspection of steam boilers. Mr. Webber severely criticizes the civil service boards, stating in effect that politics is played, but this is not always the case. He also mentions a case in which an engineer should have received the appointment.

I have sometimes heard that all boiler inspectors' positions should be filled by engineers, but I will say that the boilermaker, the man who builds and repairs the boiler, certainly knows what he is doing and is just as well qualified to inspect as any engineer.

Mr. Webber relates an instance where a new boiler was purchased, which, it was claimed, lasted only eleven months before it was found pitted to such a condition as to render it unfit for service. The only reason given was that rain water had something to do with it, but for my part I would say that I hardly consider this a satisfactory explanation, for I have never before heard of a new boiler lasting such a short time. I really believe the purchaser got a second-hand boiler and that a fresh coat of paint was all that was new about it.

Of course we all realize what took place years ago, but matters have changed, for we now have up-to-date laws in regard to manufacture and inspection. I sincerely believe, with Mr. Webber, that we should have an examination for the operator of steam boilers, but because a boiler explodes it is not altogether the operator's fault. CHARLES W. CARTER, JR.

Olean, N. Y.

We want no political license, but we do want a license to protect the engineer holding it. If an engineer is given a license, give him what goes with it. A licensed engineer surely knows enough about his plant to tell what is needed and when it is needed. No sane engineer would put his company to a lot of unnecessary expense by ordering a lot of useless material.

In a certain plant there is a 40-hp. return tubular boiler. They have kept loading onto this poor little kettle until it requires nearly 100 hp. to run the plant. Now the owners are thinking of putting in forced draft and burning hard coal under this boiler. It was washed out July 17 for the first time in ten months and about a hundred pounds of loose scale was removed; it is nearly $\frac{1}{2}$ in. thick on the tubes and tube sheets. A worthless compound is used, but the boss knows more than his engineer. In order to clean the lower 1-in. gage-pipe connection to the water column it was necessary to break a cross-connection and then drive a $\frac{1}{2}$-in. rod through both ways in order to clear it. Before this was done, it required about ten minutes for the water to show after blowing down the water column.

When cleaning the combustion chamber, it was found that the back plate yoke had broken and fallen into the soot. The manhole plate had leaked so badly that the soot was wet. R. G. SUMMERS.

Syracuse, N. Y.

What of Lower Coal Prices?

We are writing to ask if there are any prospects of a lower price for bituminous coal within the next few months. Is the Government going to make some effort to regulate the price?

It is our belief the Government should have taken the subject in hand a long time ago and not have let the situation come to such a state. Our Government does not seem able to grasp matters very well. Things of public welfare seem to be ignored and left to drift according to fancy. BAINBRIDGE REPUBLICAN.

Bainbridge, N. Y.

Definitions of Efficiency

D. M. Taylor, in his article, "What Is the Efficiency of a Steam Engine?" page 178, of the Aug. 3, 1920, issue of *Power*, has carefully discussed and explained the various definitions of efficiency used on steam-engine work. The only exception that might be raised is to the use of the term "cylinder efficiency" for the ratio of the heat turned into work per pound of steam to the heat available per pound of steam from adiabatic expansion from the initial steam conditions to the final pressure.

In the first place the term "cylinder efficiency" is confusing, since it has been proposed to use this term for an entirely different factor when applied to an air compressor or to vacuum pumps. Furthermore, the use of the term "cylinder" is not logical, for the ratio to which Mr. Taylor refers is frequently expressed on the basis of work measured in brake and even in electrical horsepower. This expression of efficiency has been used and popularized by the manufacturers of steam turbines both here and abroad, who have referred to this factor usually as the "efficiency ratio referred to the Rankine cycle" or in short as the "efficiency ratio." This is the term now commonly used by engineers and is the one that will probably be used in the new Power Test Codes.

In the second place Mr. Taylor's method of calculating this factor consists of several steps, so that errors are more liable to be made than if a single calculation were used. This simple method is a rational development of the definition offered in the first paragraph of this letter.

$$\text{Efficiency Ratio referred to indicated horsepower (or brake or electrical horsepower.)} = \frac{2{,}545}{W(H_1 - H_2)}$$

where

W = Pounds of steam actually used per indicated horsepower-hour (or brake or electrical horsepower-hour as the case may be);

H_1 = Total heat per pound of steam at initial conditions before the throttle valve;

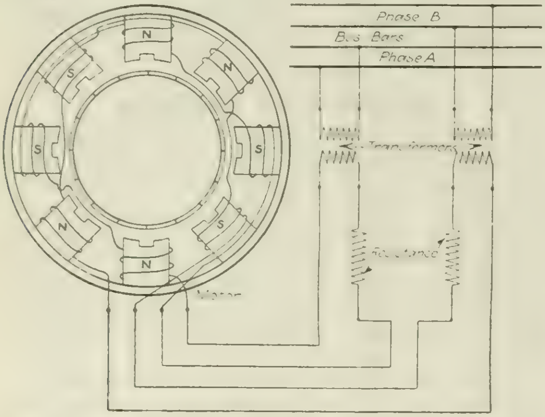
H_2 = Total heat per pound of steam after expansion at constant entropy to final exhaust pressure.

It is important that the basis on which the "efficiency ratio" is calculated, should be always specifically stated. That is, it should be stated whether the value refers to the "efficiency ratio referred to indicated horsepower" or to brake horsepower. Much confusion is caused by such a bare statement as "Efficiency Ratio = 70 per cent." One cannot judge whether this refers to indicated or to brake horsepower. The new Power Test Code of the A. S. M. E. will clarify many of these definitions and terms. A. G. CHRISTIE.

Baltimore, Md.

A Phase-Rotation Indicator

Upon installing a two-phase alternator for operation in parallel with a similar machine, it was desired to know its "phase rotation" before permanent connections were made. Not having any polyphase motors at hand, an indicator was made from an old discarded single-phase 110-volt 8-pole 60-cycle fan motor, the poles of which had shading coils. By removing the shading coils and dividing the field winding into two groups of four poles each two independent phases were obtained, thus making a 4-pole two-phase machine as shown in the figure. To prevent any possible excessive current flow when the motor was connected to the circuit, a resistance was improvised from an old flat-iron element.



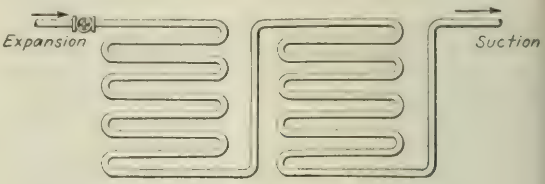
SCHEMATIC DIAGRAM OF PHASE-ROTATION INDICATOR

The fact that the number of poles was halved and the speed doubled by the new connection was of no consequence, since the rotor could stand the increased speed without harm and the machine would be in circuit only long enough for an indication. Two potential transformers were connected to the busbars and to the motor through the resistance, as shown. The rotation was noted when the busses were connected to the original machine, and then this unit was cut off and the new machine put on the busses and the phase rotation noted. If it proved to be the same as before, all connections could be made permanent, otherwise one phase would have to be reversed before doing so. This has proved to be a very handy device and may be of interest to other *Power* readers having such a motor on hand. HENRY MULFORD, Chief Elec.,

Patchogue, N. Y. Patchogue Electric Light Co.

Connection of Cooling Coils

I have a twenty-ton compressor pulling an ice-cream hardening room on the second floor, a brine tank in the basement and another brine tank in the milkroom on the first floor. The hardening-room temperature is anything below zero F.; the milkroom is at a temperature of 40 to 50 deg. F. The milkroom brine is kept at anything below zero F. The ice-cream freezer brine in the cellar is kept at from zero to 2 deg. above. We also have an eight-ton machine. At night we run the larger unit on the ice-cream brine and the hardening room and the smaller unit on the milkroom and the milk-cooler brine.



COILS AS NOW CONNECTED

If the expansion cocks on the hardening room are more than barely cracked, we get a freeze-back and get it quick. The coils all lie on racks and the ice-cream cans sit on these coils. The back pressure is 15 lb. gage; the condenser pressure is 120 lb. gage.

We are never able to see ammonia in the receiver glass. The receiver is horizontal and placed under the condenser, which has two stands. In the ice-cream hardening room we can hear a sound like water surging in the coils. I believe it is ammonia, because I can pump down to zero and in five minutes after stopping have from 5 to 15 lb. gage again.

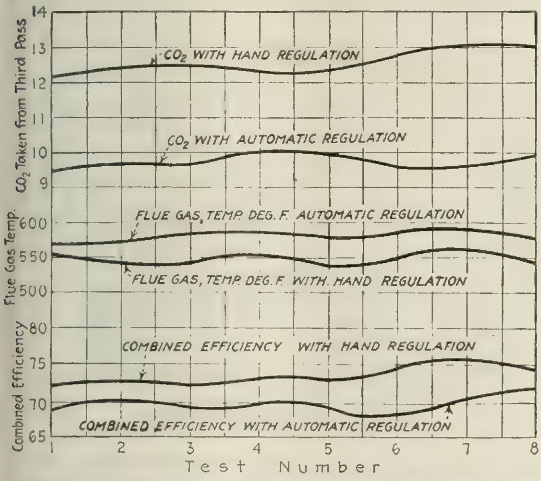
There are three hardening-room expansion cocks and two vestibule cocks. If all five are cracked ever so little, we get a freeze-back. The compressor is double-acting. If we work the big machine on the milkroom brine tank as well as on the ice-cream brine and hardening room, we get the same results and the milkroom brine warms up. All milkroom coils have a suction connection at the bottom and an expansion connection at top. All are short coils connected as shown in the sketch.

I advocate long coils with suction connection at the top and the expansion connection at the bottom. I have, in eight hours, pumped down 12 deg. F. on the ice-cream hardening room with the gage nearly zero.

Syracuse, N. Y. R. G. SUMMERS.

Automatic Regulation for Underfeed Stokers

Operating underfeed stokers, controlled by an automatic device to keep the steam pressure at a certain point, is a subject that should be given serious thought by any engineer who is contemplating installing them, because there should be taken into consideration various factors that will or will not permit of satisfactory operation. One of the most serious problems is to get a regulator to operate so that it will slowly open and close the control valve that regulates the stoker turbine or engine speed. Most regulators have a tendency to operate quickly with a variation of steam pressure, and of course this operates the valve lever quickly, with the result that the turbine is continually operating between two extremes, high and low speed, and in most cases the valves permit the steam to flow too fast to the turbine, quickly bringing it up to full speed. This is detrimental to the turbine and also has a decided effect on the fuel beds of the stokers.



CURVES SHOWING RESULTS OBTAINED WITH HAND AND AUTOMATIC REGULATION

Suppose the working pressure is 150 lb. and the regulator is set to operate at this point. The speed range of the fan and turbine is from 500 to 2,000 r.p.m. When the steam pressure is at 150 lb. the fan is running at 500 r.p.m., but if it drops to 145 lb. the fan speed will suddenly change to 2,000 r.p.m. and jump the air pressure, say, from 2 in. to 6 in. in the short space of from five to ten seconds. Then, perhaps after five minutes' operation at high speed, the steam would be back at 150 lb. and the air pressure would then change from 6 in. back to 2 in. as suddenly as it came. This kind of operation certainly decreases the efficiency of the stokers, as one of the things most essential to their successful operation is to maintain the proper ratio between the coal and air.

Different grades of coal require different amounts of air; and supposing you have a light fuel bed on one stoker and a heavy fuel bed on another and the air pressure suddenly increases from 2 in. to 6 in., what is going to happen to the fuel beds of these stokers? The heavy fuel bed will not be affected very much, but if you will look at the fire through blue glasses, you will notice large airholes in various parts of the fuel bed. The light fuel bed will be in a very bad condition, because of not having sufficient coal on the tuyeres to withstand a higher air pressure.

Automatic regulation makes nice-looking steam charts and makes it easy for the firemen, but it surely is hard on the coal pile. From tests that I have run on various kinds of fuel, both with automatic and with hand regulation, I am convinced that where good firemen are available automatic regulation will surely show a decrease in efficiency, varying in some cases from 3 to 7 per cent.

The accompanying curves are of various efficiencies, CO_2 and flue-gas temperature averages taken on tests that I have run, and I believe that these results prove my statement to be true.

In most cases with automatic regulation the flue damper must be kept in the wide open position because, when the fan is operating at full speed, it requires the damper to be in that position in order to take care of the increased volume of flue gases, otherwise a pressure is created in the furnace. This results in an increased gas velocity and greater loss in flue gases, as it is impossible to carry a low suction in the furnace when the damper is wide open, and therefore the flue temperature is increased considerably.

It will be noticed that when operating the boilers at the same percentage of rating, there is an increase, when using automatic regulation, of from 20 to 40 deg. F. in the flue-gas temperature, over hand regulation. This loss can be cut down if the firemen have differential draft gages to control the suction over the fire and regulate their flue dampers to maintain a certain low draft suction over the fire at all times. This is almost impossible to do in forced-draft stokers equipped with automatic regulation, because one has to be continually changing the boiler damper position to take care of the increased or decreased volume of gases caused by the various fan speeds due to the regulator control. Therefore, it would seem that where automatic fan control is used, it is important that an automatic control system be used to operate the boiler dampers.

In most of the plants using automatic regulation, the regulators and valves are not set and connected up to get the best results. The steam line to the diaphragm of the regulator should never be connected to an auxiliary steam line or to a header where the wiredrawing of steam occurs, but it should be so connected that the true boiler pressure only will effect the movement of the regulator. The water pipe, which furnishes the water pressure to operate the piston of the regulator, should have a valve close to the regulator, and this valve should be opened just enough to allow the water to reach the cylinder slowly, so that it will not act on the piston too quickly; it will therefore have a tendency to operate the turbine or engine balance valve much slower.

If the regulator then operates the balance valve too quickly, lengthen the balance-valve lever to about thirty inches and drill six holes in the lever about one inch apart and set the connecting chain on rod to the regulator in the hole where the best results are obtained. In all cases where I have experimented with automatic regulation, I have found that if these suggestions are carried out, it is possible to get very near ideal operating conditions when operating in conjunction with a good balanced damper-control system to control the draft over the fire automatically with the various air pressures used under the fuel bed. This is absolutely necessary where economy is desired, as it is almost impossible to get firemen to set the boiler dampers by hand when the air pressure changes often, as with automatic fan control.

From years of experience with underfeed stokers, I am firmly of the opinion that, from an economy, performance and operating standpoint, it is not good engineering to use automatic control for the fans unless the boiler dampers are also controlled automatically to operate in conjunction with each other. Therefore it would seem that it is better to control the stoker and boiler equipment by hand, rather than to have inferior automatic regulation. D. C. HESS.

Lester, Pa.

Heater and Feed-Water Control

I once accepted a position as engineer at a small electric-light plant where they had had a great deal of trouble—in fact, so much that the people were disgusted and were about to cancel the contract and franchise, claiming that the machinery was no good. The equipment included an 80-hp. high-speed engine, one return-tubular boiler, one single-phase alternator, and an open feed-water heater with no control valve in the supply. This plant also pumped the city water.

I arrived at the plant one day at 11 a.m., made a survey of the machinery and listened to the complaints of several citizens and of the man in charge. At about 4 p.m. I started up with the engine pounding in the crank, crosshead and main bearings; the alternator seemed all right with the exception of a small spark at the rectifying commutator. I soon observed that I was not getting hot water from the heater, and about 5 o'clock I saw that the water in the gage glass was milky. It was blown out, but still it was the same, and by this time the spark on the alternator had grown so big that I did not need a light in the engine room. In fact, it got so big that I had to shut down. I reset the brushes and started again. This did little good, but I managed to get by until 12 o'clock, when I pulled the fire under the boiler.

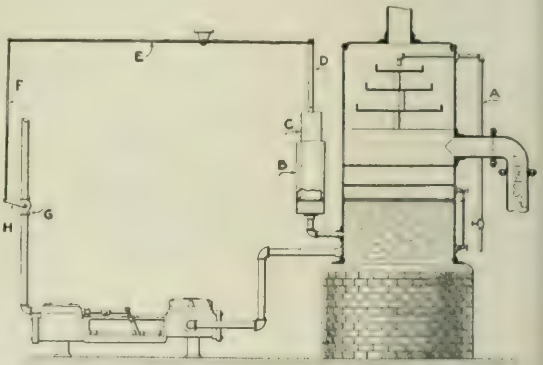
The next morning I reported to the manager and asked for two men. When we opened the boiler, we found mud eight inches deep in the back end and about one inch in the front. Why the boiler did not burn is a mystery to me. We took some pieces of chain and went over the tubes as best we could with the time we had, and I want to say that there was a difference in the firing of the boiler.

While one of the men was getting up steam, the other and myself went after the alternator. After examining the commutator carefully, I found that someone had had it off. We took a sandstone, some sandpaper and a file and dressed it down as soon as we got enough steam to revolve it. It acted about the same as it did the night before, so the next day I made a water rheostat and turned the commutator around on the shaft ¼ in., put 20 amperes on the machine and it sparked worse than ever. We shut down, turned it back ½ in. and it did so much better with the same load that we shut down again and turned the commutator back some more and put on the load. Our fireworks had disappeared, showing that the commutator had been out of step with the polepieces.

The next day we went after the engine. The bearings were worn down on the brass, so we rebabbitted them and took about ⅛ in. of liners out of the main bearings. Upon starting up, the engine ran fine; it seemed as though we were shut down when the plant was running, there was so much difference.

The heater was next opened, and it was found that the water went in at the bottom and out at the bottom, although there was an opening at the top for the water to enter. I later learned that the water got so hot that the pump would not handle it, so the engineer removed the pans and threw them on the junk pile in the rear of the lot and changed the water inlet to the bottom of the heater. This heater was set about one foot off the ground and the pump 18 inches.

There was but one thing to do and that was to raise the heater. On investigating we found that we could raise it five feet, so we procured the service of a brickmason, and by starting at 1 a. m. the heater was in place and connected up at 1 p. m. I gathered up the discarded heater pans and screens, which were still on the scrap pile as luck would have it, put them in place and started up the engine. We got hot water but the pump would not work. I removed the top of the water end and, on turning on the water, found that the springs on the suction valves were too stiff. I took them out, stretched them and cut off two turns, then replaced them, and on turning on the water, the pump cylinders were flooded. My trouble was ended so far as the pump was concerned.



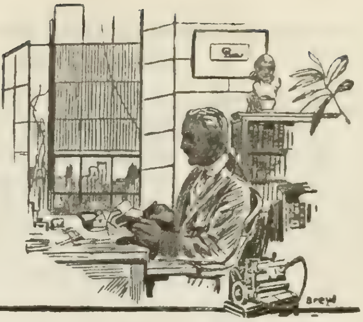
HOME-MADE PUMP CONTROL

The next thing was to get a regulator to govern the water level in the heater. How this was accomplished is shown by the accompanying illustration. Water enters at the top of the heater through the supply pipe *A*, flows over the pans and is heated by the exhaust steam which enters at a point below the pans. The water level is controlled by a galvanized-iron external float, made by the local tinner. The outside tank *B* is 10 x 20 in., and the inside one, *C*, is 8 x 20 in. It will be seen that as the water rises in the heater the float *C* rises, which carries a system of levers *D*, *E* and *F*, which are connected to the throttle valve *G* of the feed pump through the lever *H*. It will be apparent that the faster the water rises in the heater the faster the pump will run, and instead of regulating the supply to the boiler from the feed pump it is regulated from the water tower, not shown, at the valve in the pipe *A*.

After these changes were made, the plant ran like a new one; the people were much pleased and were convinced that the plant was not at fault after all, but that it was all up to the man who ran it.

East St. Louis, Ill. E. LITTLEFIELD.

INQUIRIES OF GENERAL INTEREST



Speed of Governor with Increase of Engine Speed—When an engine is speeded up, does the governor run any faster? M. F.

When speeding up is accomplished by a change in size of he driving pulleys or gear wheels, the governor makes the same speed as before, but if speeding up is accomplished by changing the governor weights or springs without changing the governor drive, then there is necessarily the same percentage of increase of the governor speed as of he engine.

Indicator Diagrams from Compound Engines—For the purpose of considering the valve setting of a compound engine, is it admissible to rely upon indicator diagrams of one cylinder taken at a different time from diagrams taken from the other cylinder? H. R. J.

The diagrams should be taken simultaneously, or at least so nearly at the same time as to insure the same conditions of load, engine speed, initial pressure, points of relative cutting-off and same back pressure. Otherwise the actual distribution of steam is largely conjectural, for the diagrams are not truthfully representative of relative performances of the cylinders.

Selection of Most Economical Degree of Superheat—In designing a new turbine station, how is the most economical degree of superheat arrived at? P. A. Y.

There generally will be saving of 2 to 4 per cent in the cost of fuel for each 100 degrees of superheat of steam at 150 lb. gage pressure. The use of a high degree of superheat is a matter of first cost and cost of maintenance against the price of fuel, depending also on the type of turbine, the load factor, the size of the units and the nature of the service as regards severe and frequent variations in the load, also having in mind the practical operation of suitable superheaters, steam piping, valves, pumps and auxiliary machinery.

Computing Indicator Diagrams Separately—In computing the indicated horsepower shown by indicator diagrams from a double acting engine, should the power be figured separately for the two ends of the cylinder, or may the net piston areas and mean effective pressures for the two ends be averaged? R. B.

For close computations, the power developed in each end of the cylinder should be computed separately as two single-acting engines, taking the sum as the total power indicated. When the values of net piston area and mean effective pressures are averaged, the calculation generally will result in a close enough approximation for most practical purposes, provided the mean effective pressures are nearly the same.

Air Chamber for Boiler-Feed Pump—What should be the size and shape of an air chamber to go on a boiler-feed pump? R. S. T.

The air chamber may be made of a large size of pipe capped at the upper end or may be of cast iron, made cylindrical or pear-shaped, the latter for greater strength of casting. The shape is immaterial so long as the vessel is strong enough to withstand the water pressure with safety and is large enough. It should have a capacity of at least six times the volume of displacement of the water cylinders, and greater volume will give smoother operation. The air chamber should be provided with a pet-cock near its lower end and another at the top for occasionally draining off the water and refilling air.

Exhaust Valves Must Not Have Lap for Compression—For obtaining compression on a single-eccentric Corliss engine, why is not lap given to the exhaust valves? M. F. S.

If compression is obtained by giving lap to an exhaust valve, thus causing it to close the exhaust port before the piston reaches the end of the stroke, it would also make the valve later in opening and the steam would not be released at exhaust until after the piston had completed its stroke. Hence the proper method of obtaining compression is to advance the eccentric beyond the 90-degree position and thereby obtain earlier release and earlier compression. Then to avoid excessive lead, that is, to hold the steam valve closed during the period of compression or until it is desirable to have the live steam admitted, it becomes necessary to give lap to the steam valve.

Operation of Reciprocating and Centrifugal Pumps in Parallel—Can a centrifugal and a reciprocating pump be operated in parallel for boiler feeding? J. K.

When a centrifugal discharge is connected into a feed line through a Y-branch, it can be operated in conjunction with a reciprocating pump discharging into the same feed line provided the reciprocating pump is fitted with an air chamber that prevents pulsation of the discharge and is not operated fast enough to maintain a feed-pipe pressure higher than the pressure that can be built up by the centrifugal. As the action of the reciprocating pump will be positive, the delivery by the centrifugal will not be parallel in the sense of bearing a constant ratio, but will be the additional flow that can take place through the check valve and the feed-pipe connections at the highest pressure that can be built up by the centrifugal.

Greater Efficiency of Exhaust Steam for Heating—What is the reason for exhaust steam heating up a building quicker than live steam? W. B.

Exhaust steam usually is wetter, containing more water swept along with the steam at the same temperature than in case of steam of quality generally discharged by a low-pressure heating boiler, or that is made drier when discharged through a pressure-reducing valve. Exhaust steam thereby contains rather more heat units per cubic foot, and the conduction of heat to pipes, coils and radiators is more rapid with wet steam than with dry steam. But where the steam supplied is of the same actual quality and pressure, there is no difference in the time required for heating up a building by live or exhaust steam, and the greater efficiency commonly attributed to exhaust steam is generally due to a more liberal supply and maintenance of actually higher pressure and temperature of the steam.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses —Editor.]

German Development of the Gas Turbine Since 1914*

The older readers of *Power* will remember the work of Hans Holzwarth on the gas turbine. In the issue of Feb. 6, 1912, was described a unit of 1,000 hp. which he had completed and tested at Mannheim. The work was done under the patronage of Thyssen & Co., and since the war it has been resumed at its establishment at Rhur. The new turbine is built along the lines of that built at Mannheim.

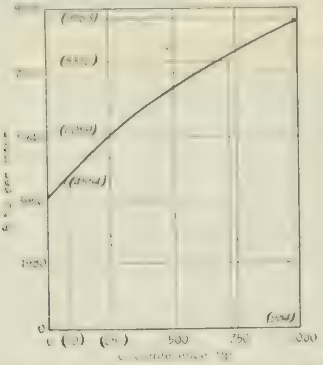


FIG. 1. TOTAL HEAT SUPPLIED COMPARED WITH POWER AT THE WHEEL

The objects sought by the inventor in the later design are:

1. Increase of the load and explosion pressure.
2. The development of a bucket and a method of fastening it to conform with the increased power conditions.
3. Shortening of the expansion period.
4. Testing of the most appropriate bucket form for continuous use.
5. Development of the most efficient type of nozzle.
6. Development of a nozzle valve suitable for carrying the higher load pressure and of a larger cross-sectional area.

It is the hope of the inventor to create a simple gas turbine which it will be possible to build in large quantities and the first cost of which will be smaller than that of a steam turbine with the necessary boiler equipment or of an internal-combustion engine, and whose total economy will be greater.

How far this object has been accomplished the following will show:

1. By increasing explosion pressure the work per cubic meter of cylinder area and the thermal power efficiency was increased.

In continuous running tests, the average explosion pressure was raised from 12 to 14 atmos. abs., as compared with 5 to 6 atmos. abs. of the Mannheim turbine.

2. The shorter the explosion period the less heat will be lost to the cylinder walls and therefore more heat will be changed into mechanical energy and the efficiency will be materially increased.

At present the time of expansion in the gas turbine is approximately 0.1 sec. In a large gas engine running at 90 r.p.m., the expansion period is about one-third of a second. Fundamentally, there is nothing to prevent a further decrease in the expansion time of the gas turbine. To do this it is necessary to increase the cross-section of the nozzles which also increases the length of the turbine blades and the flow resistances.

3. With the decrease of the expansion time the bucket pressure is increased. In the steam turbine this bucket pressure works uniformly in a comparatively small passage. In the explosion gas turbine the jet works intermittently, by short impulses in the form of a blow. Under those conditions the familiar type of bucket form is entirely unfit. A bucket is said to have been already developed which is equal to the severe requirements of continuous use. This form corrects the turning action due to the jet and provides an ample margin of safety against defects in material and workmanship. The base of the comparatively long bucket fits into a groove machined in the face of the wheel and fastened by a key driven in a slot in the bucket, which expands it in the groove. The head, body and root of the blade are made of one solid piece like the blading of a De Laval turbine.

After a number of tests and experiments soft electro-iron made in the steel works of the Thyssen Co., after proper heat treatment, proved adequate for gas-turbine service. Blades of this material stood up much better than those of harder steel or steel alloys.

De Laval nozzles and nozzles with parallel walls were tested with the result that the former type was found most suitable. Increased explosion pressure called for a further development of the nozzle valve. The object of the valve is to close the explosion chamber gastight until the ignition occurs, and to leave a large opening for expansion, quickly allowing gases to pass to the nozzle without throttling. These conditions were successfully met, and the charging and explosion pressures were increased so that ignitions are complete.

In December, 1919, a number of tests with coke-oven gas were made, as shown in Fig. 1, on the turbine built by Messrs. Thyssen & Co. The amount of gas was calculated according to the swivel baffle method. The heat value of the gas was determined by the Junkers calorimeter and found to be, on an average, 3,860 calories per cubic meter (Zero deg. C., 760 millimeters mercury). An electric load was carried on a water resistance. During the whole series of tests all the ten chambers were working and at lighter load none of the chambers were switched off. In regular operation it is intended to switch off some of the chambers by means of the governors, thereby materially improving the efficiency under partial load. The test lasted about one hour.

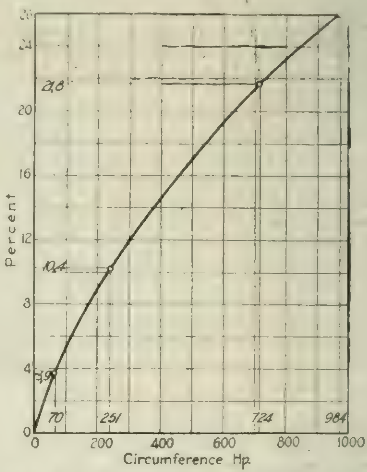


FIG. 2. OVER-ALL EFFICIENCY MEASURED AT THE CIRCUMFERENCE OF THE WHEEL DEPENDING UPON THE OUTPUT TRANSMITTED TO THE WHEEL

Test No.	1	2	3	4
Quantity of gas at 0 deg. C., 760 mm. mercury cu m per hour	300	400	550	660
Quantity of heat admitted kg. calories per hour	1,150,000	1,530,000	2,110,000	2,415,000
Output transmitted to the wheel (useful hp.)	70	251	724	984
Heat consumption Kg. calories per hp.-hr	16,430	6,090	2,915	2,450
Efficiency at the circumference of the wheel, per cent	3.9	10.4	21.8	26

Figs. 1 and 2 have been plotted, the amount of heat admitted per hour and the efficiency at the circumference dependent upon the output transmitted to the wheel being expressed in circumferential horsepower.

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*Abstract from the Zeitschrift Des Vereines Deutscher Ingenieure.

The work necessary for compressing air and gas amounted to about 5.7 per cent of the waste heat. If the efficiency of the compressors is taken to be 70 per cent, that of the exhaust steam turbine 18 per cent, and that of utilization of the waste heat 60 per cent, a total efficiency for the waste-heat plant and compressor sets of 0.7 × 0.18 × 0.6 = 7.6 per cent may be obtained.

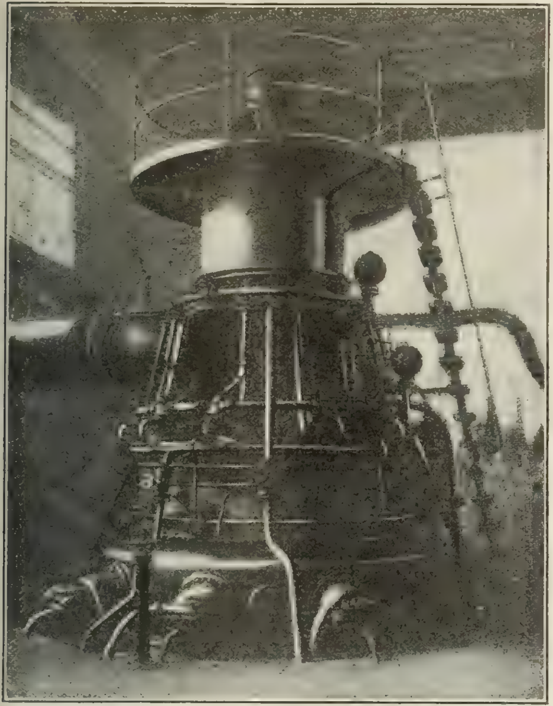

FIG. 3. ONE THOUSAND HORSEPOWER GAS TURBINE

With plants of this description it is easily possible to satisfy the power consumption of the blower out of the waste gas heat.

The Federal Water Power Commission Receives Applications for Permits

A number of applications for permits and licenses for the utilization of water power and the construction of power plants have been filed with the Federal Water Power Commission under the provisions of the Water Power Act passed by Congress at the last session.

Each application will be considered on its merits, it is announced, and the prior date of an application for a permit to a power site will be given cognizance only when all other factors are equal. The list of applicants, with the proposed power sites, is as follows:

Alabama Power Co., preliminary permit for hydro-electric plant on the Coosa River in Alabama, below Government Lock No. 2; Speel River Power Co., San Francisco, preliminary permit for power project to be located in the Tongass National Forest in Alaska; C. A. Heberlein, Prescott, Ariz., preliminary permit for project in Cataract Canyon, Coconino County, Arizona; Dixie Power Co., Chicago, Ill., preliminary permit to construct a dam across White River, near Potter, Baxter County, Ark.

Far West—Pitt River Power Company, San Francisco, preliminary permit for power project on Pitt River, California; R. W. Hawley, San Francisco, preliminary permit to develop project on Silver Creek and its branches in Eldorado County, Cal.; Beckman & Linden Corp., San Francisco, preliminary permit for project on Colorado River in Arizona and California; G. W. Spoerry, Bonners Ferry, Idaho, preliminary permit for project on Moyie Falls on Moyie River, Idaho; Utah Power and Light Co., preliminary permit for Soad Point, Lava, Narrows, and Mink power sites on Bear River, Idaho; Idaho Power Co., preliminary permit for Upper Salmon Falls project, Snake River, Idaho; Idaho Power Co., preliminary permit for Twin Falls Project on Snake River, Idaho.

Mid-West—J. D. Markham, A. Kelsey and J. F. Druar, St. Paul, Minn., preliminary permit for Kelsey-Markham-Druar Dam Site on St. Croix River, between Minnesota and Wisconsin; St. Cloud Water Power Co., preliminary permit to construct dam across Mississippi River, in Sherburne County, Minn.; W. R. Banks, preliminary permit for project on Osage River between Warsaw and Tuscumbia, Mo., and Niagara River between towns of Hahatonka and mouth of Little Niagara River; Western Tie and Timber Co., St. Louis, Mo., preliminary permit for power project on Current River, Mo., in Ripley, Carter and Shannon counties; Rocky Mountain Power Co., Butte, Mont., preliminary permit for hydro-electric project on Flathead River; The Canada Syndicate, Ltd., of Montreal, Canada, and Duncan, Young & Co., New York, preliminary permit to develop water power in Delaware River above the town of Belvidere, N. J.; C. P. Chenault, Tulsa, Okla., preliminary permit for power project on the Arkansas River at a point commonly known as Ox Bow Bend, Northwest of Tulsa, Okla.; Crown Willamette Paper Co., Portland, Ore., license for development at falls of Willamette River, West Linn, Oregon.

New York State—City of Buffalo, preliminary permit for project on Niagara River; Henry Ford and Son, license for project on Green Island, Government Dam at Troy, New York, Hudson River; Louisville Power Co., preliminary permit for project on St. Lawrence River, from the west end of Croil Island (sometimes called Baxter's Island, or Upper Long Sault Island) westerly up the St. Lawrence River to the easterly end of Gooseneck Island; Hydraulic Race Co., Lockport, N. Y., preliminary permit for power project on Niagara River, N. Y.; Paul T. Brady, New York City, preliminary permit for dam across Delaware River at a point between the village of Barryville on the New York side and the village of Shohola on the Pennsylvania side of the river; Lower Niagara River Power and Water Supply Co., preliminary permit for project located at point about 500 feet south of Michigan Central Railroad bridge, which point is about midway between Cleveland Ave. and Niagara Ave., in the City of Niagara Falls, water to be returned to Niagara River at a point in town of Lewiston, Niagara County; Niagara County Irrigation and Water Supply Co., preliminary permit for project on Niagara River, N. Y.; Niagara Falls Power Co., preliminary permit to divert water from Niagara River above the Falls, under the provisions of the treaty between the United States and Great Britain, proclaimed May 13, 1910; Niagara, Lockport & Ontario Power Co., preliminary permit for diversion and use of water for hydro-electric power purposes from above the Falls at Niagara; St. Lawrence Transmission Co., Potsdam, N. Y. preliminary permit for project on St. Lawrence River in vicinity of Long Sault Rapids, St. Lawrence County, N. Y.; Thomson & Porter, Buffalo, N. Y., preliminary permit for project on Niagara River and for hydro-electric plant in Niagara Gorge; Niagara Gorge Power Co., Buffalo, N. Y., preliminary permit for diversion of water from Niagara Falls; Roanoke River Development Co., Richmond, Va., preliminary permit for project on Roanoke River in Mecklenburg County, Virginia, between Bugg's Island and the town of Clarkesville.

Northwest—Washington Irrigation and Development Co., preliminary permit for project on Priest Rapids, Columbia, River, Wash.; Alex Polson, M. E. Reed and W. H. Abel, Montesano, Wash., preliminary permit for project at headwaters of Wynooche River in Olympic National Forest, Washington and northeastern part of Gray's Harbor; Northwestern Power and Manufacturing Co., Seattle, Wash., preliminary permit for project on Lake Crescent in Clallam

County Elwha River, in Washington. Hugh L. Cooper New York City, preliminary permit for project on Clark Fork of the Columbia River, Wash., Sound Power Co., H O Pond, president, New York City, preliminary permit for project on Sultan River and Olney Creek, in Snohomish County, Wash., and to use waters of Solduc River, Crescent Lake and Lyre River, in Clallam County, Wash.

Applications for preliminary permit or license were filed with the Federal Power Commission during the week ended Aug. 28, as follows:

Tongass Alaska Pulp and Paper Co., by M. M. Lyter, attorney, Alaska Building, Seattle, Wash., application for preliminary permit for utilization of Fish Creek, Swan Creek, Big Lake, Mirror Lake and Swan Lake for power purposes and for authority to construct power plants, pulp and paper mills on the southeast shore of Carroll Inlet in southeastern Alaska.

The Cove Co., Ocala, Fla., J. D. Robertson, secretary, application for preliminary permit to erect dam and power house on Withlachoochee River above Stokes Ferry for the purpose of generating hydro-electric power.

The State of Illinois, by Governor Frank O. Lowden, Springfield, application for license for power development on Des Plaines and Illinois Rivers.

W. A. Dromgold, York, Pa., application for preliminary permit to erect dam on or across the Susquehanna River at or near Cumberland below the mouth of Yellow Breeches, Pa.

Tri-State Power and Milling Co., of W. Va., Tri-State Power Co., of Virginia, O. L. Stearnes, president, Salem, Va., application for preliminary permit to erect dam and power house for hydro-electric purposes at a point below Anderson Falls, of New River in Summers County, W. Va.

Priest Rapids Irrigation District, by W. J. Kincaid, president, White Bluffs, Wash., application for preliminary permit to develop power in Priest Rapids of Columbia River.

Says Wage Increase Should Lower Price of Anthracite

That the anthracite coal operators increased their profits fifty cents a ton through the one dollar raise in the price of coal on April 1 in anticipation of the wage increase, was brought out by W. Jett Lauck, who was the consulting economist for the United Mine Workers, in presenting the case of the miners to the Anthracite Coal Commission. The operators did not stop here, however. In many cases the increase was much greater. A leading Washington dealer quotes anthracite for domestic use at $15.50 per ton, an advance of $3.70 since May 1. In other cities the increase was even larger.

Mr. Lauck declared that the average advance in labor costs was 17 per cent as a result of the recent award by the wage commission, and as the labor cost of producing a ton of coal ranges from $2.71 to $3.10, the increased cost to the operators with the maximum figure as a basis would be 52.7 cents per ton. On the basis of a ninety million ton per year production, the operators have taken from the public more than $30,000,000 of which they are required to pay the miners only $15,000,000.

"Prospective increases in labor costs is the reason for these advances," said Mr. Lauck, "and since the operators' estimate of what that increase would be was fully double what it has actually proved to be, it is obvious that the price to the consumer should be reduced at least $1.85 per ton, on the basis of Washington price advances since May 1."

To Hold Water Power Convention

Representatives of all the states in the Union, manufacturers and producers of power, will meet in Washington, D. C., Oct. 7 and 8 at the convention of the Water Power League of America, called to discuss the new Federal Power Act and its relation to the laws of the several states and how best to bring about the benefits expected to result from it.

The convention is called that the state officials may come in contact with the members of the Federal Power Commission with a view of co-ordinating their efforts and that a workable program may be evolved which will bring the greatest benefit to the people of the country at large.

The convention will not attempt to settle any of the questions which have been disputed in the years past. It recognizes that the United States has now adopted a policy for water power development and the day of debate is past. How to get immediate action will be the only question to be considered.

The farming interests of the country will be represented by a speaker from the National Grange who will tell what the farmer expects from the Federal Power Act. Such practical subjects as "Financing Under the Federal Power Act," "The Advantages of the Federal Power Act from the Standpoint of the Practical Developer and Operator," "Cooperation Between the Power Producer and Federal Power Commission," will be discussed by competent authorities and the Secretaries of War, Agriculture and the Navy will hold question and answer sessions at which information may be obtained direct from the fountain heads as to how their several departments are expected to function in the administration of the affairs of the Commission.

The convention will be an open one. Every manufacturer and person interested in the subject of development of the water resources of the country is invited to attend. All that will be necessary will be to notify the Water Power League of America, 116 Nassau St., New York City, and reservations at The Washington, where the convention will meet, will be made. The meeting is expected to prove one of the most important economic conferences which has been held in Washington in years.

Evanston Instructs Her School Engineers

Owing to the changed conditions in the fuel market necessitating the use of Illinois mine-run coal rather than Pocahontas or even hard coal, which some of the schools have been burning, the board of education of Evanston, Ill., decided that it would be well worth while to educate the janitors and engineers in the various school buildings in the proper methods of burning the new fuel.

Arrangements were made with Osborn Monnett, of Chicago, for a series of five lectures and inspection tours in which demonstrations were made and personal instructions given. The lectures covered combustion, storage and efficiency measures calculated to meet the conditions. The present high price of coal was an influencing factor, and in any event efficient smokeless combustion was desired, particularly as the schools for the most part are located in desirable residential sections.

Cannot Pass the Coal Increase on to Consumer

The Public Utilities Commission of the District of Columbia has cut short the effort of the Potomac Electric Power Co. to pass on to wholesale power users the cost of its coal. Commenting on this phase of the decision, the commission objected to the coal clause because there is less incentive to secure coal at the most advantageous price when it is known that the cost is passed automatically to the consumer. As the increase in the cost of coal affects all consumers, such an increase should be borne as nearly as possible by each class in its proper proportion.

The power company asked for various increases, but was allowed to advance its rates only one-half cent per kilowatt-hour. In addition it was permitted to abolish certain discounts and will receive more for street lighting.

The United States Department of Agriculture is producing gas by the destructive distillation of wheat, oat and rye straws. Although an automobile has been operated with the new combustible and it has been used for illuminating purposes and cooking, it is still in an experimental stage. Production tests are under way to determine the exact commercial value of the product.

Water-Power Commission Formulates Regulations

The first ten of the water-power regulations have been finally approved. Some time necessarily must elapse before the regulations governing the financial features of the Act can be promulgated. The regulations approved, however, contain two of great importance: those referring to permits and licenses. Regulation 9, which covers permits, reads as follows:

A. Except as hereinafter provided, preliminary permits may be issued on the application of citizens, associations, corporations, states or municipalities desirous of obtaining licenses for the construction, maintenance or operation of dams, water conduits, reservoirs, power houses, transmission lines or other project works, necessary or convenient for the development and improvement of navigation, and for the development, transmission and utilization of power across, along, from or in any of the navigable waters of the United States, or upon any part of the public lands and reservations of the United States (including the territories), or for the purpose of utilizing the surplus water or water-power from any government dam.

B. Permits will be issued only for the purpose of enabling applicants to maintain their priorities while securing the data required for an application for license and will be for such periods, not exceeding a total of three years, as in the judgment of the Commission will be necessary for studying the proper location and design of the project; for making examinations, surveys, maps, plans, specifications and estimates; for conducting stream measurements; for sinking test pits or making borings to determine foundations for dams or other structures; for securing a market for the power to be developed; for making financial arrangements; or for any other purpose necessary or desirable in the preparation of application for license.

C. Permits will not be issued for projects already constructed; for transmission lines alone; for projects of a power capacity of less than 100 horsepower; for projects which, in the judgment of the Commission, do not come within the scope of its authority under the Act, or should be undertaken by the United States itself, or do not propose adequate schemes of development, or would interfere unreasonably with projects under permit, license or other authority theretofore granted; or for projects for which data sufficient for filing application for license are already available. Permits affecting any reservation will be issued only after a finding by the Commission that the proposed use will not interfere or be inconsistent with the purpose for which such reservation was created or acquired. Permits will not be issued until after the expiration of the publication period prescribed by the Act.

D. In acting upon applications for preliminary permits, and in determining preferences therefor, the Commission may, in its discretion, upon the request of any applicant or upon its own motion, hold hearings, order testimony to be taken by deposition, summon witnesses, or require the production of documentary evidence.

E. No charges will be made for permits, but permitees will be required, as a condition of maintenance of priority to perform such work and to make such studies and investigations, and such reports thereon, as in the judgment of the Commission may be necessary or desirable to enable both the applicant and the Commission to determine the feasibility, character and extent of development which is proposed or which should be undertaken, which requirements will be expressed in the permit.

F. Upon a satisfactory showing of reasons therefor the Commission may authorize permitees to perform such construction work as may be necessary to maintain water rights under state law, or as may be desirable in preparation for the construction of project works; but the granting of such authority shall not be deemed to have created any equities or to have established any rights beyond what would have been created or established had such authority not been given.

G. Permits will not be transferable and may be cancelled by order of the Commission for failure to comply with the conditions thereof.

H. Each preliminary permit shall set forth the conditions under which priority shall be maintained and a license issued, and shall also set forth the essential terms and conditions of such license.

Regulation 10, dealing with licenses, reads as follows:

A. Except as hereinafter provided, licenses may be issued either in accordance with the provisions of preliminary permits or upon direct application therefor by citizens, associations, corporations, states or municipalities, for the purpose of constructing, operating and maintaining dams, water conduits, reservoirs, power houses, transmission lines or other project works, necessary or convenient for the development and improvement of navigation, and for the development, transmission, and utilization of power across, along, from or in any of the navigable waters of the United States, or upon any part of the public lands and reservations of the United States (including the territories), or for the purpose of utilizing the surplus water or water power from any government dam.

B. Licenses will be issued for such periods, not exceeding fifty (50) years, as in the judgment of the Commission will, in each individual case, allow for the satisfactory development and operation of the project and protect the public interest, and shall remain in full force and effect for such periods unless surrendered or terminated as provided in these regulations or revoked as provided in the Act.

C. Licenses will not be issued for projects which, in the judgment of the Commission, do not come within the scope of its authority under the Act, or should be undertaken by the United States itself, or do not propose adequate schemes of development, or lack satisfactory showing of financial ability, or would interfere unreasonably with projects under permit, license, or other authority theretofore granted, or would be opposed to the public interest. No license affecting the navigable capacity of any navigable waters of the United States will be issued until the plans of the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of War. Licenses within any reservation will be issued only after a finding by the Commission that the license will not interfere or be inconsistent with the purpose for which such reservation was created or acquired. Licenses will not be issued until after the expiration of the publication period prescribed by the Act.

D. Licenses may be altered only upon mutual agreement between the licensee and the Commission. Any such alteration shall be made a part of the license and a substitute for the provision altered, but no such alteration shall operate to alter or amend or in any way whatsoever be a waiver of any other part, condition or provision of the license.

E. Licenses may be surrendered only upon mutual agreement between the licensee and the Commission, and upon the fulfillment by the licensee of all obligations under the license, with respect to payment or otherwise, existing at the time of such agreement, and, if the project works authorized under the license are constructed in whole or in part, upon such conditions with respect to the disposition of such works as may be determined by the Commission.

F. Licenses may be terminated by written order of the Commission after such reasonable notice, not exceeding ninety (90) days, as the Commission may grant, if there is failure to commence actual construction of the project works within the time prescribed in the license, or as extended by the Commission. Under similar conditions and upon like notice the authority granted under a license may be terminated with respect to any project works or separable part thereof covered by the license, if there is failure to begin construction of such project works, or part thereof within the time prescribed in the license or as extended by the Commission; but no part of the project works shall be deemed separable for the purposes of this regulation unless so specified in the license.

G. Licenses may be revoked only through proceedings in equity instituted in the District Court of the United States for a district in which some part of the project is situated, and in the manner provided in the Act:

> (a) In case construction of the project works covered by the license, or of any specified part thereof, has been begun but not completed within the time prescribed in the license, or as extended by the Commission; or
>
> (b) In case the terms of the license are violated by the licensee.

Before the ten regulations were finally approved they were subjected to most careful scrutiny by outside interests and many of their suggestions are embodied in the regulations.

New Publications

THE McGRAW CENTRAL STATION DIRECTORY AND DATA BOOK FOR 1920. Published by the McGraw-Hill Co., Inc., New York City. 868 pages, 1½ x 8½ in., price $20.

This book is an invaluable guide and is complete in every way. It contains central station data arranged by states and cities, statistics of the central station industry, status of domestic and commercial electric service, a list of towns with a population under 1,000 getting current elsewhere, state commissions having jurisdiction over electric light and power utilities and an index to central stations whose names do not indicate their location.

NEW YORK STATE BOILER CODE

"The New York State Boiler Code," as recently amended and readopted, is now ready for distribution. The rules relate to the construction, installation, inspection and maintenance of steam boilers and should prove of value to all manufacturers of boilers, jobbers, and in repair shops. A copy of these rules can be obtained by application to the State of New York Department of Labor, State Industrial Commission, Capitol, Albany.

ONTARIO HYDRO-ELECTRIC POWER COMMISSION REPORT

The Twelfth Annual Report of the Hydro-Electric Power Commission of the Province of Ontario for the year ended Oct. 31, 1919, is now ready for distribution. The report, which contains 243 pages, is a complete account of the work performed by the commission during the year. The text contains a description of the great increase in the use of power during the war and of the sudden slump following the signing of the armistice. Operating and maintenance costs of various plants are given, as well as notes on operation, load curves, etc. The book is concluded with a statement of total plant cost, investment, operating reports, depreciation charges, horsepower, peak taken in December, 1919, street-lighting installations, cost of power and selling rates.

Personals

Harry T. Harmon is now transmission engineer for the Hyatt Roller Bearing Division, General Motors Corporation, Newark, N. J.

Gerardo Immediato has been appointed professor in charge of machine and power-plant design at the Polytechnic Institute of Brooklyn.

A. W. Huseby, formerly chief engineer, Armour Mechanical Co., U. S. Yards, Chicago, Ill., is now in the master mechanic's office of Morris & Co., Chicago.

J. C. Parmely, who has been connected with the Okmulgee Ice and Light Co. of Okmulgee, Okla., is now with the Milwaukee Electric Railway and Light Co.

B. B. Williams, at a meeting of the directors of The C. & G. Cooper Co. of Mt. Vernon, Ohio, was elected president of the company to succeed D. B. Kirk, deceased.

Elias Schlank, formerly assistant mechanical superintendent for Julius Kayser Co., Brooklyn, N. Y., is now located in Newark, N. J., as a consultant factory engineer.

D. H. MacDougall, of the Toronto Power Company, Toronto, Canada, has just been appointed Chairman of the Public Relations Section of the Canadian Division of the N. E. L. A.

A. A. Potter has resigned his position as dean of engineering at the Kansas State Agricultural College to accept a similar position at Purdue University, Lafayette, Ind.

Walter C. Lange has resigned his position as engineer with the Hammel Oil Burning Equipment Co. and now holds a similar position with The Howard Moore Co., of New York City.

Fred F. Bahnson, formerly engineer for the Normalair Co., Winston-Salem, N. C., is now vice president and engineer of the Bahnson Humidifier Co., Salem Station, Winston-Salem, N. C.

Reginald Pelham Bolton, consulting engineer, announces that James A. McHollan is now associated with him as vice president of The R. P. Bolton Co., 116 East 19th St., New York City.

Paul De Leon, consulting engineer, who for some years was in business in the East, has opened an office at Manitowoc, Wis. His work will consist of general engineering and utilities engineering.

J. H. Figee has severed his connection as engineer with the Stearns Engineering Company of Detroit and is now affiliated with the Ford Motor Company, in the Rouge plant at Dearborn, Mich.

Louis C. Seabright has severed his connections with the Stanton Heater Co. of Martins Ferry, Ohio, and is now serving in the capacity of engineer for Warren Webster & Co., 706 Rose Building, Cleveland, Ohio.

E. A. Hitchcock, formerly vice president of the Bailey Meter Co. of Cleveland, Ohio, is returning to Ohio State University at Columbus, Ohio, where he spent several years. He has been appointed dean of the Engineering College.

Jay Carrol Wheeler, who has been engaged with the Kerr Turbine Co. as construction engineer for the last ten years, has resigned to become construction engineer for the C. H. Wheeler Manufacturing Co., of Philadelphia, Pa.

Dr. Alphonse Adler, for the past ten years professor in charge of machine and power-plant design at the Polytechnic Institute of Brooklyn, has resigned and will devote all his time to his practice as consulting engineer in power and industrial plant engineering, with an office in New York City.

I. A. Baum, formerly assistant general manager for the La Salle Engineering Co., of Chicago, Ill., will in the future have only an inactive interest in that company. He is now vice president of the American Rotary Engine Co., Grand Rapids, Wis.

W. N. Dickinson has been elected president of the New York Electrical Society to succeed Edwin B. Katte. Mr. Dickinson is a consulting engineer and has been associated with several elevator companies, principally the Otis Elevator Company. During the war he was engaged in war work at Washington.

Albert Ladd Colby has resigned as the representative of the American Society of Testing Materials, on Engineering Council. He will be succeeded by C. D. Young, vice president of the society and general supervisor of stores on the Pennsylvania System, Broad Street Station, Philadelphia.

W. E. Anderson and Ward Raymond, formerly chief engineers, of Phillipsburg, N. J., with the A. S. Cameron Steam Pump Works and the Ingersoll-Rand Co., respectively, are now associated with the Pennsylvania Pump and Compressor Co., of Easton, Pa., the former as chief engineer and the latter as vice president.

G. A. Sawin, service engineer with the Public Service Electric Co., Newark, N. J., has resigned to become assistant to manager of the supply department, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. In his new position Mr. Sawin will take care of the public-utility work of the supply department.

Timothy Healy, president of the National Brotherhood of Stationary Firemen, was tendered a testimonial banquet and bon-voyage reception at the Yorkville Casino, New York City, on Wednesday, Aug. 11. Mr. Healy has sailed for England to represent the American Federation of Labor at the British Trades Congress. There were over three hundred present, and many prominent speakers wished Mr. Healy godspeed. James P. Holland was the toastmaster.

F. W. Dean, formerly mill engineer and architect, of Boston, and for nearly three years in war work for the United States Shipping Board Emergency Fleet Corporation in charge of the steamship boiler department and testing of boilers, will resign his position to become effective Oct. 1, 1920. Mr. Dean will become associated with L. N. Wheelock and J. C. Bogue, now of the firm of the Wheelock-Bogue Co., 141 Milk St., Boston, under the firm name of Wheelock, Dean & Bogue, Inc., which organization will be the New England agent for the Erie City Iron Works, of Erie, Pa., and of several other companies.

Henry Kreisinger, formerly of U. S. Bureau of Mines, has been appointed as engineer of research of the Combustion Engineering Corporation. Mr. Kreisinger will conduct investigations for the Combustion Engineering Corporation of a similar nature to those that he conducted for the Government; and the results of his work will be available to the Government as well as to the clients of the Corporation. He will make his headquarters at the Bureau of Mines Station at Pittsburgh. The first problem which he will consider will be a thorough testing of the powdered-coal plant of the Bureau of Mines at Milwaukee, Wis.

Society Affairs

The National Association of Electrical Inspectors will hold its annual meeting at Philadelphia, Oct. 12 and 13.

The Electric Power Club will hold its fall meeting at Hot Springs, Va., Nov. 15 to 18. Headquarters will be made at the Homestead Hotel.

The New York Section of the American Society of Refrigerating Engineers will hold its next regular meeting on Wednesday evening, Sept. 15, at the Machinery Club, 50 Church St. A fine program has been arranged in which W. S. Osborn of the Texas Company, will deliver a paper on "Lubrication of Refrigerating Machinery." This will be accompanied with lantern slides showing technical data and curves.

The Indiana Electric Light Association will hold its annual convention at French Lick, Sept. 15 to 17. The first session will be opened with the president's address, followed by various committee reports. Sept. 16 will be featured as commercial section day. Addresses will be given on "Voluntary Versus Involuntary Co-operation," by William L. Goodwin, and "Central Stations and Contractors," by Samuel Adams Chase; paper on "Industrial Application of Electric Power-Factor Correction and Its Effect," by T. F. English, general manager of the Indiana General Service Co.; paper on "Reduced Operating Expenses Versus Increased Fixed Charges," by George A. Neal, Northern Indiana Gas and Electric Co. A round-table discussion will follow, the election of officers closing the program.

A Great Lakes Division of the N. E. L. A. was organized at a meeting of central station organization representatives from Michigan, Indiana, Illinois, and Wisconsin, held in Chicago, Aug. 27. Officers elected for the new division are: Chairman, W. C. Lounsbury, Superior (Wis.) Water, Light and Power Co.; vice-chairman, P. H. Palmer, Indiana Railways and Light Co., Kokomo; secretary-treasurer, R. V. Prather, Springfield, Ill. The following were appointed chairmen of the division sections formed: Public relations section, A. C. Marshall, Detroit Edison Co.; commercial section, J. G. Learned, Public Service Co. of Northern Ill., Chicago; technical section, G. E. Lewis, Detroit Edison Co., Ann Arbor, Mich.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24. Among the papers to be read are: "Practical Education of Steel Mill Electricians," W. A. Cornwell; "Relation of Standardization in Electrical Equipment to Safety," Walter Greenwood; "Power Transmission for Industrial Plants," D. M. Petty; "Underground Transmission," A. L. Frerst; "Some Considerations in the Determination of Auxiliary Drives," Gordon Fox; "The Reversing Electric Mill Considered From the Standpoint of Tonnage," K. A. Pauly; "Report of Electrical Development Committee for 1920," E. S. Jefferies; "Centralized Turbine Generating Stations for Steel Mills," T. E. Keating; "Current Limit Reactance," R. H. Keil; "Report of Electric Furnace Committee for 1920," E. T. Moore, chairman, and "Standardization Committee Report." The Entertainment Committee has completed plans for several excursions to points of interest in the city.

The Sixth National Exposition of Chemical Industries will be held at the Grand Central Palace, New York City, Sept. 20-25. The exposition has been divided into sections. A fuel economy division and a materials handling division have been added. Five symposiums divided into the following classifications will be read during the week: Fuel Economy, Materials Handling, Industrial Management, Chemical Engineering, and a symposium on Ceramics. The Fuel Economy Symposium will include "Burning Coal at 100 per cent B.t.u. Efficiency," W. O. Rankin, Quigley Furnace Specialties Co.; "Saving Fuel by Controlling Chimney Losses," F. F. Uehling, Uehling Instrument Co.; "Fluid Heat Transmission," Alexander B. McKechnie, Parks-Cramer Co.; "Producer Gas and the Modern Mechanical Producer," W. B. Chapman, Chapman Engineering Co.; "Refractory Cement: Life Insurance for a Furnace," F. W. Reisman, Quigley Furnace Specialties Co.; "Preventing Conduction and Radiation Heat Waste," S. L. Barnes, Armstrong Cork Co.; and "The Reason for the Fuel Saving in the Dressler Kiln," Conrad Dressler, Amercian Dressler Tunnel Kilns, Inc.

Miscellaneous News

The Kerchoff Power Plant of the San Joaquin Light and Power Corporation, built at a cost of approximately $5,500,000, with a maximum output of plant amounting to 50,000 hp., was started Aug. 15 with elaborate ceremonies in which the electrical men of the state and the general public took part. The plant is situated on the San Joaquin River, near Auberry, about thirty miles from Fresno.

An Order Curtailing the Consumption of electric power to all Northern and Central California industries by 20 per cent was issued by H. G. Butler, State Power Administrator, on Aug. 19, following a hearing of power consumers and distributors. All cities and towns will be asked to reduce street lighting and curtail the use of electric signs. Administrator Butler gave the average weekly generation for three months at 5,600,000 kw., of which steam plants generated 2,700,000 kw.

The San Joaquin Light and Power Co. of California doubled its power with the opening on Aug. 22 of a new hydro-electric plant on the main fork of the San Joaquin River. The new plant will have a capacity of 44,000 hp., bringing the company's total power capacity to 85,500 hp. The company already had six hydro-electric plants, but their combined horsepower was only 24,000. Their other units are a steam turbine plant at Bakersfield, which has a capacity of 18,000 hp., and two steam reserve plants at Fresno and Betteravia, with a capacity of 3,500 hp.

Airplane in Power Plant Construction—What is believed to be the first use of an airplane by an individual for business purposes is announced by the San Joaquin Light and Power Co. of California. Rex C. Starr, construction engineer of the various projects now under way, has purchased a machine and engaged an aviator. The machine will be used in making flights to Huntington Lake, Auberry, Crane Valley and Kings River. Many of these places are accessible only over long mountain roads. In an airplane these projects can all be visited on the same day.

Caribou Power Project—An order issued by the Railroad Commission Aug. 19 authorizes the Great Western Power Co. of California to float a bond issue of $3,500,000. The proceeds will be used to defray the cost of completing the Caribou power development on the Feather River and the transmission line from the Caribou plant to Valona, Contra Costa County. It was originally estimated that the cost of the Caribou plant and the transmission line would total $6,057,430. Today it is estimated that the total will reach $10,674,897.66. According to the evidence submitted with the application, the increase is due to enlarging the tunnels so as to permit of the construction of an 80,000-kw. plant instead of a 60,000-kw. plant as originally planned and to unforeseen difficulties experienced in tunnel construction. Increases in cost of materials and supplies, increases in wages and difficulty in keeping employees permanently engaged on the construction work are also given as reasons for the additional cost.

Business Items

The Mesta Machine Company has opened an office in the Singer Building, New York, from which point all its foreign business will be handled. The New York office will also be the sales office for the New York and Eastern States territory. M. M. Moore will be in charge.

The Burke Electric Co. announces the appointment of L. L. Myers as general Western sales manager. Mr. Myers' headquarters will continue to be in the Illuminating Building, Cleveland, Ohio, where he has been the Burke Electric Co.'s sales representative for the Cleveland territory for several years. **L. B. Ritchie** has been appointed General Eastern Sales Manager, with headquarters at 30 Church Street, New York City, where he has for some time been sales representative for the New York territory of the Burke Electric Co.

Trade Catalogs

"Insulating Compounds" is the title of a new bulletin by the General Electric Co. The booklet is designed to assist the purchaser in the selection of proper insulating compounds. Various materials handled by the company are described and photographic illustrations of machinery used in the manufacture of these products are shown.

"Permutit Water Rectification Systems" is the title of a new 30-page catalog published by The Permutit Co., New York City. Brief descriptions accompanied by illustrations are given of the various apparatus handled by the company including water-softening systems, filters, salt tanks, etc. A copy of the booklet will be sent on request.

The General Electric Co. has ready for distribution Bulletin No. 41,311 entitled "Synchronous Condensers." The text covers power-factor correction and power-factor control through synchronous condensers. Particularly interesting sections of the bulletin are the data on power factor, causes and effects of low power factor and the application of the synchronous condenser, with several calculations of such installations for both power-factor correction and control.

The Sprague Electric Works of the General Electric Co., New York, has issued a 70-page booklet entitled, "The Universal Key." The booklet contains illustrations and descriptions of the complete line of conduit boxes and covers handled by this company. It is compiled in such a manner that it furnishes a quick reference for matching any standard wiring device to any desired box and cover. A copy will be sent on request.

The Locomotive Superheater Co., of New York, has published a Data Book for Engineers. The object of the book, which is of handy pocket size, is to assist stationary engineers in their every-day work by furnishing them with useful data such as they have occasion to use frequently. The material for the book has been gathered from various authoritative sources and should prove of value to engineers. A copy will be sent to anyone interested upon request.

"Pelton Impulse and Reaction Turbine Installations" is the title of a new 48-page catalog published by the Pelton Water Wheel Co., of New York. This booklet is designd to show the scope and activities of the Pelton Company in the hydro-electric fild. A number of illustrations show Pelton units operating under varying conditions of head, volume and capacity. They embrace horizontal and vertical turbines of both reaction and impulse types, used in large generating stations, automatic and remote-control plants and in exciter sets.

The General Electric Co. has ready for distribution bulletin No. 48,715 entitled "Insulating Fabrics." This booklet deals entirely with various classes of insulating materials put on the market by the company. It is an illustrated bulletin, the photographs telling the story in outline, of how such fabrics are produced. Views are shown of baking ovens used in producing varnished fabrics, the process of insulating field coils with varnished fabric tape, the taping and wrapping of armature coils with varnished fabric. A list of standard materials is given, designed to assist customers in making a selection. A copy will be sent on request.

New Construction

PROPOSED WORK

Me., Deering (Portland P. O.)—St. Joseph's Convent had plans prepared for a convent to include a dormitory, chapel, autorium, etc., here. A steam heating system will be installed. About $300,000. O'Connell, Show, 18 Boylston St., Boston, Mass., Archts.

Me., Lewiston—The Androscoggin Mills will soon award the contract for about one hundred 1 story two-family houses for workmen, including steam heating systems. About $1,000,000.

Me., Skowhegan—The Central Maine Power Co., 40 Water St., Augusta, plans to build a hydro-electric plant. About $1,350,000. Frank H. Mason, Chief Engr. J. A. Leonard, Resident Engr.

Mass., Norwood—J. W. Beal, Archt., 62 Sumner St., Boston, will soon award the contract for a 2 story, 136 x 280 ft. textile mill including a steam heating system for the Holliston Mills, Lennox Ave. Plans include a 1 story, 50 x 70 ft. boiler house. About $200,000.

Mass., Tyngsboro—D. Sheehan is in the market for an 11 x 15 ft. Erie engine.

Mass., Wakefield—Heywood Bros. and the Wakefield Co. will soon award the contract for a factory including two 205 hp. Heine boilers. C. A. Van Derveer, Genl. Mgr. Noted Jan. 6.

Conn., Montville—Robert Gair, 50 Washington St., Brooklyn, N. Y., is having plans prepared for several houses including a steam heating system. About $250,000. Lockwood Green, 101 Park Ave., New York City, Engrs.

N. Y., Long Island City—The Bd. Educ., 500 Park Ave., New York City, plans to build a school on Grand and 6th Aves. to cost about $900,000 and a school on Wool and Laconia Sts. to cost about $500,000. A steam heating system will be installed in each. C. B. J. Snyder, Municipal Bldg., Archt. and Engr.

N. Y., Richmond Hill, L. I.—The Bd. Educ., 500 Park Ave., New York City, plans to build a high school addition including a steam heating system on Cedar Ave. About $500,000. C. B. J. Snyder, Municipal Bldg., New York City, Archt. and Engr.

N. Y., Richmond Hill, L. I.—The Bd. Educ., 500 Park Ave., New York City, plans to build a school including a steam heating system on Hillside Ave. About $900,000. C. B. Snyder, Municipal Bldg., New York City, Engr.

N. Y., Syracuse—The Bd. of Mgrs. of Onondaga Co. received bids for the installation of heating systems in the proposed children's and adults' pavilions at the Onondaga Tuberculosis Sanatorium from Ed. Joy, 133 Market St., $25,373 and $12,778; Ed. Bates, 228 West Water St., $23,404, $9,550; W. B. Goldie, 274 James St., $20,174, $10,314.

N. J. Woodlynne (Camden P. O.)—The Camden Ice Co., c/o Benj. Howell Lackey, Archt., 509 Federal St., Camden, is having plans prepared for an ice plant and coal yards here. A steam heating system will be installed in same.

Va., Ashland—The Henry Clay Inn Co. is in the market for a hot water heating plant, deep well pump and gasoline engine. S. Hatcher, Purch. Agt.

Va., Richmond—C. H. Bruner, 715 West Broad St., is in the market for an air compressor.

Va., Richmond—The Verra Hat Works, 211 North 1st St., is in the market for boiler injectors and air compressors.

Va., South Richmond (Richmond P. O.)—R. H. Richardson, 1310 Hull St., is in the market for an air compressor.

La., New Orleans—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until September 23 for the installation of a refrigerating machine at the Post Office and Court House here.

La., New Orleans—Emil Weil, Archt., Whitney Block, will receive bids until September 27 for a 4 story addition including a steam heating system for the Touro Infirmary.

O., Cleveland—Jacob Babin, Hotel Olmstead, has purchased a site and plans to build an 8 story, 50 x 190 ft. commercial building including a steam heating system on Euclid Ave. between East 30th and East 40th Sts. About $600,000.

O., Cleveland—The Glidden Co., Madison Ave., plans to build an 8 story commercial building including a steam heating system on Euclid Ave. and East 55th St. About $500,000. A. D. Joyce, Pres.

O., Cleveland—The Babies Dispensary and Hospital, 2500 East 35th St., had plans prepared for an 8 story, 60 x 150 ft. children's hospital including a power plant at 11020 Euclid Ave. About $500,000. Abram Garfield, Natl. City Bldg., Archt.

O., Cleveland—The B. F. Keith Theater Co., 1564 B'way., plans to build a theater and office building including steam heating system. About $1,000,000. Rapp & Rapp, 190 North State St., Chicago, Ill., Archts.

O., Cleveland—The Natl Lamp Co. of the General Electric Co., Nela Park, East Cleveland, plans to build a 1 story factory including a steam heating system on Alonzo Ave. near Aetna Rd. G. H. Johnson, Nela Park, Archt. and Engr. About $[illegible].

O., Cleveland—William [illegible], 2905 Ostend Ave., is having plans prepared for a 3 story, 120 x 200 ft. commercial theater building including a steam heating system at East 141st St. and St. Clair Ave. About $[illegible].

O., Elyria—The Reliance Crane Co. is having plans prepared for a 1 story, 118 x 180 ft. factory and power house. About $175,000. Watson Eng. Co., Hippodrome Bldg., Cleveland, Engrs.

O., Lakewood (Cleveland P. O.)—The Bd. Educ., 1456 Warren Rd., received bid for steam heating system in the proposed addition to school at Clifton Blvd. and Summit Ave. from Price & Weller, 707 [illegible] Rd., Cleveland, at $16,[illegible].

O., Lorain—The Bd. Educ. received bids for a 1 story grade school on 11th St. and Hamilton Ave. from Chas. Peterson & Co., 1500 Euclid Ave., Cleveland, at $214,000 and Geo. Kraft, Lorain, at $218,522; for steam heating system from Chappel Warren Co., St. Clair Ave., Cleveland, at $60,000. Noted Feb. 3.

Mich., Detroit—The City Plan Comn. engaged Smith, Hinchman & Grylls, Archts., 710 Washington Arcade, to prepare preliminary plans for a 6 story city hall including a steam heating system on Woodward Ave. About $3,000,000.

Ill., Chicago—E. E. Roberts, Archt., 105 North Clark St., will soon receive bids for a 3 story, 115 x 240 ft. milk bottling plant including a steam heating and refrigeration system on Claybourne Ave. and Division St. for the Borden Farm Products Co., 136 West Lake St. About $250,000.

Wis., Janesville—The city will receive bids until October 1 for furnishing an 8,000,000 gal. horizontal cross compound crank and fly wheel pumping engine. C. V. Kerch, City Hall, Engr.

Wis., Manitowoc—The Jacquet Motor Corp. is having plans prepared for a 3 story, 150 x 300 ft. trunk factory on Main St. Motors, etc., will be installed in same. About $75,000. Alfred Jackson, Mgr. H. B. Kamschulte, Archt. and Engr.

Wis., Marshfield—The city received low bids for boilers from the Wickes Boiler Co., Saginaw, Mich., $19,868 and $22,225; for superheaters from the Dravo Co., 1195 30th St., Milwaukee, $3,320 and $3,950; for F. W. Heaters from the Warren Webster Co., 53 West Jackson Blvd., $2,750.

Wis., Merton—The Merton Dairy Products Co., will receive bids about September 11 for a 3 story, 60 x 145 ft. factory on Main St. Motors, etc. will be installed in same. About $40,000. M. Tullgren & Sons, Wisconsin Natl. Bank Bldg., Milwaukee, Archts.

Wis., Milwaukee—The Sewerage Comn. is having plans prepared for a power house including equipment, $250,000, sewage tanks and equipment, $2,175,000, boilers, piping and equipment, $500,000, etc.

Wis., Wauwatosa—The Bd. of Administration plans to build a 1 story central heating plant including equipment. About $300,000.

Ia., Wapello—F. G. Wright, Co. Aud., will receive bids until September 22 for a drainage pumping plant including 2 centrifugal pumps of equal capacity driven by oil engines, etc. About $30,000.

Minn., Chisholm—The city clk. will receive bids until October 15 for a 2 story, 195 x 300 ft. municipal building, including a steam heating system. About $650,000. Anthony Puck, Torrey Bldg., Duluth, Archt. and Engr.

Kan., Topeka—The Security Benefit Association is having plans prepared for a hospital and detention building including a small garage and power house. About $300,000. Schmidt, Garden & Martin, 104 South Michigan Ave., Chicago, Archts.

N. D., Devils Lake—The Farmers' Cold Storage Co. plans to build a creamery and cold storage building. About $100,000. Thomas Malony, Pres.

Mont., Miles City—The Yellowstone Irrigation Co. is promoting a power and irrigation project. About $500,000.

Mo., St. Louis—The city will receive bids until September 21 for an addition to the boiler room at the Koch Hospital. Noted August 10.

Ark., Judsonia—The Arkansas Hydro Electric Development Co., Little Rock, plans to build the first unit of a hydroelectric plant on Little Red River about 18 miles from here including 10,800 hp. power plant and dam. About $1,208,000. J. E. Sirrine, Greenville, S. C., Consult. Engr.; Dickinson & Watkins, Little Rock, Resident Engrs.

Ore., Bandon—The city has applied to the state engineer for permission to divert 25 sec.-ft. water from Wilson Creek for power purposes. Plans include a 1,000 kw. power plant.

Cal., Honcut—The Irrigation Bd. plans to build a canal and irrigation reservoir system in the Honcut-Yuba Irrigation Dist. The project includes gravity and pumping diversion at separate points. About $1,780,636. V. P. McCray and E. T. McCray, Engrs.

Cal., Sacramento—M. J. Desmond, City Clk., will soon award the contract for furnishing transformers, sluice gates, centrifugal pumps, induction motors, intake conduits, pumping station, power manhole, etc., for the proposed pumping and filtration works.

N. S., Windsor—T. B. Akins, Windsor, and Wright & Jodrey, Wolfville, are interested in a company which is having plans prepared for a dam, power house, pulp mill, etc. About $250,000.

Que., Three Rivers—Mr. Lambert, City Engr., is in the market for one 100 hp. 62 cycle, 2,200 volt, 900 rev., 75 amp. electric synchronous motor.

Ont., Fenelon Falls—Oliver Smith, Engr., Lindsay, is having plans prepared for a new water works system including a pumphouse and the installation of electrically operated centrifugal pumps. About $50,000.

Ont., Kapuskasing—The Spruce Falls Co. plans to develop the water power here.

Ont., Richmond Hill—The Loyal True Blue & Orange Home, County Orange Bldg., Richmond St., Toronto, plans to build a 3 story children's home including a steam heating system on Yonge St. About $300,000.

Mexico, Villa Acuna, Coahuila—The Mexican Government has granted a concession to Antonio Guijosa for an electric light and power plant here.

CONTRACTS AWARDED

Mass., Boston—The Tremont Trust Co., 14 State St., has awarded the contract for a 12 story, 100 x 130 ft. bank and office building on Court St. to J. H. Broderick, 101 Tremont St. A steam heating system will be installed in same. About $2,300,000.

Mass., Fall River—The New England Oil Corp. has awarded the contract for an oil storage building, pumping station, etc., to the Unit Constr. Co., 299 Madison Ave., New York City. About $5,000,000.

R. I., Bellefonte—The Imperial Printing & Finishing Co. has awarded the contract for a 1 story, 27 x 135 ft. generator building to the C. I. Bigney Constr. Co., 357 Westminster St., Providence. About $25,000.

N. Y., New York—The Herald Sq. Printing Co., care of H. C. Volz, Archt. and Engr., 373 Fulton St., Brooklyn, will construct an 8 story loft building, including a steam heating system. Work will be done by day labor.

N. Y., Yonkers—The Yonkers Electric Light & Power Co. has awarded the contract for a 1 story sub-station, to William Young & Co., 411 West 41st St., New York City, at $75,000.

Pa., New Castle—The Bd. Educ. has awarded the contract for a 3 story, 210 x 310 ft. high school to Moore & Lamb, 202 Stambaugh St., Youngstown, O., at $340,[illegible]. A steam heating system will be installed in same.

D. C., Washington—The Dist. Comrs. have awarded the contract for the installation of a heating and ventilating system in the Petworth School and addition to the Federal Heating Co., 316 13th St., N. W., at $33,938.

Va., Danville—The Riverside & Dan River Cotton Mills has awarded the contract for a power house to the Aberthaw Constr. Co., 27 School St., Boston, Mass. About $100,000.

O., Cleveland—The city has awarded contracts as follows: turbo-generator, Allis-Chalmers Mfg. Co., 1121 Schofield Bldg., $188,000; switchboard, Westinghouse Mfg. Co., 6905 Susquehanna St., Pittsburgh, Pa., $12,707; condenser and auxiliaries, Wheeler Condenser Co., Indianapolis, Ind., $65,000. Noted Aug. 17.

Mich., Detroit—The Bd. Educ., 50 B'way, has awarded the contract for heating ventilating and plumbing systems in the Cooper school, to J. W. Partlan, 51 Park Pl., at $93,800; in the Leland school addition, Custer school and Crossman school addition, to the Drake Avery Co., 40 State St., at $91,915, $92,212, $51,821; and in the Carstens school, to W. J. Rewoldt, 506 Owen Bldg., at $62,108. Noted Sept. 7.

Mich., Kalamazoo—The Bd. Educ. has awarded the contract for a 3 story, 140 x 363 ft. school, to the Vanderhorst Co. at $554,512. A steam heating system will be installed in same.

Ill., East St. Louis—The Eagle-Picher Lead Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a factory here including power plant, boiler room, machine shop, etc., to the Wimmer Contg. Co., Victoria Bldg., St. Louis, Mo. About $600,000.

Wis., Sheboygan—The H. J. Holman Co., 1716 Calumet Drive, has awarded the contract for a 2 story, 60 x 120 ft. overall factory to J. Hammes, 1409 Lincoln St., at $6,000, and is in the market for motors, etc.

Wis., Sheboygan—The Sheboygan Cigar Box Lumber & Mfg. Co. has awarded the contract for a 3 story 60 x 85 ft. cigar box factory and remodeling present power house, installing new boilers, etc., to J. Hildebrand, 907 North 4th St. About $10,000.

N. D., Grand Forks—The Industrial Comn. of North Dakota, has awarded the contract for the installation of 17 motors of various sizes in the new terminal mill and elevator here, to the General Electric Co., 410 3rd Ave., North Minneapolis, Minn. Noted Aug. 30.

Mo., St. Louis—The Bd. Educ. has awarded the contracts for 4 schools here, to the Murch Bros. Constr. Co., Exchange Bldg., $328,930; E. C. Gerhard Bldg. Co., Post-Dispatch Bldg., $280,268; Kellerman Constr. Co., Victoria Bldg., $298,458 and $437,799. A low pressure steam heating and forced ventilation system will be installed in each.

Mo., St. Louis—The Bridge & Beach Mfg. Co., 503 South 1st St., has awarded the contract for 17 buildings including a power plant, etc., on Union and Brown Aves., to the Fruin Colnan Contg. Co., Merchant's Laclede Bldg., at $800,000.

Tex., Austin—The State Bd. of Control has awarded the contract for the installation of a heating plant in the Confederate Home here, to Kirkwood & Wharton, San Antonio, at $20,316.

See Pages 82 - 96 Need Competent Help? See Pages 82 - 96

POWER

Volume 52 New York, September 21, 1920 *Number* 12

An Opportunity *for the* Engineering Profession

"Everywhere we look we see the products of engineering."

THE foregoing might well be taken up as a slogan for engineers. Yet, in spite of this ever present reminder of their work, engineers as a class figure little in public affairs and, with few exceptions, in directing large enterprises. Many are well up the ladder, but few are at the top.

Various explanations for this have been offered. Some attribute it to the engineer's training, which teaches him to think along concrete lines; others have sought to blame his modesty and lack of self-advertisement; while a few have even questioned his claim to such aspirations.

That a man, because he is an engineer, should be more modest or retiring than another who happens to be a lawyer or a business man, may seem incredulous, for it will be argued that this is a matter of personal disposition; yet it is a fact that the lawyer and, to a lesser extent, the business man, are accustomed to come forward with their views and argue their cases, which habit tends to cultivate aggressiveness and often leadership.

Engineers in general are to be found more as employees than as directors of work for which by training they are eminently fitted; and as such the very nature of their occupations tends to restrict their opportunities to certain channels and divert their attention from the broader problems.

The war brought about public recognition of engineering accomplishments. There was need of something to sustain and capitalize such recognition. Individually, engineers could do little, but collectively, the opportunities were without limit. There was a general demand from the ranks that action be taken, and the movement, which has been gaining momentum for the last two years, has crystallized into the Federated American Engineering Societies, which held its founder meeting last May. Since that time engineering societies all over the country have signified their intention of joining in this great co-operative effort for public service.

The second meeting of the Federation is to be held in Washington on November 18, at which time plans will be formulated for concrete action. The program will be found elsewhere in this issue.

The influence of such an undertaking cannot be overestimated, and it behooves every engineer to throw his hearty support into the work through the channels of his local society.

New Northeast Station at Kansas City

A STRICTLY modern power station to supply efficiently power and lighting for Kansas City, Mo., and the surrounding territory has been needed for years. The three older plants serving the city had become inadequate, and during the war period a new plant of ample capacity became imperative even in the face of high prices and the adverse manufacturing conditions existing at the time. A level tract of land on the Missouri River, with good railway and water facilities was chosen as the site. Construction began in 1917 and has been continued as rapidly as possible. As the property was low and made up for the most part of sand and silt deposits, all foundations were sunk to bedrock and provisions made to take distribution lines out overhead. Sand has been pumped from the river bed so as to bring the ground above high water, and a levee has been built along the river bank to fully protect the site.

One of the latest high-pressure stations with plans calling for an ultimate capacity of 270,000 kw. It is featured by combination high-and low-pressure economizers, submerged ashpits, vertical condensers with hydraulic vacuum nozzles, a ring bus system and a number of other features new on the electrical end.

Reference to the property plat shown in Fig. 1 will indicate the tentative layout of the station. The plan shows four unit groups with a condenser well for each and two intake wells for the four. The first group unit is to consist of three 20,000-kw. machines, two of which have been installed and put in operation; the third is now being erected. Each of the other three condenser wells is to serve two 35,000-kw. machines, so that the ultimate intention is to have four units made up of nine machines having an aggregate capacity of 270,000 kw. The general layout shows the transmission lines coming out on the river side of the station, a coal-storage yard on the opposite side and railway tracks leading to each department of the plant for handling coal and ashes and the mechanical equipment. The layout is self-explanatory, and it is evident that there is still room for extension above the ultimate capacity planned.

The outstanding features of the plant are a special arrangement of high- and low-pressure economizers, a steam temperature of 675 deg. made up from an operating pressure of 300 lb. gage and superheat of 250 deg. F., chain-grate stokers 17.5 ft. long, submerged ashpits, vertical condensers placed in a pit to meet the great changes in river level, and a number of new features on the electrical side. A study of Figs. 8 and 9 will disclose the general arrangement of the initial installation, and the accompanying table will give the sizes and relative proportions of the equipment serving the two machines now in operation. At 80 per cent power factor each of these machines is rated to develop 20,000 kw.; making 40,000 kw. for the initial installation. Three-phase 60-cycle current is generated at 13,200 volts. The two machines first installed are served by six boilers, each having 13,512 sq.ft. of steam-making surface and a maximum generating capacity of 110,000 lb. of steam per hour. With the addition of the third machine two more boilers are being installed. It is the expectation that, normally, seven boilers will carry the three turbines, leaving one boiler in reserve. This is a provision of 1.576 sq.ft. of steam-making surface per kilowatt, or an allowance of 6.3 kw. to the boiler-horsepower.

The eight boilers are arranged four on either side of a central firing aisle, with the high- and low-pressure economizers above the boilers and induced-draft fans between the economizers and the smoke flue. Each pair of boilers is served by a steel stack 10 ft. diameter and 126 ft. high above the boiler-room floor. Individual overhead coal bunkers having a capacity of 125 tons, or a 24-hr. supply, are placed over the central firing aisle, on either side, with a skylight between, and below is a concrete coal-storage pit containing the coal crushers with a capacity of 820 tons per boiler, sufficient for a six-day run at normal capacity. This arrangement calls for an exceptionally high building. To allow coal cars to come in at ground level below the unloading crane, the boiler-room floor is 30 ft. above the ground and 70 ft. below the roofs covering the boilers and economizers. An innovation is a submerged ashpit, into which the ashes drop directly from the stokers, this forming a seal and doing away with the usual spray pipes. The ashes are transferred from the pits by traveling cranes equipped with grab buckets to railway cars also operating at the ground level. It will be understood that the incoming coal is transferred by the traveling crane either to storage or directly to the crushers and thence overhead to the bunkers by means of the continuous bucket conveyors shown with their lower runs under the crushers. Reference to the vertical section of the plant will show that the boilers are of the cross-drum type, with the stokers under the low end and the rear wall of the setting drawn in to meet the bridge wall Inspection doors at this point allow the fuel bed to be inspected or sliced when necessary. To facilitate the removal of slag and soot, drop legs continued from the tube headers place the first row of tubes 21 in. center-to-center below the second row. With the bottom of the mud drum below the front tube header 10 ft. above the floor line and the slope of the boiler upward, a furnace volume of 3,100 cu.ft. has been provided. This reduces to 8.9 cu. ft. per square foot of active grate, and when burning coal at the maximum rate obtainable with induced draft, about 45 lb. per hour per square foot of grate, the furnace volume per pound of coal becomes approximately 0.2 cubic foot.

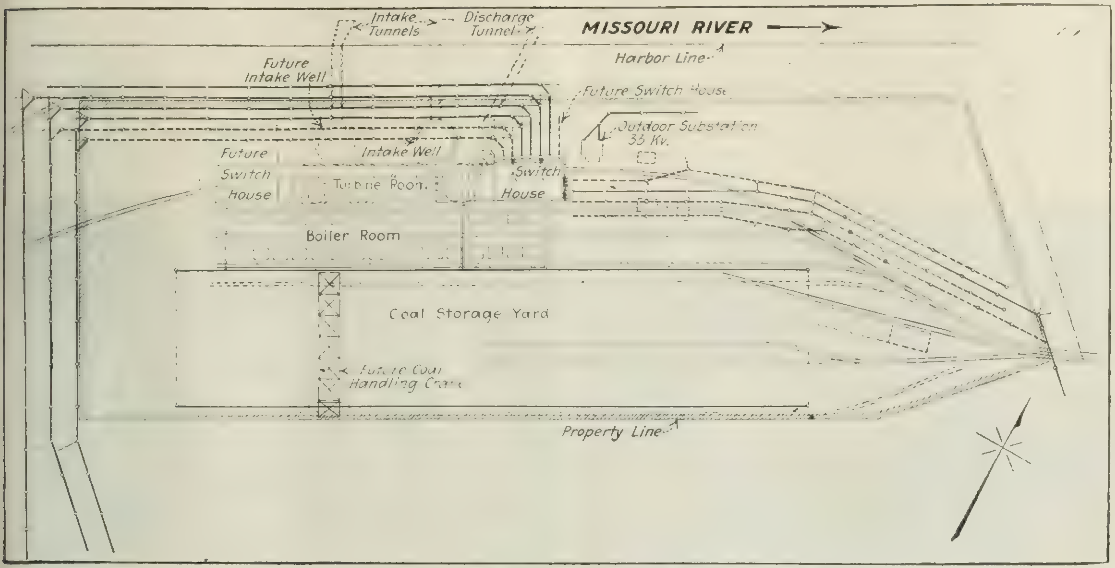

FIG. 1. PROPERTY PLAT, SHOWING THE PROPOSED LAYOUT

Except for their unusual size the stokers are standard, but of heavy construction. There are two per boiler, each 10 ft. wide and 17.5 ft. long, giving an active grate area of 350 sq.ft., which bears a ratio to the steam-making surface of 1 to 38.6. Burning the coals of Kansas and occasionally the semi-lignites of Arkansas requires a grate of large proportions if the boiler is to operate at high capacity. The stokers are designed to operate at speeds ranging from 2 to 11 in. per minute, allowing a wide margin for variation in thickness of fuel bed or in rate of travel to suit the time element established by the quality of the coal being burned. The stokers are driven by belt from a lineshaft which is turned either by an engine or a motor, both on the boiler-room floor and one of each for each row of four boilers.

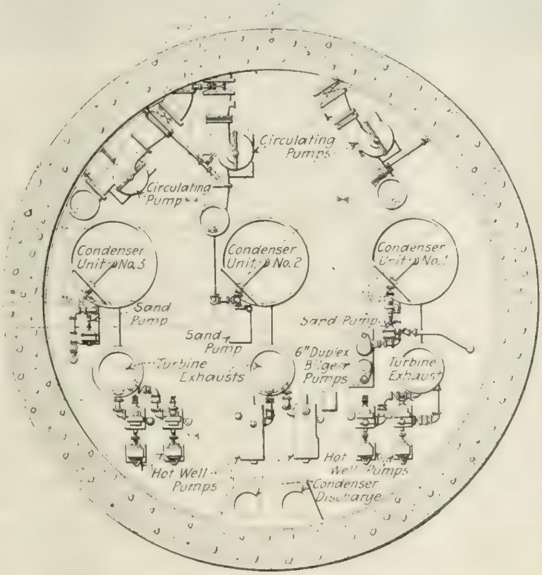

FIG. 2. PLAN OF FIRST CONDENSER WELL

Previous mention of the economizers has been made in *Power*.* High operating pressure and corrosion from the condensation of vapors in the flue gases were the two factors determining the division of the economizer into two sections—one a high-pressure section made of steel to better withstand the pressure, and the other a standard low-pressure cast-iron economizer to resist the corrosion from the condensed vapors. The former resembles a section from a Stirling boiler. It is located immediately above the boiler outlet, contains about one-third as much surface as the boiler proper and is baffled for three passes of the gases. The elements of the low-pressure section have 4,838 sq.-ft. of surface, as compared to 4,205 sq.ft. for the hotter part of the economizer and 13,512 sq.ft. for the boiler. The proportions are such that the water in the cast-iron section is heated to something less than 200 deg. F., say 170 to 190 deg., which will prevent the formation of steam and put the water into the high-pressure section at a temperature sufficiently high to prevent condensation on the tubes and the resulting corrosion.

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*Issue of April 15, 1919 pp. 556-7

FIGS. 3 TO 7. VIEWS OF TURBINE AND BOILER ROOMS, BENCHBOARD, FEEDER PANELS AND AUXILIARY POWER-DISTRIBUTING PANELS

The gases are drawn through the economizer sections by two induced-draft fans driven by a slip-ring induction motor with numerous points on the controller giving a range in speed of about 2 to 1. The controllers are located on the main floor near the boiler fronts.

Feed water is largely condensate discharged by the hotwell pumps through a closed feed-water heater, one for each condenser, into the cool compartment of an immense feed tank mounted over the boilers. Motor-driven pumps then force the water through the low-pressure section of the economizer, from which it runs by gravity into the hot compartment of the feed tank. From the latter turbine-driven boiler-feed pumps take their suction and force the water through the high-pressure steel economizer into the boiler. There will be six of these pumps for the eight boilers.

Makeup water under float control comes into the hot compartment of the feed tank from a large concrete tank below the basement floor. This tank receives all pure steam and water drains and a supplementary supply from deep-well pumps to maintain the water level. Deep-well pumps also supply the house service, the muddy river water being used only for condenser cooling purposes.

In the steam-piping layout the long expansion bends will be evident. The piping is extra-heavy, steel fittings are employed and the high-pressure joints are welded to make them steamtight.

Reference to the plan view of the station will show that the turbine-room floor is practically clear of auxiliary machinery, the only machinery in addition to the main units being the turbine-driven exciter. These machines have a rating of 20,000 kw. at 80 per cent power factor. Three-phase 60-cycle current is generated at 13,200 volts. In the city current is distributed at this voltage, but for outlying districts the supply is stepped up to 33,000 volts in an outdoor substation located on the premises. The machines have direct-connected exciters, and in reserve there is a separate steam-turbine reduction-gear unit rated at 200 kw. Each main generator is also provided with an air washer to clean and cool the air used for ventilation.

All condensing equipment is located in a well 70 ft. in diameter and 57 ft. deep below the turbine-room floor. Each turbine is served by a condenser of the vertical two-pass type containing 35,000 sq.ft. of surface in 1-in. tubes 18 ft. long, the steam-condensing capacity being 225,000 lb. per hour, which reduces to 6.4 lb. of steam per square foot of surface. A vertical exhaust pipe 12 ft. in diameter extends from each turbine to the bottom of the well. Exhaust steam enters the condenser through an opening extending practically the full height between the tube plates. Condensation from the turbine and the exhaust pipe collects in the hotwell at the bottom of the latter, and the condensation from the condenser drains to this same hotwell. From here the hot water is taken by either one of two condensate pumps, one a reserve, and is passed through preheating tubes shut off from the condenser, to the feed tank in the boiler room.

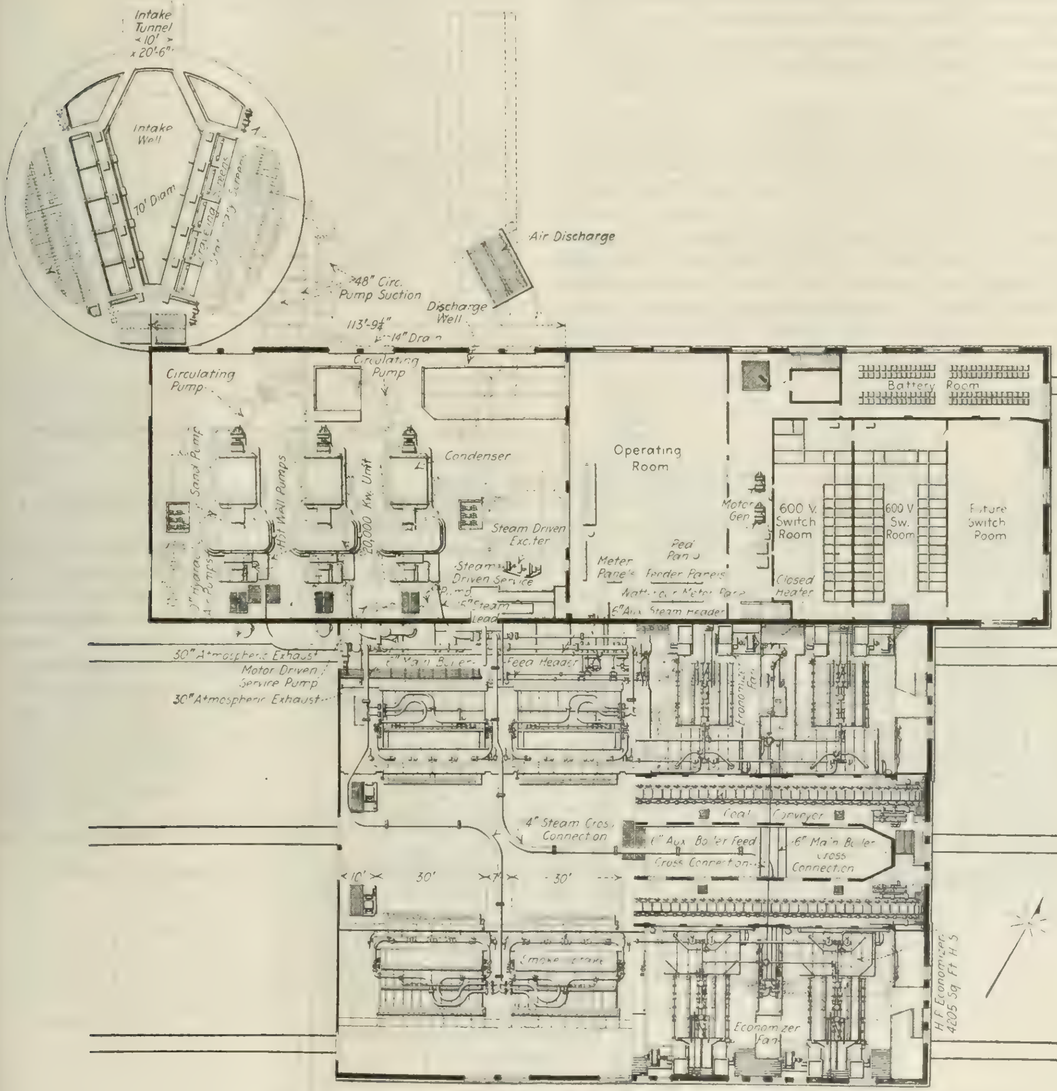


FIG. 8. GENERAL ARRANGEMENT PLAN OF STATION

Circulating water enters at the top of the condensers and leaves at the same level at the opposite side. It is supplied by a vertical volute pump drawing from the intake well at the rate of 35,000 gal. per min. It is driven at 514 r.p.m. by a vertical induction motor. The intake well, which is 70 ft. in diameter and 13 ft. deeper than the low-water level, serves two condenser wells. Water from the river enters the center of the well, and from one side water is drawn off to the three units under discussion. It passes through a bar-iron grill, then through traveling screens, and finally through stationary screens before entering the 48-in. main leading to each circulating pump. Discharge water leaves the station by means of a tunnel to a point down the river. As the water carries a great deal of suspended matter, a sand pump has been provided for each condenser to remove any accumulation that may collect in the bottom head.

Air is removed from each condenser by three 10-in. hydraulic nozzles, the water for operating these nozzles being supplied by two motor-driven 10-in. centrifugal pumps connected in a closed circuit. The nozzles discharge into a tank cooler in which the air is liberated and the water is again taken by the pumps and forced through the nozzles. To keep the supply of water cool, a sufficient amount of water from the deep-well supply is admitted to maintain the required temperature. Fig. 2 is a plan view showing the arrangement of the condenser equipment in the well.

On the electrical end a ring bus system is employed. Fig. 10 shows the plan as it is drawn up for the first two unit divisions of the plant, consisting of five machines. As the diagram shows, these five machines are connected to the one ring bus. Each generator supplies its particular section of the bus and the corresponding feeders. Between each unit is a 5 per cent bus reactance with a short-circuiting switch so interlocked with the generator switch that it will close when the latter opens and cut out the reactance, and vice versa, when the generator switch closes, the short-circuiting switch is automatically opened. Owing to this provision only one reactance can intervene between running generators, and the voltage troubles that might ensue if the current from one section of the bus should pass through several reactances in series, are eliminated. Three per cent reactors are introduced in the feeder circuits.

Fig. 11 is a single-line diagram showing the electrical layout. Current from each main unit is fed at the generator voltage of 13,200 volts, into either its respective main bus or the reserve bus. The latter is not of the ring type and has no bus reactances, although it does have the sectionalizing switches. As previously stated, each section of the main bus is supplied by its respective generator and has a definite number of feeder circuits. In addition each division supplies through an 1,800-kva. transformer a 600-volt alternating-current bus for the auxiliary motors belonging to the particular units in question. To take care of the various station motors which are used in common for the entire station, driving supply pumps, cranes, etc., another 600-volt bus has been provided, and in addition there is an emergency 600-volt bus fed by a reserve transformer, which may be thrown onto any one of the aforementioned low-tension busses in the event that their respective transformers are out of service. The station auxiliary service is alternating-current three-phase 60-cycle induction motors, both slip-ring and squirrel-cage type being employed. Where the service requires variable speed, slip-ring induction motors are used, with suitable control equipment to give the variation desired.

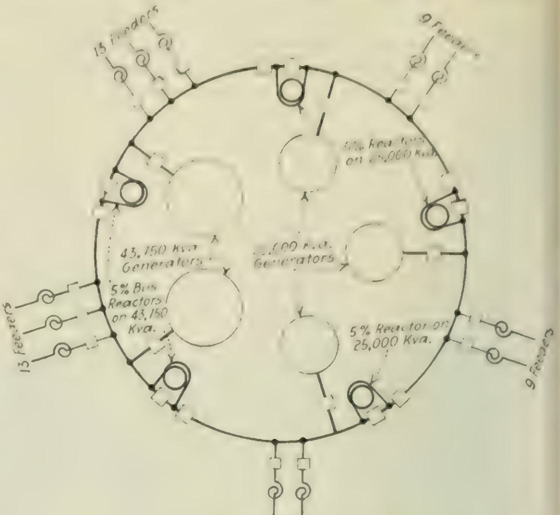

15 Feeders
9 Feeders
5% Reactors on 25,000 Kva.
43,150 Kva Generators
5% Bus Reactors on 43,150 Kva.
Generators
5% Reactor on 25,000 Kva.
15 Feeders
9 Feeders
9 Feeders

FIG. 10. RING BUS SYSTEM FOR THE FIRST FIVE MACHINES

Differential relays actuated by two sets of current transformers, one at the generator neutral and the other at the generator oil-circuit breakers, protect the generator-armature circuit. In case of grounds or short circuits in the generator windings or leads, these relays open the main and neutral oil circuit breakers and the field switch, suitable interlocks being used to insure the proper sequence of operation. The respective generator neutrals are connected to the neutral bus through single-pole oil circuit breakers, and the bus itself is permanently connected to ground through resistance.

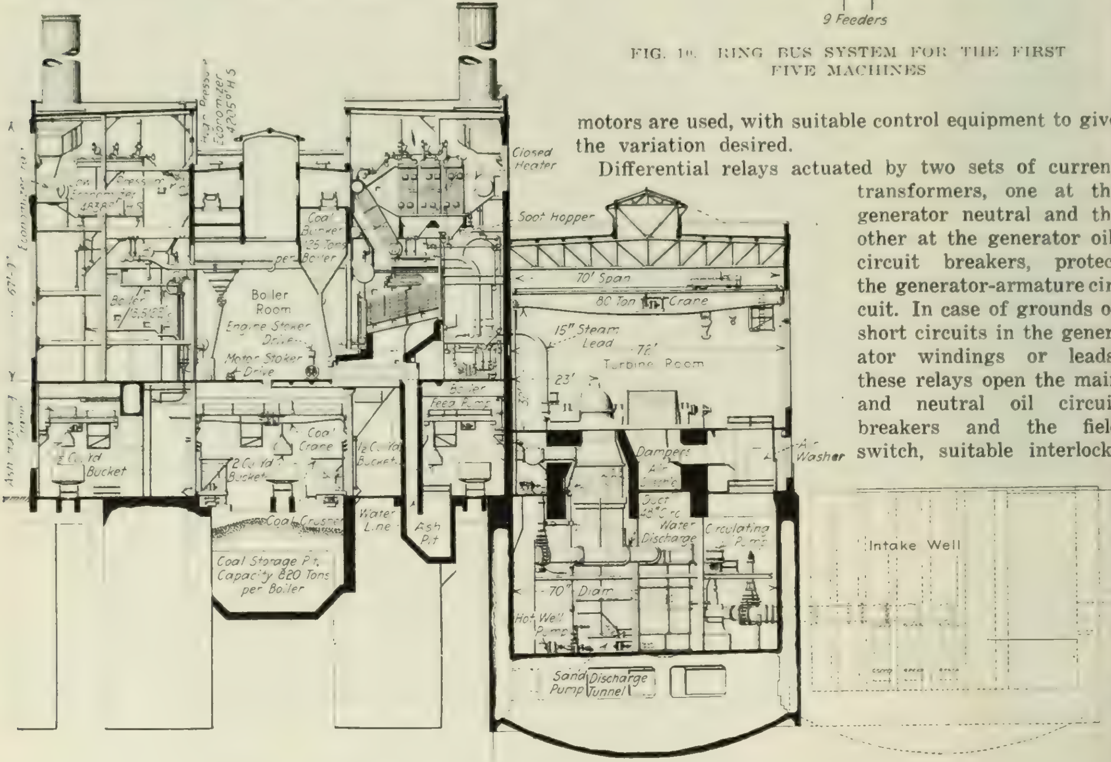


FIG. 9. VERTICAL SECTION THROUGH BOILER AND TURBINE ROOMS

With the exception of the neutral breakers all generator circuit breakers are of the triple-pole single-throw type. All 13,200-volt oil circuit breakers are motor-operated. The generator neutral circuit breakers and all 600-volt auxiliary feeder oil circuit breakers are of the solenoid-operated type, and this applies also to the generator field and exciter switches. The larger auxiliary motors such as are employed to drive the circulating pumps, hotwell pumps, etc., are fed directly from 600-volt oil circuit breakers in the switchhouse. The smaller auxiliary motors are fed from inclosed-fuse, lever switches of the safety type. These switches are arranged in groups, being fed from busses supplied through 600-volt oil circuit breakers in the switchhouse. Some idea of this new departure in station auxiliary distributing panels may be obtained from Fig. 13.

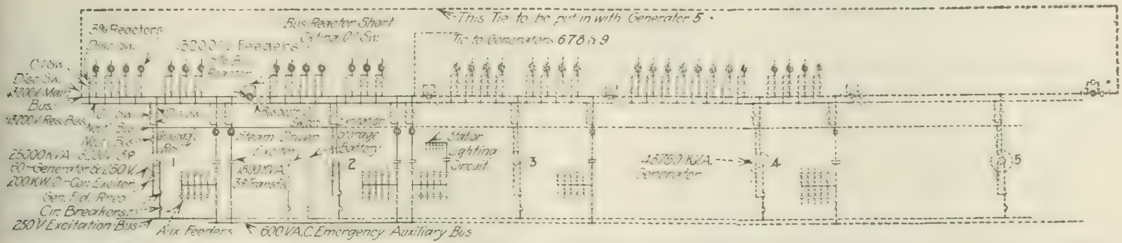


FIG. 11 SINGLE-LINE FLOOR DIAGRAM OF ELECTRICAL LAYOUT

As indicated in the plan view of the stations, the switchhouse is located at one end of the turbine room. This structure will serve the first two unit divisions of the plant, and a similar switchhouse at the opposite end of the station will serve the remaining units when installed. Fig. 12 will show that the switchhouse has three floors. The operating room for the entire station is on the top floor overlooking the turbine room. On the same floor are the storage batteries, consisting of two 125-volt 62-cell units connected in series with three-wire connections to give 125 volts for switch control and 250 volts for emergency lighting or excitation. Space has also been allotted to the 600-volt auxiliary feeder circuit breakers which are mounted on open, pipe framework with fire walls between every two groups of breakers. Underneath is a conduit floor principally for the control and the stationary auxiliary feeder cables. The first floor of the switchhouse contains the 13,200-volt bus structure and the oil circuit breakers, as well as exciter and field switch panels. On the basement floor the bus and feeder reactors are located almost immediately under their respective circuit breakers. The grounding resistances, generator and neutral switches and generator field rheostats are also placed on this floor. Ventilation is insured by a motor-driven fan with louvers in the floor above to allow the heat to flow upward during the colder months. Under the basement floor are manholes to receive the 13,200-volt feeder cables. The generator cables enter below the first floor through fiber ducts laid in concrete. All the modern instruments usually employed in such a station have been installed on the bench and switchboards. There are standard signal systems between the benchboard and each unit, consisting of an eight-circuit signal box with push-button switches and lamps with lenses lettered for the different operations. A duplicate box with a signal bell to attract attention is mounted on each turbine-room gage board, and here, too, is an indicating wattmeter to show the load on the machine. A duplicate instrument is placed on the boiler-room gage board so that both turbine-room operators and the boiler force may know the exact load that is being carried. For convenience in operation all 600-volt auxiliary feeder oil circuit breakers are electrically controlled from panels on the turbine-room floor.

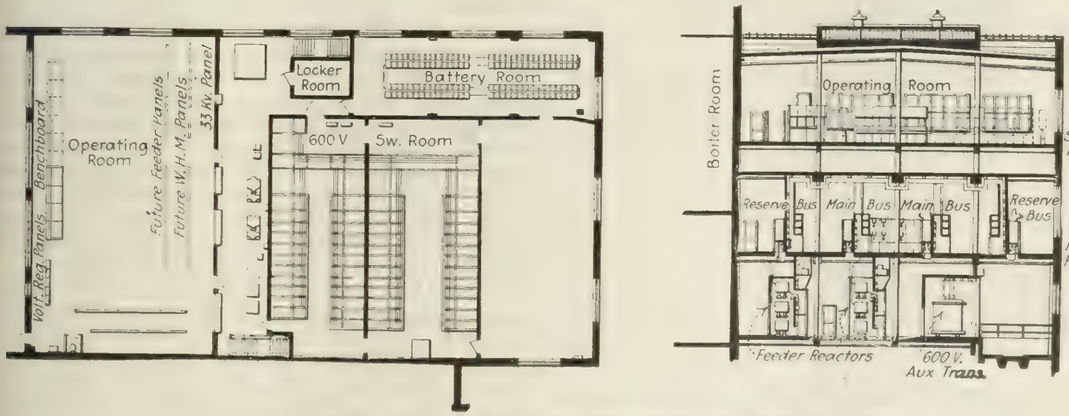


FIG. 12. SECOND-FLOOR PLAN AND ELEVATION OF SWITCHHOUSE

An interesting innovation is the system installed for generator fire protection. It consists of a pipe ring at either end of the machine inside of the end shield, with nozzles projecting from these circular pipes toward the stationary windings. The pipes are brought to the turbine-room wall at a distance from the machines, so that a hose connection can be easily and quickly made in case of fire.

Sargent & Lundy, consulting engineers, of Chicago, are responsible for the design and installation of the station. Joseph F. Porter is president of the Kansas City Power and Light Co., and H. C. Blackwell is vice president and general manager. Edwin Jowett has charge of the operation of the station.

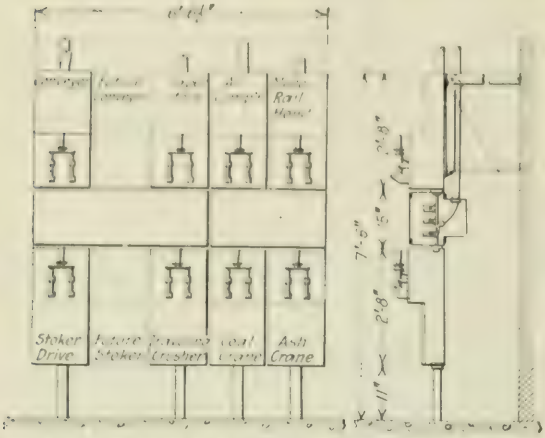


FIG. 13. CONCRETE BUS AND OIL-SWITCH COMPARTMENT

PRINCIPAL EQUIPMENT OF NEW KANSAS CITY PLANT FIRST TWO UNITS

Boilers	
Type	Water-tube, B. & W. cross-drum
Number installed	6
Steam-making surface, sq.ft.	13,512
Working pressure, lb. gage	300
Superheat, deg. F.	250
Superheater, B. & W., sq.ft.	3,863
Temperature steam, deg. F.	675
Capacity of each boiler, max. lb. steam per hour	110,000
Stokers	
B. & W. chain grate, two per boiler, 10 ft. wide, 17 ft., 6 in. long, belt-driven from line shaft, one engine and one motor per four boilers	
Grate area, active, per boiler, sq.ft.	350
Capacity, max. lb., coal per hr.	18,000
Economizers	
B. & W. high-pressure steel economizer, surface, sq.ft.	4,205
Green low-pressure cast-iron economizer, surface, sq.ft.	4,838
Fans	
Green induced-draft, two per boiler, driven by one 150-hp. slip-ring induction motor, r.p.m.	600
Capacity, lb. gas per min. per boiler at 375 deg. F.	5,500
Stack	
Steel	One per two boilers
Height above boiler-room floor, ft.	126
Diameter at top, ft.	10
Free area, sq.ft.	78.54
Boiler Ratios:	
Ratio grate area to steam-making surface	1 to 38.6
Ratio superheater surface to steam-making surface	1 to 3.5
Ratio surface in h.p. econ. to steam-making surface	1 to 3.2
Ratio surface l.p. econ. to steam-making surface	1 to 2.8
Stack area per 100 sq.ft. steam-making surface, sq.ft.	0.29
Breaching area per 100 sq.ft. steam-making surf., sq.ft.	0.36
Connected grate area per sq.ft. of stack	8.9
Pumps:	
Boiler feed, 4 Worthington, 4-stage, 4-in. cent. turbine-driven, capacity of each, g.p.m.	600
Service, 2 Worthington cent. one motor- and one turbine-driven, capacity of each, g.p.m.	850
Makeup, 2 yeomans, vertical, motor-drivers, capacity, g.p.m.	200
Deep well, 2 American Well Works, vertical volute, motor-driven at 1200 r.p.m., capacity of each, g.p.m.	700
Feed-Water Heaters:	
One per unit, closed type, Patterson-Kelley, cast-iron shell, copper tubes, capacity, lb. water per hr., from 75 to 120 deg. F.	250,000
Coal Storage:	
Overhead steel bunkers, one per boiler, tons	125
Pit under central aisle, tons per boiler	820
Cranes:	
Coal-handling, one Whiting, four-motor traveling type, 2-cu.yd. bucket, span, ft.	38
One locomotive crane, W. B. Lover Co., capacity, tons	15
Ash-handling, two Whiting four-motor traveling type, 1½-cu.yd. bucket, span, ft.	18.2
Turbine room, one Whiting, four-motor traveling type, 80-ton hoist, 15 ton aux. hoist, span, ft.	70
Coal Crushers:	
Two four-roll traveling, Orton & Steinbrenner, cap. per hr., tons	125
Coal Conveyor	
Two continuous-bucket, Link-Belt, cap. per hr., tons	125
Turbines	
Two G. E. single-cylinder, horizontal, 23-stage	
Rating at 80 per cent. power factor, kw.	20,000
Speed, r.p.m.	1,800
Operating pressure at throttle, lb. gage	250
Superheat, deg. F.	250
Net weight of unit, lb.	412,000
Weight per kw. of rating, lb.	20.6
Generator	
Two G. E. three-phase, 60-cycle, 13,200-volt	
Rating at 80 per cent. power factor, kw.	20,000
Air for cooling, cu.ft. per min.	55,000
Air washer, one per unit, Sturtevant	
Exciter	
One to each unit, direct-connected, 250-volt, kw.	110
One spare, turbine-driven, reduction gearing, kw.	200
Condenser	
Two Worthington surface, vertical, two-pass, 1-in. tubes, 18 ft. long, surface, sq.ft.	35,000
Capacity of each to condense, lb. steam per hr.	225,000
Traveling screens for two machines, four, Chain Belt Co.	
Condenser Auxiliaries	
Circulating pumps, Worthington, vertical volute, one per unit, cap., g.p.m.	35,000
Pump capacity per lb. steam, condensed, lb.	78
Driven by vertical induction motor, hp.	458
Speed, r.p.m.	514
Condensate pumps, two per unit, Worthington two-stage 5-in., capacity, g.p.m.	800
Driven by 177 hp. ind. motor, r.p.m.	1,200
Vacuum pumps, three per unit, Worthington hydraulic vacuum nozzles, supplied by two motor-driven 10-in. cent. pumps, cap. each, g.p.m.	3,200
Switchboard	
G. E. design and equipment.	

Mine Hoist to Carry One Hundred Men

As in all other trades the working hours of the miner have been shortened. The time spent in lowering the men into the mines or hoisting them to the surface is thus a factor of increasing importance, as it represents a larger fraction of the working time and consequently has a corresponding influence upon the output. It is to the mines' interest, then, in particular where large bodies of men are employed, to provide larger and faster hoists, so that this item of loss may be held to a minimum.

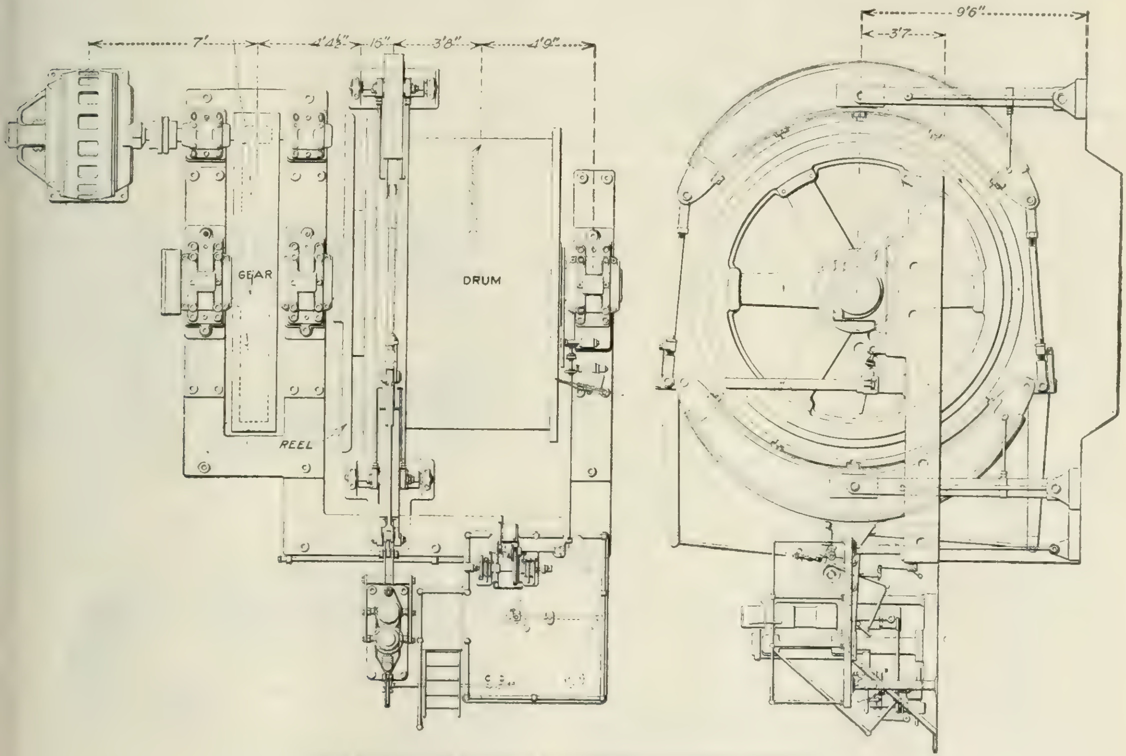
It was with this idea in view that the United Verde Copper Co. ordered for its mine at Clarkdale, Ariz., a Nordberg man hoist of unusual proportions. The hoist, which is of the single-drum motor-driven type, is designed to operate in balance at a rope speed of 800 ft. per min. It has capacity to carry at one time 100 men, which is about three times the number usually handled. In addition to the large carrying capacity an unusual feature with this hoist is the provision of a reel, independent of the drum although keyed to the drumshaft, for carrying the flat counterbalance rope.

The hoist has three main bearings, with a herringbone reduction gear between the drum and the motor, the latter being of the induction type rated at 350 hp. and having a speed of 345 r.p.m. The entire hoist weighs approximately 165,000 lb., and the drum, which is 12 ft. in diameter, with a 6-ft face, weighs 65,000 lb. The drum has been designed to hold 2,500 ft. of 1⅞-in rope in two layers. Its shell is of rolled steel plate 1½-in. thick with cast-steel end rings. The spiders are cast separately and fastened to the end rings with turned bolts driven into reamed holes. The reel has a bottom diameter of 6 ft. and is 5¾ in. wide to take a 5½-in. flat rope. The loading is approximately as follows:

Men, lb.	16,500
Empty double-deck cage, lb.	13,500
Two loaded cars ore cars, lb.	12,000
2500 ft. 1⅞-in. rope, lb.	12,200
Maximum cable pull, lb.	42,200
Counterweight, lb.	30,000
2100 ft. ½ x 5½-in. flat rope, lb.	8,800

The hoist is provided with one set of brakes of the gravity post type, operating on a brake ring bolted to the drum. The brake itself consists of a pair of wood-lined brake posts supported on heavy carrier bolts to the bedplate. The posts are mounted so as to compel parallel motion when engaging or releasing. The tops and bottoms of these posts are drawn together by means of drawbars and forged steel levers, having turnbuckles for adjustment.

Control is effected hydraulically; the brake and clutch are operated by outside-packed plunger-type thrust engines using oil under pressure furnished by an accumulator. The oil is admitted to and exhausted from these thrust cylinders by balanced poppet-type hydraulic valves operated by a system of floating levers arranged so that the plunger of the thrust engine follows the motion of the operator's lever. Whenever the operator's lever comes to rest, the plunger also comes to rest, and is locked in that position owing to the fact that both inlet and exhaust valves are closed. In this way the operator has full control of the brakes just as if he were operating them by hand.



PLAN OF MAN HOIST AND DESIGN OF POST BRAKE

The accumulator is of the direct-pressure loaded plunger type, consisting of a vertical hydraulic plunger and a loaded cylinder working on it. To the upper end of the cylinder is secured a cylindrical steel bucket arranged so as to bring its center of gravity as low as possible, the bucket being of sufficient size to hold the proper weight of sand or other material to balance the working oil pressure.

Two motor-driven triplex pumps, one unit acting as a reserve, supply the necessary oil for the operation of the brakes. Bypass valves, operated by the movable bucket, have been provided for bypassing the surplus oil. One of the most interesting features of the unit is a mechanically operated safety device provided to protect the operation of the hoist. At each trip the power is automatically shut off and the brakes automatically applied by means of cams driven from the drumshaft. The cams are constructed to give gradual operation of the brakes and insure the complete stopping of the hoist by the time the load reaches the top of the run. Should one of the clutches be disengaged and the load lowered on the brakes, the brakes will be applied gradually and the load brought to rest at the bottom of the descending trip. In case of overspeeding the brakes are applied, the current cut off and the hoist brought to rest. Any attempt to overwind or start the hoist in the wrong direction will result in the instant application of the brakes and the shutting off of the power.

All these operations take place every trip made by the hoist if the operator leaves the controller levers alone, but these features do not interfere if the operator takes control of the operating levers and wills to stop the hoist in the ordinary manner.

Owing to the Chinese fondness for things durable, giving good service a long time, electric-plant equipment of sterling quality, capable of withstanding untrained usage, is in strong demand now that electricity is coming into its own in China, comments the *North China Daily News*. Many orders have been given for power and lighting plant for cotton mills, and the demand for lighting plant for cities in the interior is steadily growing. Steam turbines are to the fore where large plant is concerned and they are being introduced to some extent in the smaller plants, since the advance in the price of crude oil.

Using the Indicator on a Diesel Engine

Unfortunately, the average Diesel engineer has no conception of the value of an indicator as a means whereby the valve setting may be properly checked. It happens that the Diesel operator is usually the product of an automobile repair shop and his experience has been almost entirely along automatic lines. The tendency to employ such men rather than steam engineers is practically universal. This is wholly the fault of the steam-engineering profession in that it has never seriously taken up Diesel engineering. The ex-automobile mechanic knows nothing of the indicator and attempts to set the valves by shop data. After an engine has been in operation for some time, the old shop data cannot be considered as dependable, since considerable backlash now exists. The indicator is the only means whereby faulty adjustment can be detected.

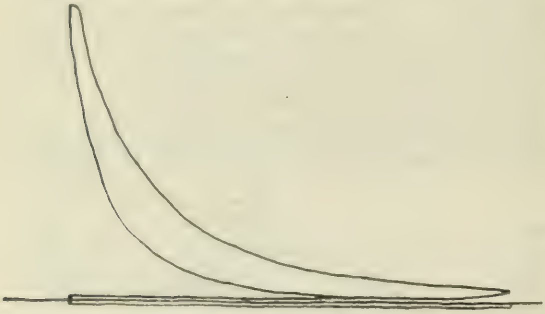


FIG. 1. LATE EXHAUST OPENING

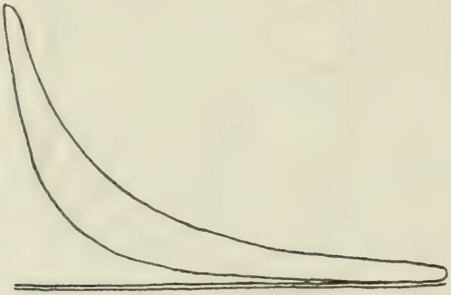


FIG. 2. CORRECT EXHAUST OPENING

As an example of faulty valve setting attention is called to Fig. 1. Here the exhaust valve opens extremely late and imposes a considerable back pressure on the piston. An engine having the valve opening so late will labor and show an inability to carry its load.

Fig. 2 is a diagram from the same engine after the exhaust-valve opening had been advanced. A light spring was not available, and as a result the point of valve opening is not so clearly indicated as is desirable. In this case, if the engineer had had an indicator and had used it, the engine would have been tuned up at once.

Every Diesel-engine plant should be provided with an indicator; if the management is unwilling to invest, it is money well spent even though the engineer must dig down into his own pocket.

Commutator Made from Copper Block

By Vernon Pearson

Some years ago I had occasion to replace the commutator of a small generator; the job was done in what I believe to be an unusual way, and I pass it along for what it is worth.

The dimensions of the commutator to be replaced were, roughly, 2-in. face by 2¾-in. diameter. A block of copper was secured about this size and a 1¼-in. hole drilled through its center and placed in a lathe on a mandrel. The back gears were used for a dividing head, and the number of slots were laid off across the face ends. Then, after taking the blank off the mandrel, the slots were sawed down to within 1/32 in. of the bore, as shown in Fig. 1.

These slots were next filled with sheet mica coated with shellac. A 2½-in. pipe coupling was placed in the lathe chuck and bored out to within about 1/64 in. of the outside diameter of the blank, with the outer end of the bore beveled off to make entrance easy. After trimming the excess mica, the blank was forced into the coupling, Fig. 2, by placing the two between the jaws of a vise and closing them. The piece was then mounted in the lathe chuck and the center hole bored out to its proper size, thus removing the 1/32-in. of metal left to hold the blank together. A careful inspection was made of the bore to see that no pieces of chips remained to bridge any slots, and then the piece was mounted on a mandrel and the ends shaped to receive the clamping rings.

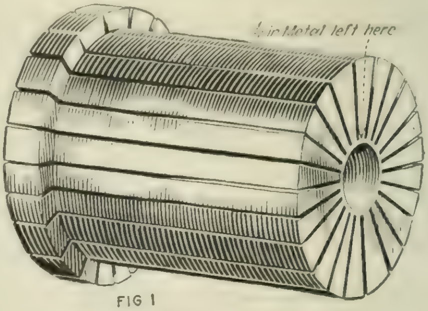


FIG 1

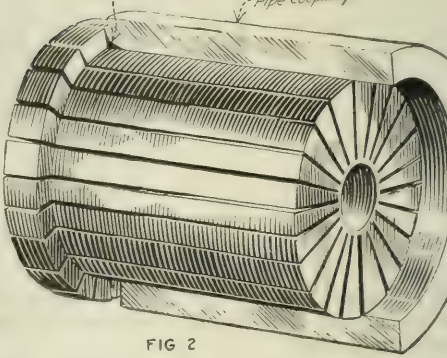


FIG 2

FIGS. 1 AND 2. SHOWING CONSTRUCTION OF THE COMMUTATOR

After mounting the new commutator on the armature shaft, the pipe coupling was pulled off and the face turned down to a fine finish.

Lining Up a Motor for Shafting or Machine Drive

By K. A. Reed

How to install a motor on the ceiling, wall or floor and line it up to shafting is explained and methods of handling the motor during installation are given.

FOR the inexperienced it is generally somewhat of a job to properly install a motor so that its pulley will line up correctly with the pulley on the lineshaft to which it is to be belted or to the individual machine which it is to drive and in such manner that satisfactory operation will be obtained. Upon giving the problem serious thought, however, it will be found that by bearing in mind a few fundamental principles and applying them to each individual case, the solution is usually fairly simple.

In the first place, as every engineer knows, the shaft of the motor must be exactly parallel to the lineshafting or the shaft of the machine which the former is to drive. Secondly, the center of the pulley of the motor must be in line with the center of the pulley on the lineshaft to which it is to be belted, and such details as leaving room for tightening the belt (that is, do not mount the motor too close to a column or beam, which would prevent it from sliding on its base), having the motor as accessible as possible for cleaning, with the oil wells easy to get at, choosing just the right place for the starter, etc., must not be overlooked. In selecting the location for the motor, the question of proper distance between shaft centers for the ratio of the pulley diameters should be taken into consideration. If the motor is to be suspended from the ceiling or mounted on the wall, care must be used to see that a foundation of proper design is provided. For floor mounting the foundation should be at least eight inches or a foot above the floor level so that the motor will not be injured by water when washing the floor or dirt from sweeping, and will be accessible for inspection or repairs.

It is usually possible to secure, from the district office of the manufacturer of practically any motor, a dimension leaflet giving complete information about the motor, similar to that shown in Fig. 1. From such a leaflet it is a simple matter to find all the dimensions required for the sliding base or rails, if the foundation is to be concrete or wood, or for the motor feet if it is to be mounted on the frame of a machine arranged for individual drive. In the case of wall or ceiling mounting the foundation details are likewise simplified, and the actual weight of the motor is given. If, however, it is impracticable to secure a dimension leaflet, the principal dimensions can, by using a little care, be accurately obtained by measurement from the motor itself. Such dimensions might be listed as *D*, *E*, *W*, *T*, *J* and *M*, and for the purpose of clearing beams, columns, etc., *H*, *B* and *F*. The essential dimensions can be obtained as follows:

Dimension *D* is taken when the motor is exactly half way between surfaced parts of the slide rails, which act as guides for the motor feet; that is, when the same length of these guides projects beyond each end of the motor feet, Fig. 1. Under these conditions *D* is, therefore, one-half of the distance between the bolt holes in the slide rails in a direction at right angles to the shaft.

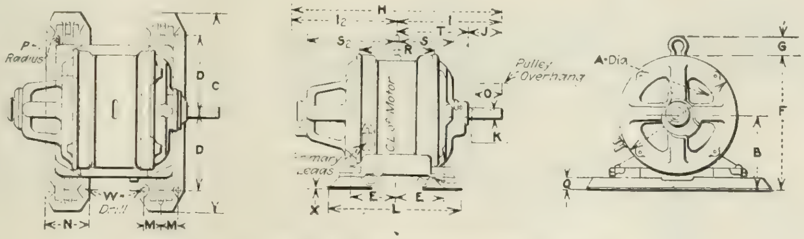


FIG. 1. MOTOR DIMENSIONS DATA SHEET

Frame No.	Fig. No.	Dimensions in Inches Corresponding to Letters in Outline Views														
		A	B*	C	D	E	F	G	H	I	I_2	J	K	L†	M	N
320	4	13 7/8	8 11/16	20	7 3/8	4 1/4	15 5/8	1 1/4	22 15/16	11 3/4	11 11/16	3 1/2	1 1/4	14 1/4	6 7/8	
330	4	13 7/8	8 11/16	20	7 3/8	4 1/4	15 5/8	1 1/4	24 3/16	11 7/8	12 5/16	3 1/2	1 1/4	14 3/4	6 7/8	
350	4	13 7/8	8 11/16	20	7 3/8	4 3/4	15 5/8	1 1/4	24 9/16	12 1/16	12 1/2	3 1/2	1 1/4	14 3/4	6 7/8	
460	5	17 1/4	10 7/16	26	10	5 7/8	19 1/16	1 7/16	32 1/4	17 9/16	14 11/16	5 11/16	1 [illegible]	16 5/8	2 3/16	5 [illegible]
540	5	20 3/4	12 3/8	31 1/4	12	6 1/4	22 1/4	1 9/16	35 7/8	19 3/4	16 1/8	6 3/16	1 7/8	18 3/4	2 3/8	6 1/4
550	5	20 3/4	12 3/8	31 1/4	12	7 1/4	22 3/4	1 9/16	37 7/8	20 3/4	17 1/8	6 3/16	1 7/8	20 1/4	2 3/8	6 1/4

Frame No.	Fig. No.	Dimensions in Inches Corresponding to Letters in Outline Views								Key			Approx. Net Wt., Lbs.			
		P	Q†	R	S	S_2	T	W	X†	a	b	c	Bare Motor	Additional for Sliding Base	Additional for Slide Rails	Additional for Pulley
320	4	1	1 5/16	7	5 9/16	9 3/4	7 3/4	5/8	3/16	2 7/16	5/16	1/4	180	20	..	2
330	4	1	1 5/16	8 1/4	6 3/16	10 3/8	8 3/8	5/8	3/16	2 7/16	5/16	1/4	221	20	.	3
350	4	1	1 5/16	8 5/8	6 7/8	10 9/16	8 9/16	5/8	9/16	2 7/16	5/16	1/4	230	20		3
460	5		1 7/16	[illegible]	8 1/2	12 7/16	11 7/8	3/4	1/4	4 13/16	3/8	1/4	375		30	4 1/4
540	5		1 5/8	10	9 27/32	13 11/16	13 9/16	7/8	5/16	4 7/8	7/16	5/16	525		45	11 1/4
550	5		1 5/8	12	10 27/32	14 11/16	14 9/16	7/8	5/16	4 7/8	7/16	5/16	630	.	45	11 1/4

* This dimension will never be exceeded. When exact dimension is required liners up to $\frac{1}{16}$ inch may be necessary

† Approximate.

Table correct at date of publication; for latest data apply to nearest district office of the Company.

To get *W* simply measure the diameter of one of the bolt holes in the slide rails. *T* may be secured by placing the end of a rule on the center line of the motor at the eye-bolt, and dropping a plumbline just flush with the oil well in the end bell at the point *x*, Fig. 3. In order to get *J*, place the rotor in the bearings so that one-half of the total end play is on each end of the shaft and measure that portion of the shaft which projects beyond the end bell. By placing a straight-edge across the top of the motor and dropping a plumbline flush with the oil well on one end and another plumbline flush with the end of the shaft, dimension *H*, Fig. 1, is obtained. With the motor resting on the slide rails on the floor, measure the distance from the floor to the center of the shaft and to the top of the motor for dimensions *B* and *F* respectively. Dimension *M* is most readily obtained by turning one of the slide rails upside down and taking half the distance between the holding-down bolt holes in a direction parallel to the motor shaft. Likewise dimension *E* is obtained by turning the motor on its side and taking half of the distance between the bolt holes in the feet in a direction parallel to the shaft. It should be borne in mind at all times that the magnetic center is not always the mechanical center of the motor and this point must be given special attention when connecting a motor to a pump, blower or other machine by means of a flange or other type of solid coupling.

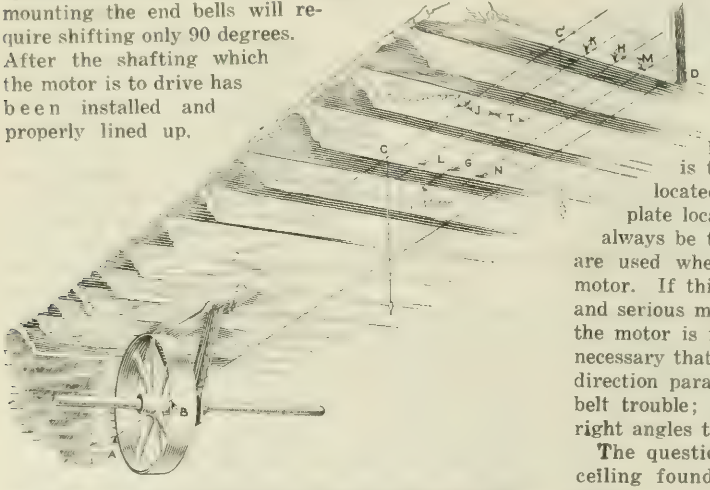


FIG. 2. SHOWS METHOD OF LINING UP MOTOR ON CEILING

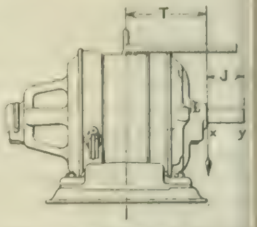


FIG. 3. OBTAINING MOTOR DIMENSIONS

When installing a motor for ceiling operation it is, of course, necessary to turn the end bells, or bearing housings, 180 deg. around the yoke, so that the oil wells will be in the proper position. If the machine is a direct-current motor, it will be necessary to remove the brush-holder yoke and to put the yoke back in place again when the end bell is turned. In making any change in the position of the leads, care should be observed to see that they are replaced in exactly the same electrical and physical position as the original, so that when connections are made in accordance with the diagram accompanying the motor, proper operation will be obtained. For wall mounting the end bells will require shifting only 90 degrees. After the shafting which the motor is to drive has been installed and properly lined up, fasten a strong cord to a support which has been placed in front and near the center of the pulley on the line-shaft to which the motor is to be belted. Extend the cord across the shaft and somewhat beyond the motor location on the ceiling and move it until it is exactly even with the rim of the pulley at the point *B* on the side opposite to that on which it is fastened at *A*, as per Fig. 2. Draw the cord tight and secure it to the ceiling or to a piece of wood extending down from the ceiling at the point *D*, after which two points *C* and *C'* can be located on the ceiling by means of a plumbbob, as indicated. The line *CC'*, of course, coincides with the outside rim of the driving pulley on the motor shaft. Locate two points *G* and *H*, the distance *J* plus *T*, plus the overhang of the pulley, Fig. 1, from points *C* and *C'*, and the line *GH*, which is parallel to *CC'*, will be the center line of the motor. To obtain the overhang of the pulley place a square or straight-edge across the diameter and measure the distance from the end of the hub to the outside rim. As a rule the location of a standard pulley on a motor shaft is such that the outside end of the hub is not flush with the end of the shaft. After this center line has been located and the distance between shaft centers determined the bolt holes for the sliding base or rails can be readily located from Fig. 1, and are indicated in Fig. 2 by the lines *KL* and *MN*. In building concrete foundations it is usually customary to make a wooden templet either according to dimensions taken from the motor itself or the dimension leaflet. After locating the center line of the motor in the same manner as in the case of ceiling mounting, the templet supporting the holding bolts for the slide rails or base is properly located above this line and carefully leveled. The concrete is then poured in the form which has been provided. When it is necessary to mount the motor on the wall proceed with the line as in the case of ceiling mounting and locate a point *C* at any convenient place on the wall near the ceiling, Fig. 2. With the plumbbob draw the line *CC'*, and this line, as in the former case, coincides with the outside rim of the driving pulley on the motor shaft. Line *GH*, which is the center line of the motor, can now be located and the holding-down bolts for the bedplate located as in the former case. Care should always be taken to see that rigid timbers and bolts are used when building a wooden foundation for a motor. If this is not done vibration is sure to follow and serious motor trouble may be the result. Whether the motor is mounted on a ceiling, wall or floor, it is necessary that the slide rails or bedplate be level in the direction parallel to the motor shaft in order to avoid belt trouble; leveling the bedplate in the direction at right angles to the motor shaft is also advisable.

The question of actually placing the motor on its ceiling foundation often proves troublesome if the motor is too heavy for four or five men to handle while standing on a platform. Under these circumstances a scaffold strong enough to support the motor and men safely should be built under the foundation and as close to the bottom of the foundation as possible and still permit the motor to be raised by a block and tackle and landed on it, as shown in Fig. 4. A safe and easy way to handle the motor when it is upside down and prevent it from turning is to support it on a wooden frame made out of 2 x 10-in. planks the top sides of which are curved to fit the frame of the motor, as shown on top of the scaffold. This frame should be placed on pipe rollers so that the motor can be easily moved under its proper position.

When this has been done each end of the frame in which the motor rests can be raised alternately a few inches at a time and blocking inserted until the motor reaches its operating location. Placing the motor on its foundation on the wall is a much simpler operation, since it is only necessary to suspend a chain block or block and tackle from the ceiling immediately over the foundation near the wall and lift the motor directly onto the holding bolts.

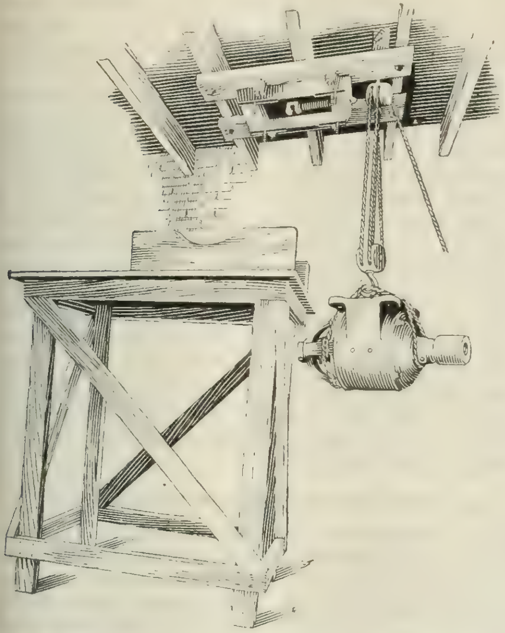


FIG. 4. METHOD OF HANDLING MOTOR WHEN INSTALLING IT ON CEILING

Royer Flow Indicators

In the June 17, 1919, issue the Royer Flow Meter was described. Since that time the manufacturers, the A. H. Sloan Co., Inc., of Detroit, have made refinements in the design and developed a number of types for specific uses. All the meters are based on the Pitot-tube principle and are purely indicating instruments.

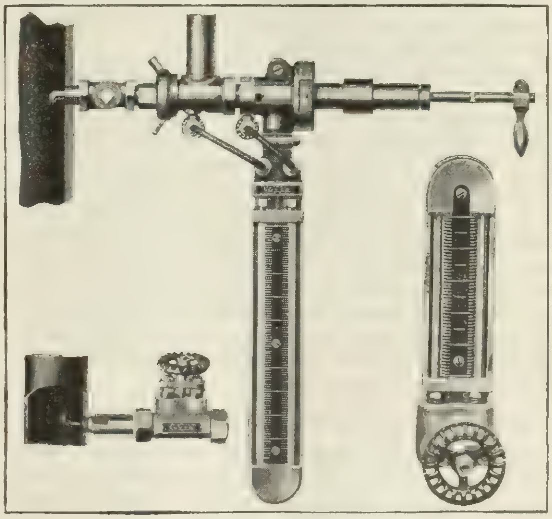
In the accompanying illustration the upper view shows a light, compact meter for portable use. A shut-off valve is attached to the pipe, and the instrument is inserted into the valve and secured by means of the wing nut, after which the valve is opened for the entrance of the impact tube. The main body, or barrel, of the instrument is separated into two chambers. The impact chamber consists of a bored opening in the outer half of the body of sufficient length to permit a range of movement for the impact tube when making a search or traverse for the mean velocity point in all sizes of pipe. This chamber is connected to one leg of the U-tube by means of a valve and flexible high-pressure tubing. The static chamber leads from the end of the connection inserted into the wall of the pipe terminating at the valve and has flexible connection to the other leg of the manometer. The two chambers are separated by a simple type of stuffing box, the gland of which is the outer half of the main body of the instrument carrying the impact chamber.

The manometer is so mounted that it is adjustable for various slope angles, the position being controlled by the leveling collar mounted thereon. This feature enables the operator to measure low velocities such as are encountered in the metering of air and gases. It may also be removed from the plug end of the instrument and mounted on a separate base, where there is sufficient vibration in the pipe line to interfere with accurate reading or where it is necessary to apply the plug in a position that would be inaccessible for obtaining a reading.

The two lower views show the instrument designed for measurement of chemicals such as bicarbonate of soda solutions, saponified oils, cutting compounds, ammonia liquors and other corrosive mediums. The nozzle plug is shown at the left and the manometer at the right. An oil seal is sometimes provided to prevent the solution being measured from coming in actual contact with the steel parts, and those parts which it is impossible to protect are made from monel metal or other alloys, depending upon the chemical action encountered.

This type of meter is especially adapted for conditions where the point of measurement is isolated from the place at which the actual reading is to be taken, that is, the indicating unit, or manometer, is separated from the other member of the meter, commonly called the nozzle plug, which carries the impact and static chambers which are connected to the two legs of the U-tube in the manometer unit.

In applications involving the measurement of liquors or solutions carrying solids such a tar, the instruments are furnished with a steam connection for clearing the impact tube. The same instrument is also adaptable for measuring fluids under extremely high pressures.



THE ROYER FLOW INDICATOR

The upper view shows an indicator for portable use, and the two lower views show a type designated for measuring corrosive mediums.

The average increase in freight rates on commercial bituminous coal under the new rates which will go into effect shortly by permission of the Interstate Commerce Commission will be about 57 cents per ton according to an estimate of a railroad statistician of high standing, given to the *Coal Review*.

Reminiscences of An Engineer

By W. D. Forbes

In a former article I referred to the Baxter engine, which, it seems to me, anticipated the fundamental idea of the locomobile engine. In the locomobile engine the heat of the boiler and smokestack is utilized to keep the cylinders hot. This conforms with the dynamic law which would make for economy in any design of steam-driven machine.

Mr. Baxter, I believe, was the man who designed the system of propulsion for the Erie Canal. In his system the propeller was only partly submerged, and I think it was reported as the most satisfactory system presented. A prize was offered in the early seventies, I believe, by the State of New York for the best method of canal towing, but I do not think anyone received the prize. Now we have from France records of experiments driving canal boats with a propeller entirely in the air, and it appears from them that the system is practical, but I think that the published reports of the trials give results that can be fairly questioned. The speeds obtained seem far too high for the power expended. Mr. Baxter started on the right road by lifting his propeller, but did not go quite far enough.

I do not have the records handy of the results of my Baxter-engine tests, but I am quite sure that they showed a water consumption of less than half of that of the usual small steam engine. The only reason why this engine was not widely used, it seems to me, was that the low cost of fuel resulted in buyers of small prime movers giving little or no thought to economy, first cost governing.

People bought the Baxter engine mainly because it was self-contained and good looking. About the time I tested the engine, I went to the graduating exercises of a class at Stevens, when Professor James Denton, one of the graduates, read his thesis on "Locomotive Traction." Horatio Allen delivered the address to the class. I went to President Morton's house after the exercises and met Mr. Allen, and in a conversation with several engineers there he remarked that he often thought that it would be possible to send the exhaust of a locomotive around the cylinders and steam chests and thus effect a great saving in steam, and he believed that too little attention had been given to keeping the cylinders of locomotives hot.

THE ENGINES OF THE "BATTERY," STEVENS' STEAMER

The conversation then turned to marine steam engines, and it came out that the first engines designed for the celebrated Stevens' steamer, the "Battery," were multi-cylinder affairs, eight cylinders in each engine, driving the propellers direct. Twin screws were fitted in the design, but the engines were never built, although the patterns had been made. At that time the "Battery" was partly finished, and in walking down Hudson Street, Hoboken, on the east side you walked over the bow of the "Battery." The boat was constructed in a hole, dug to receive it, as it was believed by marine men that it would not be possible to launch such a heavy vessel in the usual way, so the hole was dug and a bulkhead left between it and the river. This was to be dredged away, allowing the water to fill the hole and float the vessel.

John Stevens' first propeller boat was built in 1804. It had twin screws coupled up with gears, and the boiler was a coil or coils of pipe. This is in general the design that we are putting into ships today.

Just above President Morton's house was Castle Point, the home of the Stevens family for many years, and the house was the first dwelling ever heated by steam. The work was laid out and done by Francis Stevens, a cousin of the late Col. E. A. Stevens, about 1840, I think. Castle Point now belongs to Stevens Institute, and its many rooms have been fitted up by the various classes that have been graduated.

Francis Stevens always claimed to have invented the valve cams used on beam engines, which made the valves move in quick jumps without a jar, and it was fascinating to watch these cams work. Another member of the family laid claim to having invented these cams, but from the talks I had with Francis and others, I made up my mind it was a combination invention. One of the Stevens got the idea of having cams lifting the valves, but, as first made, the contact was a blow in fact and gave trouble; and then Francis improved on the idea by the rocking cam, or, as he often called it, the "alligator jaw," which made the cam action smooth and quick just where quickness was wanted. Of course I may be wrong in this assumption, but I know that Francis had in his possession the original drawings of the cams.

COMPOUND ENGINES FOR RAILROAD TUGBOATS

Francis Stevens was the engineer of the Hoboken yards of the Pennsylvania Railroad floating equipment, and he designed the first compound engines used on the tugs of that company. These engines were steeple compounds, and the first I ever saw where the low-pressure cylinder was set above the high and the stuffing boxes were interior ones; that is, they could not be reached without taking out the low-pressure pistons.

The reason for this design was to keep the engines as low as possible for if the usual exterior stuffing boxes had been used the height of the engine would have been materially increased. The interior stuffing boxes never gave any great trouble. Remarking on this to one of the towboat engineers, he said: "If those stuffing glands leaked, how could I find it out unless I got cards taken?" Of course, to a certain extent, that was true. The packing used in the stuffing boxes was metallic, and Mr. Stevens told me that its design was obtained from the Cold Spring works, just across the Hudson River from West Point. Mr. Stevens remarked that his experience went to show that the metal of the packing had more to do with its satisfactory working than did its design. I do not wish to give the impression that Mr. Stevens was the first designer of a compound engine in America, as that honor belongs without doubt to Charles Hyde, of Bath, Maine.

THE WILLANS COMPOUND ENGINE

Speaking of steeple compounds, there was one of this class that sold in England to an extent, I was told, that was equal to all other styles of engines put together. It was known as the Willans. It was single-acting and most often seen in multi-cylinder design. It was almost silent in action, and being entirely inclosed, it required very little care, and its economy was satisfactory. I think the Bullock Co., of Chicago, undertook to make the engine in this country, but I never ran across one here.

Economy is a word just now in the mouths of all people and is not confined to engineers. A reduction in manufacturing is equal to an advance in price, so everyone is hard after economy of production, but at times economy is disregarded for reasons which offset any apparent saving.

THE DIRECT-ACTING STEAM PUMP

The most striking example of this, in engineering, to my mind, is the direct-acting steam pump. The cost of pumping with this design is known to all engineers, but the design is so simple, compact and cheap, and the pumps are so easily obtained, that the economy is willingly disregarded. I suppose more pumps of this style are in use than all other designs put together several times over. All one has to do is to explain the requirement and get just what is wanted, almost by return mail, and it will fill the bill. The pump is self-contained and can be piped up by anybody, and a very short time after its arrival it can be put to work. All this is fine and practical, but when it comes to paying for the steam to run and then seeing the work done, one is sad, that is, the one who is doing the paying. I do not believe that the design could be driven out of the market if the steam consumption was four times as great as it is or if prices were increased in the same proportion.

When Alexander Hamilton conceived the idea of making Paterson, N. J., the great manufacturing center of the country, he did so because the water power of the Passaic River was, he considered, quite enough to do the work for all America. At that time water was the only power known to him or to the world. How short was his vision! Yet it was far greater than other men of his time. Within two miles of the Falls the Rogers people turned out locomotives by the score in less than 75 years from the death of that great man, eclipsing the power of the falls many times. The river for power, the river for transportation, was Hamilton's idea, and for his time it was a correct one.

THE CORLISS ROTARY ENGINE

I was once taken, by George H. Corliss, to a place just outside of Providence, R. I., to look at a foundation for a pumping engine which he had built, I think. Mr. Corliss was a man with whom I got on very well at times, and he seemed to be impressed with my ability to "chase x's" and several times got me to work out mathematical problems for him seemingly with the intention of merely noting the difference between my way of working and his.

On this trip Mr. Corliss opened a vague conversation on a steam prime mover, at last saying that he had an idea of a single-piece engine; that is, where only one part would move, except the governor.

"What!" I exclaimed. "A rotary engine?"

This annoyed Mr. Corliss and he at once changed the subject, but returned to it later in the day, suggesting that I undertake to build the apparatus, but he as designer or originator of the idea need not be known. I did not like undertaking the work under any such understanding, so for some years the rotary engine was never referred to between us. At last Mr. Corliss asked me to make some drawings showing the principle of the engine so that he could have a patent search made. Now that Mr. Corliss is dead, I do not feel that I am acting unfairly to his memory in giving an outline of his idea.

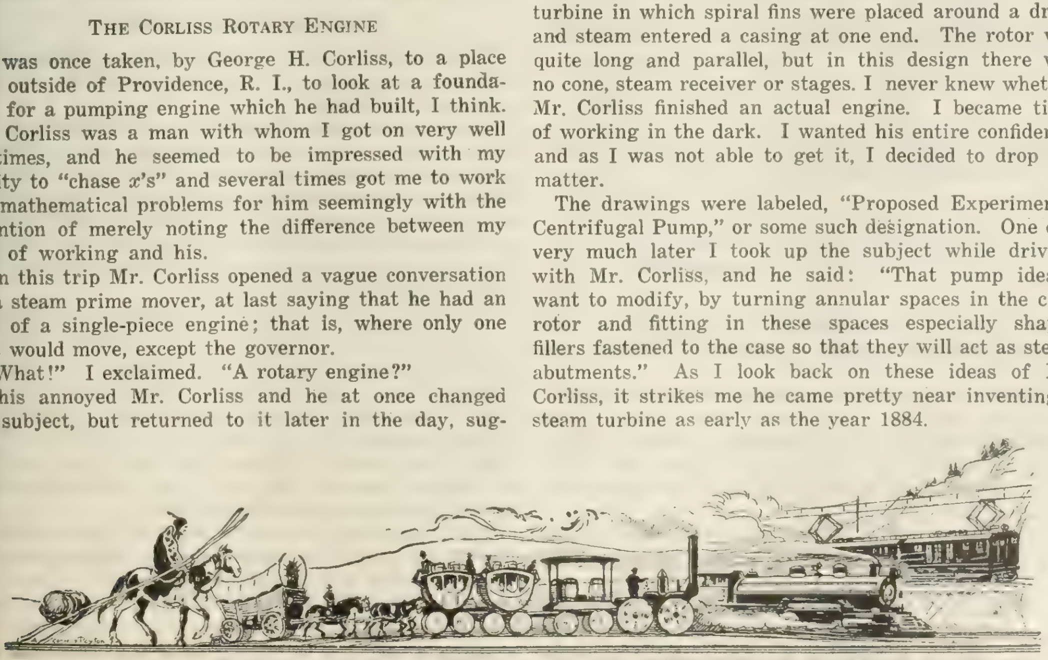
The engine consisted of a cast-iron case which was cone-shaped, a rotor fitted the bored taper hole of the casting, and on this rotor were to be milled steam pathways the bottoms of which were parallel to the center of rotation. The faces of these steam pathways were to be curved, a tangent leading, however, to the curved face, the curves increasing, slowly at first, then steepening rapidly to a short tangent at the larger end. The special form of curve was only on the power side of the pathway. The steam entered at the smaller end of the cone from several nozzles, and as it traveled along the pathway was, of course, meeting with an increasing surface, owing to the cone shape.

A first cone was separated from a second by heads pierced with holes, thus making a steam chamber, and from this chamber the steam was again led into nozzles in the second head to a second cone, larger, of course, than the first. Several cones were to be used, making stages, and it was proposed to use a condenser. After the drawings were begun, Mr. Corliss changed them by adding check valves to the exhaust holes, and he proposed to use a little live steam in each chamber.

One side of the steam pathway was to be formed with great care, and Mr. Corliss cut three forms out of paper. One was the form at the end of the first tangent, one at the middle, and one at the end of the pathway that led to the final tangent. How he arrived at these forms I was never told, but I was to make the complete spiral pathway lead smoothly to these cross-sections.

If I remember rightly, Mr. Astor patented a steam turbine in which spiral fins were placed around a drum and steam entered a casing at one end. The rotor was quite long and parallel, but in this design there was no cone, steam receiver or stages. I never knew whether Mr. Corliss finished an actual engine. I became tired of working in the dark. I wanted his entire confidence, and as I was not able to get it, I decided to drop the matter.

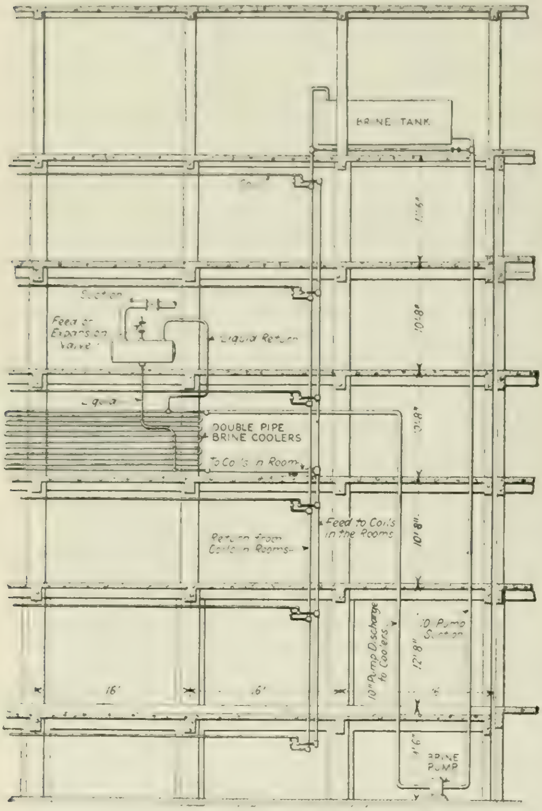
The drawings were labeled, "Proposed Experimental Centrifugal Pump," or some such designation. One day very much later I took up the subject while driving with Mr. Corliss, and he said: "That pump idea I want to modify, by turning annular spaces in the cone rotor and fitting in these spaces especially shaped fillers fastened to the case so that they will act as steam abutments." As I look back on these ideas of Mr. Corliss, it strikes me he came pretty near inventing a steam turbine as early as the year 1884.



Handling the Flooded-Type Brine Cooler

By B. E. HILL

SOMETIMES with the flooded-type brine cooler as applied in connection with the double-pipe brine cooler, the accumulator is used. The duties of the accumulator, when used for this purpose, are similar to those of a blowoff tank connected to the blowoff lines from steam boilers. A blowoff tank is used to prevent blowing high-velocity steam and water into the city or private sewer lines and thereby prevent damage to them. As the blowoff tank is vented to the roof (atmosphere) with a line large enough to cut down the high velocity, this allows the water to flow off into the sewer while the steam is carried off through the vent.



PIPING LAYOUT IN A WAREHOUSE

A boiler carrying 150 lb. pressure has a boiling point around 365 deg. F. When water from such a boiler is suddenly released to atmospheric pressure with a corresponding boiling temperature of 212 deg. F., a portion of the water is instantly flashed or evaporated into steam.

In the case of the accumulator, as shown in the illustration, assume that it is used in connection with sharp or low-temperature freezer work. The liquid is fed into the accumulator under a pressure of 180 lb. and a corresponding temperature of about 95 deg. F. The pressure that is carried on the accumulator for low-temperature work we will assume to be zero, or atmospheric pressure. As the boiling point at atmospheric pressure is about 28½ deg. F. below zero, a portion of the liquid ammonia is instantly flashed or evaporated into a vapor for the same reason that the high-temperature water is evaporated as it leaves the blowoff tank and goes into the atmosphere.

The object of the accumulator is to remove the vapor or saturated ammonia gas from the liquid ammonia and feed the liquid ammonia to the brine cooler at the reduced temperature due to the reduced pressure, allowing the gas evaporated in this way to pass off into the suction line and on to the compressor the same as the steam from the vent in the blowoff tank passes out to the atmosphere.

The merits of the accumulator, when used for this purpose, over the direct feed into the bottom coils lie in the fact that it affords a space large enough to separate the gas from the liquid and pass the gas on its way back to the compressor without first passing it through the entire length of the brine-cooler coils.

Another advantage of the accumulator is the safety feature. In case a sudden change in temperature of the brine through the brine cooler causes a rapid evaporation of ammonia and throws the liquid out of the coils into the accumulator, which would gravitate back to the cooler instead of to the compressor, as would be the case where there is no accumulator, the latter would act the same as a separator on a steam line and the coils act like a priming boiler that is short on steam space.

The illustration shows a system of calcium brine coolers with the pumps in the basement or cellar floor and a makeup brine tank on the seventh floor, an explanation of which is hardly necessary.

The Shell Brine Cooler

The shell brine cooler is nearly like a surface steam condenser and also embodies the principles of the return-tubular boiler.

For simplicity, capacity, efficiency, compactness, durability and no leaks, the well-designed and well-built shell brine cooler is among those at the top of the list. There have been mistakes made in these coolers as well as in all other apparatus. The writer will try to point out some of the most serious as a guide to the engineer operating these coolers or who is expected to draw up specifications for their purchase.

The best design of shell for durability and strength has the longitudinal seams riveted together with a double butt-strap seam with the calking edges welded inside and out. The heads are flanged out beyond the shell, which allows for expansion and contraction without serious strain on the tube sheet caused by a short bend. The tubes for these coolers can be made either of charcoal iron or steel, rolled and beaded the same as the tubes in a return-tubular boiler.

The capacity as well as efficiency of these coolers is due to the circulation, there being no dead corners as is the case with the submerged brine cooler. The large area or surface for the saturated gas to pass out into the suction line as soon as evaporated, without passing through a long line of piping as is the case with the double-pipe and other types of pipe brine coolers, makes it possible to carry the brine temperature closer to the temperature of the boiling ammonia without generating an internal pressure caused by the violent boiling of ammonia. The closer the engineer can run the boiling point of the ammonia in the brine cooler to the temperature of the brine, the greater will be its capacity and efficiency; in other words, carry the suction pressure as high as the required temperatures will permit, which will give the maximum capacity, and install a brine cooler that will deliver brine as close to the boiling point of the ammonia as possible and practical.

The greatest objection to the installation of a plant to obtain the capacity and efficiency as mentioned, is the cost of the evaporating coils or brine coolers of sufficient pipe and tube surface and design to obtain results.

RAPID CIRCULATION OF BRINE

As before stated, one of the greatest features of the shell brine cooler is the rapid circulation of brine. One of the mistakes that has been made in the past is in carrying this valuable feature too far, the brine being made to pass back and forth through the tubes so many times that the combined area of the tubes in each pass was reduced to such an extent that the friction head was abnormal, there being a difference in pressure between the inlet and outlet of from 15 to 90 lb., depending on the quantity of brine required to be pumped through the cooler.

These coolers are limited in the diameter of the shell to about 48 or 54 in., and the number of passes in many instances have been made from eight to twelve, with bad results as to friction head. It is the judgment of the writer that in no case should the number of passes exceed six, and in no case should a brine cooler be purchased without complete specifications, stating the range in temperature, maximum quantity of brine to be passed through the cooler in a stated time, allowable friction head between the inlet and outlet, etc., which will put it up to the manufacturer to design the cooler to meet requirements.

MANUFACTURERS' GUARANTEE

Owing to the danger of "freeze-ups" in these coolers, the manufacturer in most, if not all cases, will not guarantee them for anything but a solution of calcium chloride of sufficient strength to prevent freezing. The late P. J. Slagle, chief engineer for Swift & Co. for many years, "thrashed" this point out with several of the leading manufacturers and has successfully operated the shell brine cooler for years in many of the Swift plants with a solution of common salt brine. The circulation in these coolers is so nearly perfect in all parts of the cooler that it is only necessary that the circulation be kept up, and to do this the engineer must have some assurance that the pump is kept going at all times while the machines are in operation. Mr. Slagle, being thoroughly familiar with this part of the operation, installed a check valve on the outlet end of the brine line with the stem extending through a stuffing box. Attached to the valve stem is a lever which answers the double purpose of a counterweight, which closes the check valve when the flow stops, and makes contact with an electric switch. This lever is so adjusted as to ring a bell and light a red signal light when the pump stops or shows to the danger point, as the valve will vary the distance of opening according to the flow of brine.

These coolers can be arranged for installation either horizontally or vertically. The horizontal installation requires more floor space and less headroom, but is much easier to repair when necessary. The vertical installation requires less floor space and more headroom and is much more difficult to repair.

These coolers, whether installed vertically or horizontally, should have a trap or good make of steam separator in the suction line between the cooler and compressor, it being installed high enough above to drain back into the cooler in case of overfeeding or priming. Take the same precaution for safeguarding the compressor that you would to safeguard an engine from the boiler, as the cooler is the boiler of the refrigerating plant.

REFRIGERATION EFFECT CIRCULATED FROM DELIVERY OF BRINE PUMP

To determine the refrigerating effect delivered by the reciprocating brine pump, the first essential is to ascertain with a reasonable degree of accuracy the amount of brine pumped. To do this, close the discharge valve on the pump line and start the pump, regulating the speed at a point where the discharge gage registers normal working pressure; the gage in this case must be tapped below the discharge valve. After the pump has been regulated to hold the required pressure, count the strokes for five or ten minutes and get a good average of the strokes per minute.

Now, for example, assume that the water or brine end of the pump to be used in the test is 10 in. in diameter and 12 in. stroke, and also that the average number of strokes with the discharge closed was found to be 18 per min. Assume brine at 80 deg. salinometer and the specific heat, which in this case would be 9.6 lb. and 0.80 respectively. Then to reduce the 385.4 gal. per min. to pounds, 385.4 × 9.2 = 3,545.68 lb., and as there was a rise in temperature of 4 deg. between the discharge and return brine and a specific heat of 0.98, the refrigerating effect delivered per 24 hours would be $\frac{3{,}545.68 \times 0.94 \times 4}{200} = 66.65$ tons refrigeration.

Oxyacetylene Welding of Damaged Engine Cylinders

Although practically every job undertaken by a welding shop represents a saving of time, labor and money, it is not until some particularly large job comes along that the value of oxyacetylene welding is driven home with a punch. One of these large jobs, the execution of which resulted in substantial saving, was recently completed by the Imperial Welding Co. of Minneapolis, Minn.

The parts to be repaired were the fractured high- and low-pressure cylinders of a 1,000-hp. compound steam engine employed to furnish power for a flour mill. The damage was due to the piston rod fracturing close to the crosshead and the pistons driving through the ends of the cylinders. The fractures in the low-pressure cylinder are shown in Fig. 1. The crack shown in the upper left-hand corner of the picture extended back to and completely around the inlet-valve port. The crack shown at the bottom of this cylinder extended no farther than can be seen in the illustration.

As the casting was preheated the men could not, of course, have worked from the position shown, but they give an idea of the size of the cylinder bore.

The high pressure cylinder, indicated at the right in Fig. 2, was also badly broken, as the welded section shows. Fig. 3 shows the low-pressure cylinder after it had been welded.

Inasmuch as the engine was of an obsolete type and occupied excessive space in the engine room, upon a report of the accident the owners decided that they would replace it by a steam turbine, but when the matter was taken up with the manufacturers, it was found that no delivery date could be promised within ten months. This long delay was, of course, out of the question, no outside power being available in the interim.

Then an effort was made to obtain the old patterns from the firm that had originally made the cylinder. Here again the owners met with disappointment. The original patterns had been destroyed, and new castings would have cost approximately $9,000 exclusive of freight charges and cost of installation. The location of the engine room and adjacent machinery was such that the cost of installation would have reached a high figure and would have brought the entire bill, exclusive of the costs of delay, up to approximately $15,000.

Having failed to obtain a steam turbine and not caring to spend such a large amount for new castings, the owners took the matter up with the welding company and upon being assured that the cylinders could be satisfactorily welded the job of reclamation was given to them and men were set to work at once to repair the damage.

Four men were employed in doing the work, the actual time to weld the castings being forty-eight hours. The total amount of time to chip out the castings and otherwise prepare for welding, as well as to actually make the welds, was three weeks. The operation presented no unusual difficulties, preheating being done one section at a time.

The material used for the work consisted of 30 cylinders oxygen, 26 cylinders acetylene, 4 lb. flux, 407 lb. cast-iron rod, 1,150 lb. charcoal and 32 carbon blocks ' x 6 x 12 inches.

The actual cost of welding these cylinders was $1,572.22. Not taking into consideration the delay that would have resulted if new castings had been made the owners were able to save over $13,000 by taking advantage of the welding process.

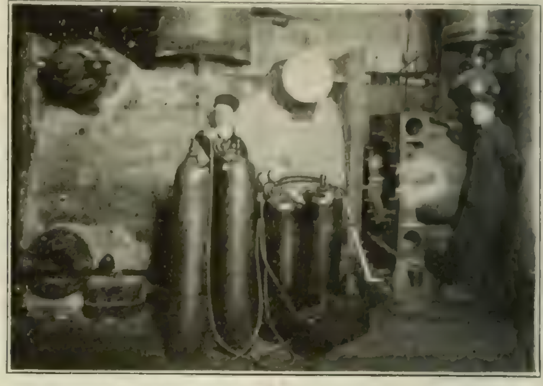


FIG. 2. APPARATUS AND WELDED HIGH-PRESSURE CYLINDER

A month ago the Department of Justice issued special instructions to all district attorneys to bring action against those who are enhancing the price of coal illegally. As a result, indictments have been brought against nearly five hundred bituminous coal dealers throughout the United States. The next thirty days will see even a larger number indicted, it was predicted at the Department of Justice.

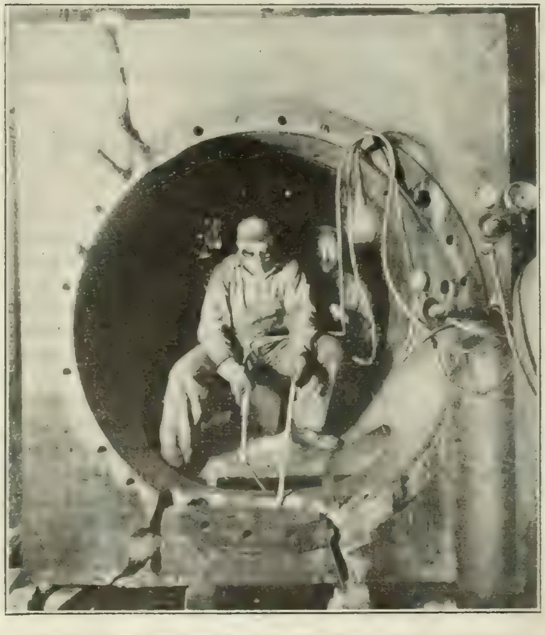


FIG. 1. FRACTURE IN LOW-PRESSURE CYLINDER

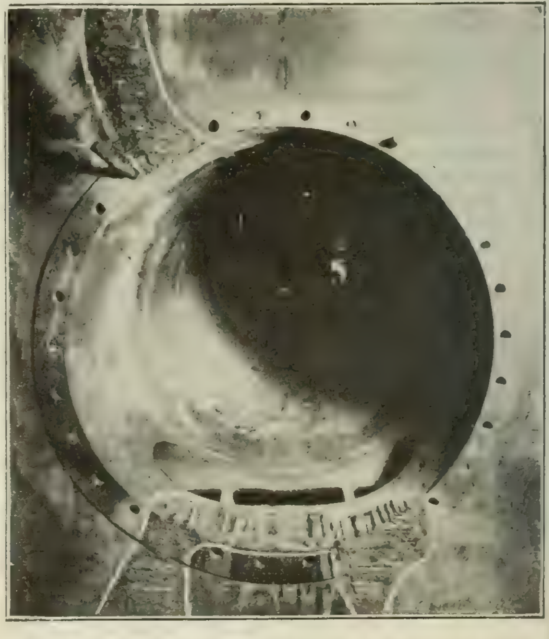


FIG. 3. LOW-PRESSURE CYLINDER AFTER WELDING

Checking Three-Wire Three-Phase Switchboard Wattmeters

By H. C. Yeaton

All switchboard indicating wattmeters should be checked frequently in order to insure their accuracy, and the following covers two methods of checking three-wire three-phase switchboard wattmeters.

In the portable polyphase wattmeter method connect a portable polyphase wattmeter in the circuit, as shown in Fig. 1, 2 or 3. The current terminals of the portable instrument are connected in series with the current terminals of the switchboard meter, and the potential terminals of the former are connected across the potential circuits. The connections, Fig. 1, are those where both current and potential transformers are used, in Fig. 2 current transformers only are used, and in Fig. 3 the instruments are connected directly into the circuit.

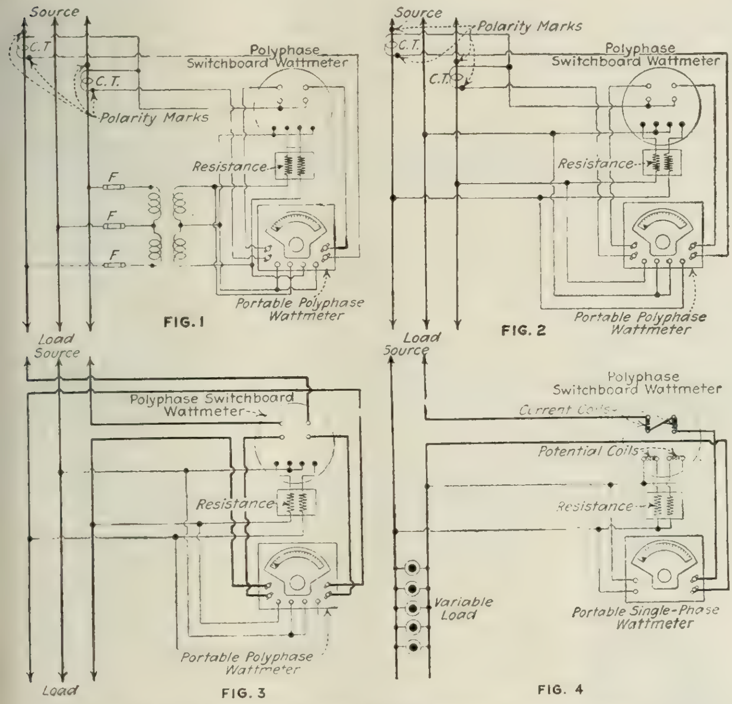

Source
C.T.
C.T.
Polyphase Switchboard Wattmeter
Polarity Marks
Resistance
F
F
F
Portable Polyphase Wattmeter
Load
Source
Polarity Marks
C.T.
C.T.
Polyphase Switchboard Wattmeter
Resistance
Portable Polyphase Wattmeter
Load
Source
Polyphase Switchboard Wattmeter
Resistance
Portable Polyphase Wattmeter
Load
Source
Polyphase Switchboard Wattmeter
Current Coils
Potential Coils
Resistance
Variable Load
Portable Single-Phase Wattmeter

FIG. 1 FIG. 2 FIG. 3 FIG. 4

FIGS. 1 TO 4. CONNECTIONS FOR CHECKING WATTMETERS

Switchboard-wattmeter scales are usually marked in primary watts, which are the actual watts or kilowatts of the circuit, and on a balanced circuit at unity power factor are equal to

Primary Amperes × *Primary Volts* × 1.732

The calibrating watts of a three-wire three-phase wattmeter are the watts required to make the pointer deflect from zero to full scale, and equal

Scale Range in Watts ÷ *Potential-Transformer Ratio* × *Current-Transformer Ratio*

Then by checking the calibrating watts of the switchboard meter with the portable meter, the accuracy of the former may be determined. For example: Suppose that in Fig. 1 the three-wire three-phase circuit has a rating of 100 amperes and 2,200 volts. Each potential transformer has a ratio of 20:1 or 2,200 to 110 volts; and each current transformer has a ratio of 20:1 or 100 to 5 amperes. The full-load watts of the circuit at unity power factor would be equal to 2,200 × 100 × 1.732, or 380.6 kw., but as this value would cause the scale to have an uneven ending, a 400-kw. scale would probably be marked on the instrument.

Suppose, now, that the pointer on the switchboard meter indicated 200 kw., then the calibrating watts for this point would be equal to $\frac{200,000}{20 \times 20} = 500$. Therefore, if the pointer of the switchboard instrument indicated 200 kw., it would mean that only 500 watts were impressed on it to produce this deflection, and the portable wattmeter, also being connected on the secondaries of the transformers, would indicate 500 watts if the switchboard wattmeter was indicating correctly. [The switchboard wattmeter is calibrated so that it reads directly in primary watts or kilowatts and does not have to be multiplied by the transformer ratios, where portable wattmeters are calibrated to read the watts passing through the instrument and must be multiplied by the transformer ratios to obtain primary watts.—Editor.]

The foregoing method checks only one point as it probably would not be convenient to vary primary load. Several points may be checked during the day, however, if the load varies on the circuit.

Another method that can be used to check more than one point on a three-wire three-phase wattmeter is to short-circuit the current transformers and disconnect the instrument from the circuit. Then connect the switchboard instrument on a single-phase circuit with a portable single-phase meter, using a variable load, as shown in Fig. 4. In the figure the current coils of the switchboard meter are connected in series, and the potential coils, together with the resistances, are connected across the circuit. The current winding of the portable instrument is connected in series with both current windings of the switchboard wattmeter, and its potential terminals are connected across the circuit. Therefore, as there are two current and two potential elements in the switchboard meter and one current and one potential element in the portable instrument, the total watts impressed on the polyphase meter would be twice those impressed on the single-phase meter, consequently the calibrating watts per element of the switchboard wattmeter equal

Scale Range ÷ *Current Trans. Ratio* × *Potential Trans. Ratio* × 2

Therefore, by determining the calibrating watts of the switchboard wattmeter, from this formula, the scale readings of the instrument may be checked with the single-phase wattmeter.

Suppose that it is required to check the switchboard wattmeter, as given in previous example, at the readings 100, 200, 300 and 400 kw. First connect the two instruments as shown in Fig. 4. The calibrating watts per element of any reading equal *Scale Reading* ÷ *Potential Trans. Ratio* × *Current Trans. Ratio* × 2. Substituting the readings 100,000, 200,000, 300,000 and 400,000 for the scale reading and dividing by 20 × 20 × 2 (800), the following calibrating table can be made up:

Switchboard Wattmeter Readings in Kilowatts	Calibrating Watts Per Element of Switchboard Wattmeter	Portable Test Wattmeter Readings
100	125	125
200	250	250
300	375	375
400	500	500

Other readings can be checked in the same manner, if it is so desired, but four or five readings are usually sufficient to determine the general accuracy of an indicating switchboard wattmeter.

Coleman's No-Leak Safe Tube End

Following is a description of a method of applying tube ends, the object being to double the life of ordinary tubes, do away with leaking tube ends, to be practically 90 per cent efficient by actual test and to save from 10 to 20 per cent of the fuel bill.

As is well known in locomotive practice, with the old style of tube the Prosser expander forms a semicircular corrugation on the water side of the tube plate. The edge of the semicircle frequently only touches the top of the copper ferrule which is in contact with the plate and does not prevent more or less working of the tube in the plate, which eventually results in leaking tubes, caused by expansion and contraction. The Coleman safe tube end, Fig. 1, which is manufactured by the Coleman Boiler Appliance Co., 406 Grosse Building, Los Angeles, Cal., has a square machined shoulder that fits tightly against the copper gasket which rests solid against the plate. This, with the tapered holes through the plate, 1½ to the foot, forms a wedge where the end is finished and headed down on the tube plate on the fire side and holds the square shoulder against the plate, and prevents movement of the tube in the plate due to either expansion or contraction; hence it prevents leaks. The shoulder carries the vibration.

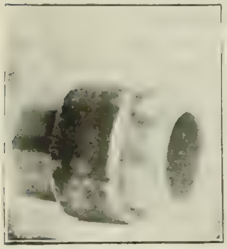


FIG. 1. COLEMAN TUBE POINT

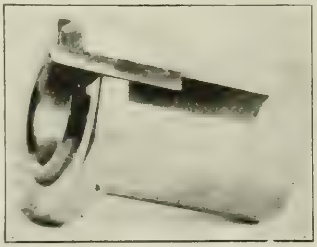


FIG. 2. TUBE POINT WELDED AND EXPANDED

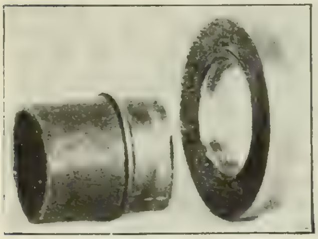


FIG. 3. TUBE PULLED OUT OF THE TUBE SHEET

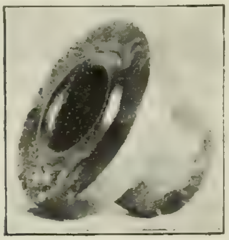


FIG. 4. TUBE PARTED, BEADING HELD

The merits claimed for the Coleman device lie in the increased thickness of the flue point and in the tapering holes through the flue sheet at the firebox, tapering from the firebox side. When the flue point is set firmly against the plate at the water side and the expansion is taking place, the flue is pushed against the square shoulder on the water side of the sheet and is not pushing the bead away from the sheet on the fire side, as is done by the old method. When the tube is contracting, instead of pulling against the bead and loosening the tube, it is pulling against the tapered hole in the plate and not straining the bead.

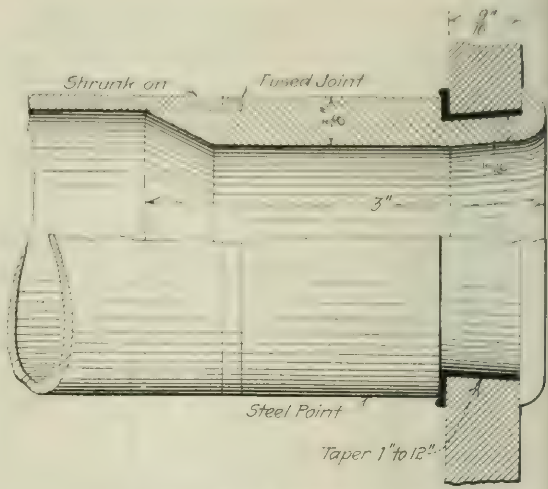


FIG. 5. DETAILS OF COLEMAN TUBE END

Figs. 2 and 3 show a tube welded to a tube point and expanded into a ring which represents a tube sheet. A copper ferrule is shown between the tube point and the tube sheet, but Mr. Coleman advocates omitting this ferrule, using a thin one between the shoulder on the point and the inside of the tube sheet. This eliminates one joint in the tube sheet.

In order to properly and conclusively demonstrate the superiority of the Coleman method, both were put under test with the result that a tube with the ordinary expanding and beading pulled out of the tube sheet when under test at a pull of 24,130 lb. and started with a pull of 21,000 lb. This is shown in Fig. 3. Under test the Coleman joint failed to start, but the tube started to break outside of the weld at a pull of 34,000 and parted at a pull of 36,330 pounds, Fig. 4.

The Coleman process has been tested out on one of four engines on the Rio Grande division of the Santa Fe Railroad. These engines were all of the same class and type. Engine 1,117 was equipped with the Coleman safe-tube ends, and the other three engines were fitted with the old-style flue ends, the test being for efficiency, mileage and coal saved. It lasted over fifteen months, when the tubes in No. 1,117 were found as good as when first put in and were declared good for another six months' service. The other engines had each received a second set of tubes four months before.

Operation and Adjustment of Turbine Machinery
VII—Fitting Carbon Ring Packing

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

VARIOUS numbers of rings are used in packings to suit different conditions. Fig. 1 shows two packing rings used to hold the vacuum end of a turbine. The lower drain is normally closed. Steam is admitted through the upper drain so that the leaking of steam past the inner ring is compensated for and a little extra is supplied, which usually condenses and leaks out of the turbine casing. The steam exerts an axial pressure *P*1 and *P*2 against the carbon rings, as shown. This tends to hold them against the surfaces *D*1 and *D*2. Under ordinary circumstances this joint is practically steamtight. The actual leakage takes place along the shaft. The joints of the rings hold steamtight.

Packing for holding high-pressure steam in the first stage of an impulse turbine—small machine—is shown in Fig. 5. A small amount of steam leaks past the first ring Fig. 1, and this is forced into the drain by the resistance offered by the second ring. This type of packing is generally equipped with three rings instead of two, as shown in Fig. 2. It is more difficult for the steam to leak by two rings than one. The leakage going through the drain pipe is much less. Large machines seldom have less than three rings.

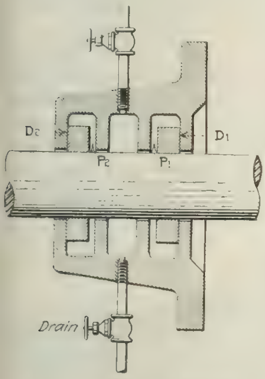


FIG. 1. TWO PACKING RINGS

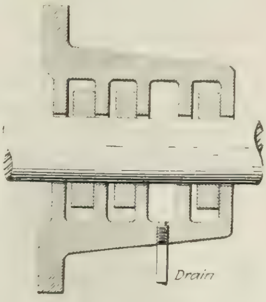


FIG. 2 THREE PACKING RINGS

Fig. 3 shows the same packing with a drain placed between the first and second rings which carries the leakage from these rings into some part of the turbine where the pressure is lower, so that the leakage may expand and do work. The drain between the second and third rings acts the same as in the two-ring packing.

Fig. 4 shows a high-pressure packing adapted to a condensing turbine. Steam is supplied for the purpose of sealing against the vacuum. When the turbine is loaded and a steam pressure exists between the first and second rings, the sealing steam is not necessary. Often the sealing steam is supplied through a reducing valve and the steam line is equipped with a check valve. Another combination of four rings to accomplish the same purpose is shown in Fig. 5. Sealing steam is here admitted between the third and second rings. It can be left turned on whether the turbine is loaded or unloaded. The drain is placed between the first and second rings and leads to one of the lower-pressure stages of the machine. The drain between the third and fourth rings opens to the atmosphere.

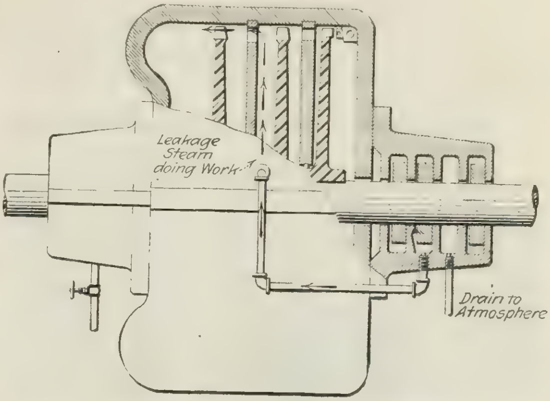


FIG. 3 SHOWING PIPING OF DRAIN BETWEEN FIRST AND SECOND RINGS

Various combinations of rings and drains are used to suit the conditions of the machine. In any case the action will be the same as far as leakage is concerned, whether the rings are carbon or metallic. The latter material is used principally on small machines.

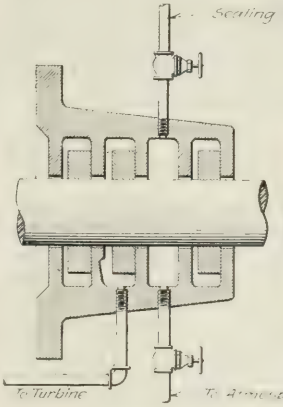


FIG. 4 HIGH-PRESSURE PACKING

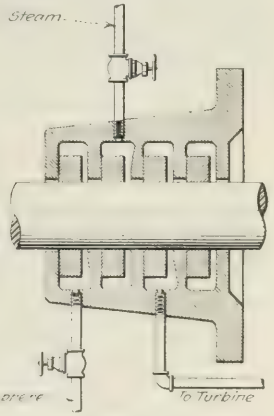


FIG. 5 COMBINATION OF FOUR RINGS

In impulse turbines it is often the practice to place interstage rings between two stages to prevent steam leaking from the higher to the lower stage. These rings are generally single and seldom more than double. Carbon or the labyrinth metallic ring is generally used.

Old rings can be refitted for a fraction of the cost of new rings, more especially in larger machines. When new rings are installed, the engineer should thoroughly understand their nature to be sure that the factory has supplied them with the proper dimensions, machine work and clearances. The principles of adjustment are as follows:

1. The ring should not be smaller than the diameter of the shaft.

2. This should not exceed the diameter of the shaft more than a certain fixed amount.

3. The rings should be free to move in their grooves so that they can change their position when expansion or contraction of the turbine casing changes its relative position with the shaft.

4. Joints between the segments should be true flat surfaces bearing throughout their whole extent.

5. These joints should be held together firmly by the springs.

6. The rings should not be too free in the casings.

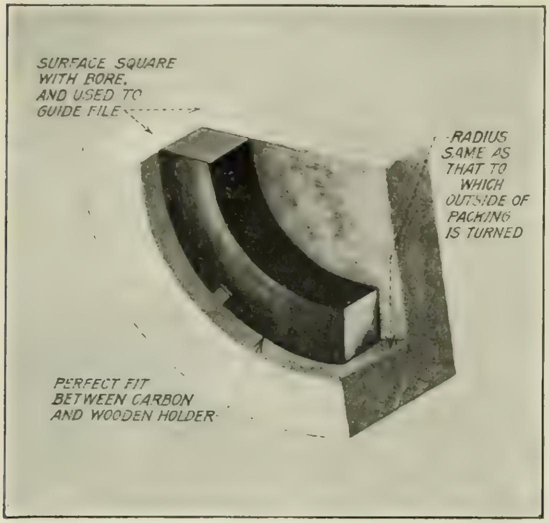

SURFACE SQUARE WITH BORE, AND USED TO GUIDE FILE
RADIUS SAME AS THAT TO WHICH OUTSIDE OF PACKING IS TURNED
PERFECT FIT BETWEEN CARBON AND WOODEN HOLDER

FIG. 6. MODEL FOR HOLDING OLD RINGS

7. The joints in the various parts of the casings should be made steam-tight.

When the ring is smaller than the shaft, it causes cutting or vibration, as described. Usually, a day's run will wear it into running condition when the difference is only 0.004 to 0.006 in. in diameter. The rings are generally fitted to exceed the shaft by 0.002 in. or 0.003 in. per inch of shaft diameter, which is an allowance for ordinary shaft expansion together with a net clearance of approximately 0.0005 in. to 0.001 in. per inch of diameter. For high pressures and superheat allow 0.003 in. per 1 in. diameter

In refitting old rings a good way is to have a wooden model made of the size of the packing which is split in an axial plane, as shown in Fig. 6. The joints can be dressed down to a true surface with a file so that the ring will come together to a considerably smaller diameter than the shaft; each joint should be marked with a number so that it can be taken apart and correctly put together. This complete ring should be put in a lathe and centered as nearly as possible with its outside surface. The inside can then be bored to the proper diameter. If it is rebored too large, the joint surfaces can be dressed with a file.

The bored surface of the rings can be made smooth by polishing with No. 00 sand paper. Emery cloth should never be used on the packing as the particles of emery may stick to the packing and badly cut the shaft.

Another way of making the ring diameter smaller before boring it in the lathe is to place the ring assembled on a board and clamp it as shown in Fig. 7. Be sure that the joints are in good contact. Then take a hacksaw and cut through each joint, keeping the saw in a radial position so that the blade lines up with the center of the ring. The segments can then be removed, and the thickness of material which was thus cut off from each joint should allow the ring to come close enough together for purposes of refitting.

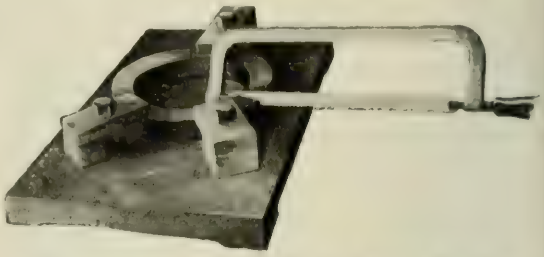


FIG. 7. METHOD EMPLOYED IN MAKING RING OF SMALLER DIAMETER

When rings are but slightly worn so that 0.003 to 0.006 in. must be taken from the diameter, it is not necessary to rebore, but only to file the joint surfaces as before described. If desirable to fit these without a wooden form, the easiest method of keeping the surfaces true is to place all the segments together in a vise (see Fig. 8). Line up the joint surfaces at each end so they are in a plane before tightening thoroughly in the vise. Remember that carbon is brittle and will not stand much pressure. If the vise jaw is rough, line it with sandpaper. All the joint surfaces on one end can now be filed together. This makes it much easier to handle the file to produce a practically true surface. If the segments are filed one at a time, it is difficult to make the joints bear on the entire surface.

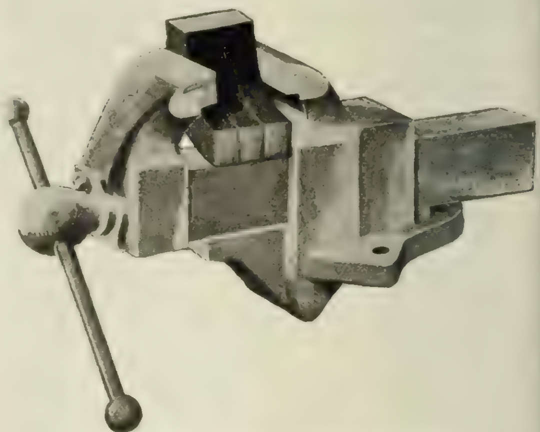


FIG. 8. RINGS BEING FITTED IN VISE

EDITORIALS

The Status of the Oil-Engine Operator

THE manufacturer has excellent grounds for his claim that the oil engine has emerged from the development stage. Only a radical partisan of the steam engine will refuse to agree that the oil engine has arrived. This prime mover has been sold to the engineering public; the efforts of all concerned in the industry should be directed toward seeing that it stays sold.

The present-day problem is not one of design, but is essentially one of operation. There is one condition existing in numerous oil-engine stations which, if not corrected, will eventually result in a recession of the popularity of this prime mover. This is the degree of engineering intelligence and skill possessed by the engine operator. Only in a few instances are the operators as well trained as are the engineers in steam plants of equal capacity. It seems quite the custom to employ some man who has had a few months' experience in an automobile shop. This man, who knows nothing of engine maintenance or even of the theory of the engine's operation, is placed in charge of a machine costing thousands of dollars. Even men who have operated oil engines for a considerable time appear to understand only in a vague way the principles of the engine's cycle, the necessity of keeping the various parts in adjustment and the amount of clearances allowable in the several moving parts.

The engine manufacturer realizes the high-grade workmanship required in the construction of the engine and so employs only the highest type of machinists. The power-plant management should be impressed with the thought that only high-grade mechanics are capable of successfully operating the engine. The engineer should realize that the machine under his care represents the highest development of prime mover—that the slightest departure from proper operating procedure will eventually result in a failure—that adjustments are matters of but a few thousandths of an inch. There is no room for the yardstick or the wooden rule in the Diesel-engine plant.

In practically all instances of oil-engine failure, the underlying cause has been the lack of care the engine received from the operating force. Largely, the fault is not one of slothfulness, but comes from lack of information at the command of the engineer.

It follows that both the plant management and the oil-engine builder must take steps to remedy these conditions. When making a sale, the manufacturer should insist that the purchaser secure the services of an operator who, however little he knows of oil engines, is a mechanic. In most cases the best type of man can be found in the ranks of the steam engineer. However, care must be exercised to see that the engineer is adaptable.

After the purchaser has engaged his engineer, the latter should be given a course of training at the builder's factory. Here he should be set at work as an erector's helper rather then as an observer. With such training the engineer should be able to show satisfactory results in the power plant. The Diesel engineer must keep in touch with operating practice of other plants. Only by interchange of ideas and experience can the oil-engine operator hope to keep abreast of the times.

In His Working Clothes

NOT long since the editor passed a half day with the chief engineer of a large manufacturing company. He has come up from the ranks, and what education he has he won for himself out of the solid rock. He has no degree of M. E., but he knows that power plant to the last shade of intimacy. He may not have a very clear-cut idea of what is meant by "thermodynamics," but he knows how to make that plant run on the least possible number of B.t.u. His language and appearance are not of the most polished, but he talks the language of the power plant intelligently and makes it say things; and what he may lack in upkeep and grooming is compensated by the spick-and-span condition of his plant and the state of inspected readiness of everything depending upon his supervision. His men regard him as a master of power-plant engineering; and he is, quite as much so as many whose names are painted upon the doors of consultant offices.

In looking about the plant, a situation was disclosed where a considerable saving could obviously be made by a simple change in practice. This change, however, involved an expenditure for equipment which required the approval of those higher up; and this approval the chief could not get.

The advantage of the change was so apparent, the return upon the necessary investment so certain and so considerable, that the editor ventured to express the doubt that was in him as to the convincingness with which the proposition had been presented, which brought out the response:

"I presented it all right, but they had seen me in my working clothes."

There is a whole lot of human nature in that response and in the situation.

If the existing condition had been described to the president or board of directors by a professional engineer of impressive appearance, accustomed to meeting men of this class in a concise and convincing brief, it would probably have been adopted.

Too many men having the power of decision in such cases pay more attention to the source of such a recommendation than to its merits.

They are often incapable of weighing the advantages and disadvantages of a proposition and subjecting it to an engineering analysis, but they are very susceptible to the impressions aroused by the appearance and position of the one who suggests it; and if these impressions are not satisfying and impelling, they will combine with inertia and the natural reluctance to spend money, in producing an unfavorable reaction or a failure to act at all.

Too many of us fail to detect the diamond in its rough casing—to value an idea at its true worth because of the channel by which it reaches us. The men whose devotion to exacting practical work has kept them isolated and diffident about making advances to their superiors in authority are, by their very association with the intimate details of their plants and their operation, full of ideas for their betterment.

They would be more so if they were given some encouragement in their consideration. It is a wise superior with the taste of whose cigars these men are familiar.

Preventing Elevator Accidents

MUCH has been accomplished in industries toward accident prevention by the installation of proper safeguards and educational safety propaganda, but there still remains a great deal to be done. Passenger and freight elevators contribute their quota each year to the accidents of the country, notwithstanding it is possible, by the use of safety devices, to prevent ninety per cent of all accidents. Why the installation of these devices has not been made mandatory by state law throughout the country may be accounted for in the same way as the lack of suitable boiler laws and other statutes for public safety in many of the states.

Statistics have shown that at least seventy per cent of all elevator accidents occurring to persons traveling on passenger and freight elevators happen in connection with the opening to and from the elevator shaft. In states where elevator hatchway and car doors must by law be equipped with suitable and effective interlocks so that the car cannot be started until all doors are closed and locked, injury to persons entering and leaving elevators is practically unknown. Nevertheless, in spite of the proved effectiveness of door interlocks in preventing accidents at elevator landings, few states require by law their installation. Accidents due to the elevator car falling have been practically eliminated by the installation and maintenance of proper safety devices, so much so that the modern passenger elevator is the safest means of transportation. Is it not about time to give a little less thought to the cost of installing and maintaining interlocks on elevator-shaft doors and more to the accident-prevention possibilities of these devices and make it mandatory by law that all elevator doors must be so equipped?

Proper Alignment of Electric Motors

IN THE application of an electric motor no feature is of any greater importance than the proper installation of the machine. Not infrequently, the purpose of proper design, good workmanship and materials and correct application have been defeated by poor installation.

Good installation includes the proper foundations, alignment and high-grade wiring. Misalignment of the motor to the machine it is driving, if gears are used, will cause excessive wear on the gears and bearings, even breaking of the gears and vibration. This vibration will be transmitted to the current-carrying parts of the motor and will result in unending electrical troubles. With chain or belt drive, although there will not be the vibration transmitted to the motor as with gear drive, there will be excessive wear of either the belt or chain. The latter in particular is expensive.

There may also be caused an excessive end oscillation of the armature which will result in electrical troubles. Strange as it may seem, once a motor is installed out of line it is in general a long time being rectified, those responsible apparently being willing to struggle along with the mistakes of the past.

The proper alignment of a motor with the machinery is not a difficult job even when the former is mounted on the ceiling, as in shown by K. A. Reed in the article, "Lining Up a Motor for Shafting or Machine Drive," in this issue. From Mr. Reed's explanations the solution of the problem may be reached by applying a few well-known principles, and is not a hit-or-miss proposition. It is so simple that one wonders why there are so many motors out of line with the machinery they are driving. As Mr. Reed points out, it is not enough that the center of the drive on the motor line with the center of that on the driven machine, but the motor must be level on its foundation. Foundations out of level cause the rotating element to tend to pull out of the magnetic center, resulting in oscillation that frequently causes trouble. When the motor is mounted on the ceiling, it offers the most difficult problem of alignment, but this resolves into a careful laying out of a few lines on the ceiling, after which the foundation is easily located. In fact, the most difficult part of the job is getting the motor in position after the foundation has been put into place.

President Wilson's prompt and firm refusal to reopen the award of the Anthracite Wage Commission is to be heartily commended and, it is believed, will meet with general approval. The point at issue was that of holding to an agreement and not a question of whether the award was adequate. Both the miners and the operators had agreed in advance to accept the findings of the commission, in the personnel of which they had equal representation. That the award did not meet the expectations of some of the miners is unfortunate, but if adjustment of disputes by properly constituted commissions are to amount to anything their decisions must be accepted; otherwise we are likely to be involved in constant industrial turmoil. On the other hand, the miners must be shown by the President that he intends to deal as firmly with the operators and coal dealers in the prosecutions recently undertaken by the Department of Justice.

In this issue W. D. Forbes, under the heading, "Reminiscences of an Engineer," tells of some of the early work of Baxter, Stevens, Allen and Corliss. One is accustomed to live so much in the present as to lose sight of the advances that have been and are being made in engineering practice. It is indeed a privilege, therefore, to occasionally meet with someone like Mr. Forbes, who can take us back to intimate association with these pioneers in steam engineering.

There has been considerable discussion during the last two or three years on the advisibility of installing turbo-alternators in extremely large sizes. However, be the weight of the argument for or against such machines, evidently the large operating companies retain their confidence in them as demonstrated by the orders placed for this class of equipment.

CORRESPONDENCE

Water Hammer in Elevator Pressure Lines

In the Aug. 17 issue of *Power*, page 267, Mr. Ryan speaks of trouble caused by too much vacuum in the suction line of an elevator pump with only about 7 ft. in length lift, some of the discharge lines being as much as 1,500 ft. long.

The sketch does not show a stop valve or foot valve in the suction pipe, which brings the weight of the lift on the pump suction valves. The old air-inlet valve, described as being connected to the discharge and suction pipe, would appear to be an arrangement for priming as well as an air inlet. The absence of an air-cushion chamber on a pump of such size is somewhat of a handicap, but one could be made out of 4- or 6-in. pipe and connected to the top of the discharge chamber to help steady the flow through the 1,500-ft. lines.

I have had similar troubles with the discharge lines to the tanks, although they were not so long. I have never seen the time that I could get too much vacuum n a pump to lift water, for the highest possible vacuum is 30 in. and the theoretical lift of water is 34 ft., which is difficult even if the pump is primed. I have seen pumps run so fast that the water could not follow the piston and thus caused a break between the water volume in the suction pipe and the piston in the pump cylinder, which made the piston bound forward, after pulling steadily for a few inches of the stroke, with a snapping pound much resembling water hammer in a steam pipe. Anyone not familiar with this sound and some who are would think at first that the pistons were loose.

It is most likely, judging from the illustration shown, that the suction strainer on Mr. Ryan's pump became corroded and choked, having been shut down all summer, by the grease from the elevator machines mixed with ground fiber of the packing, getting into the return and collecting on the strainer.

If such is the case, it would cause the pipe lines to vibrate through to the pressure tanks. I think that putting a vacuum breaker on the suction line, which allowed air to enter, partly broke the vacuum and stopped the hammer in the pump and also eased off the thud sound in the discharge-pipe line by giving a little air cushion to the pipe and building up a larger air volume in the pressure tank, which aided much to relieve the obnoxious sounds. The pressure tank should not contain either too much water or too much air. Had Mr. Ryan continued to make use of the old air-inlet valve on the suction pipe, he probably would have obtained the same result that he did with the new air valve. That the pump lost its water so easily leads one to believe that the suction valves or springs, or both, were badly worn and that the valves were leaking.

A small air leak in the suction line would not cause failure of operation, because if the suction valves were tight air could not get back through them when water-sealed, and it would be forced up through the discharge valves with whatever water passed through them. Such a leak would have given the same result as the vacuum breaker or air-inlet valve. If the suction valves were tight, the pressure on the discharge valves would keep them water-sealed and the air would escape where there was least resistance, through the suction valves. This would give a tremendous hammer from the pump to the tank each time the piston reached the end of the stroke. If the pump was able to retain its priming and pump any water, the pressure in the tank would slam the valves down hard on the discharge and on the suction-valve seats as the pistons passed the ends of the stroke.

All such pumps will slam and hammer when started up, just as the cylinders begin to fill with water, because a long suction pipe contains a large volume of air which should be allowed to escape through the drip on the dicharge chamber before the pump is put in service, and as the pump is running a little fast on a high lift, it should be throttled down some to prevent possible breaking of valve bolts or stretching the piston rods where they pass through the water pistons.

Cambridge, Mass. R. A. CULTRA.

Testing Governor and Valve Adjustment

In the Aug. 24 issue of *Power*, p. 307, C. W. Peters speaks of the danger of having the valves and governor of an engine so adjusted that the speed will not be controlled in case of the main belt breaking or the engine otherwise losing its load.

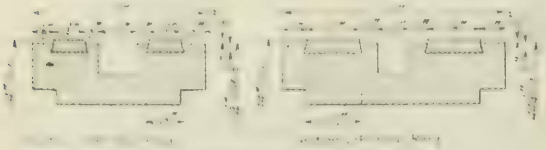
The governor and valve adjustment is easily proved by forcing the governor against the top collar and taking an indicator diagram while in this position from one end and then, after the speed has steadied down, indicating the other end of the cylinder. The valves should show no opening, or at least the retarding force shown by that part of the diagram below the atmospheric line should be equal to or greater than the part above the line. J. O. BENEFIEL.

Anderson, Ind.

Red Metal in Steam Engine Pistons

On page 95 of the July 20 issue of *Power*, Mr. Hamkens says, in that part of his article relating to the use of red metal in steam-engine pistons, that it is not feasible to allow the red metal to project 1/32 or 1/16 in. above the face of the piston with the idea of supporting the piston solely on the soft-metal strips, as the latter wear down in a short while and allow too much play between the bull ring and the cylinder walls.

The accompanying drawing shows a section through the bull rings of two 24 and 44 by 42-in. cross-compound engines that have been in service for the last twenty years direct-connected to 500-kw. generators. We have never had trouble with these pistons due to the 1/8-in. projection of red metal shown. In fact, the soft-metal strips always outlive the steam-packing ring, and their value is shown by the fact that the cylinders have never been rebored and have worn less than 1/16 in. from their original diameter.



SECTION THROUGH HIGH AND LOW PRESSURE BULL RINGS

ADOLPH QUADT.

Perth Amboy, N. J.

Where Should the Beginner Start?

In *Power* of Aug. 10, page 229, J. A. Lane asks the question, "What has become of all the first-class firemen within the last five years?" and says he believes this to be a pertinent question. It is. Have these fellows been promoted to the engine room, or have they gone into more lucrative jobs?

The attractive wages offered in production work during the late war lured many a man from his old-time job, and the man in the fire hole certainly was not an exception. However, conditions are now undergoing a great change, the labor market has eased up, fabulous wage rates are no longer being offered, but will be based on the ability to produce.

On the other hand, the price of coal has steadily gone up, so that today the economical use of fuel is of paramount importance. In consequence it may be that experienced firemen who found it advantageous several years ago to leave their jobs, may now find it just as much to their advantage to seek positions in the boiler rooms.

Mr. Lane, in his suggestion that young men be started in the engine room, with the view of later promoting them to the boiler room, voices the trend of the present day. In production plants the purchasing, storing and handling of raw material through the various producing operations into finished salable product are constantly being studied by experts with a view of reducing waste and holding the cost of finished product to a minimum. Production methods are being applied in the boiler room in converting the potential energy in the fuel into such form that it may be useful for heat, light or power applications.

It might be well to more or less definitely settle the question, "What is a fireman?" Is he a coal heaver, combustion engineer, boiler-room manager, water tender, etc? Let us have opinions as to the qualifications of a first-class fireman.

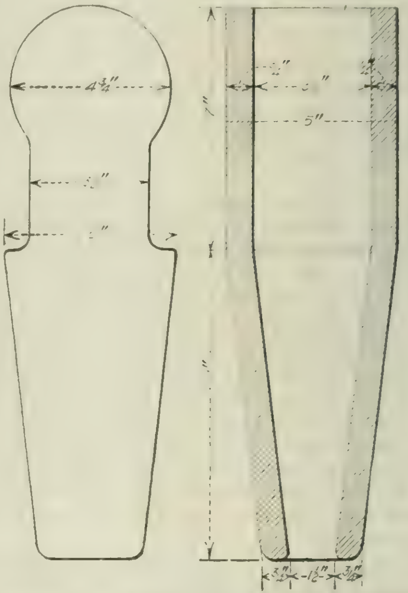
J. B. CLAPPER.

Cleveland, Ohio.

Socketing Hoisting Cables

The Spring Valley Coal Co. has practiced the Riebling system of socketing hoisting ropes with zinc for the last fifteen years, and it has given excellent results, as described in the article "Reserve Strength of Elevator Ropes," by W. Voightlander, page 115, *Power*, July 20 1920.

It is our practice to resocket the hoisting ropes every six months. Our socket for 1⅜-in. ropes, shown in the figures, was designed by the writer and is made in steel casting. It will be noted that the basket is made longer than is usual practice and the lugs are far enough apart to allow the zinc casting to pass between them. When we wish to remove the zinc, we cut the wires off close to the top of the basket with a hacksaw and back out the zinc with a punch and sledge. This saves heating the socket and adds to its life. In ordering sheave wheels, it is our practice to order them grooved for 1½-in rope and then use them on 1⅜-in. rope. This gives plenty or room, and we never have trouble with a new rope binding in the groove.



PLAN AND SECTION VIEW OF CABLE SOCKET

A. H. HALLADAY,
Master Mechanic Spring Valley Coal Co.

Spring Valley, Ill.

[Mr. Halladay's letter is interesting and should prove valuable to many *Power* readers. From the number of inquiries received, there is apparently considerable difficulty experienced with wire cable on both elevators and mine hoists. To promote an exchange of experiences, *Power* would appreciate articles for publication, on the practice of a number of its readers in maintaining and socketing hoist cables.—**EDITOR.**]

Valve Cam Worked Ahead

A rather peculiar thing has happened to one of my double 30 x 60-in. engines, developing a maximum of 2,500 hp. All valves are actuated by cams, and one cam has slipped ahead. No. 1 diagram was submitted to me first. The assistant engineer was instructed after shutting down at 5 p.m. to turn the head-end exhaust cam back to the mark, as it was ahead.

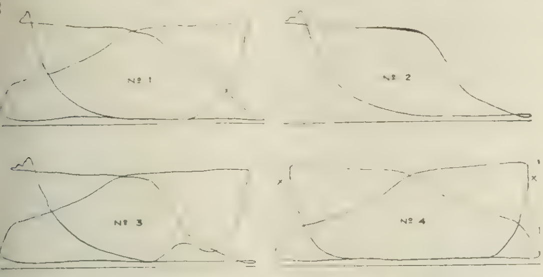


DIAGRAM NO. 1. CAM SLIPPED, KEEPERS OPEN; NO. 2, RESULT OF MORE CAM SLIPPAGE; NO. 3, CRANK END GETTING BACK TO POSITION; NO. 4, BOTH ENDS APPROXIMATELY CORRECT

Half an hour after shutting down, No. 2 diagram was submitted, with the remark, "She's pounding." Then the diagram, No. 3, was taken, the assistant remarking that "the other end was now on the 'bum,'" and that the compression had gone "dippy."

I suggested that when the head-end exhaust cam had been adjusted the crank end would take care of itself. No. 3 diagram shows that the exhaust opened so quickly that it built up the back pressure on the crank end, making it look as if the crank-end exhaust had started to close and build up compression, losing it a second later, then picking it up again. It was the exhaust line in general, as the back-pressure gage would have shown had the engineer looked closely.

Single indicator cocks are used, and one motion is just a trifle longer, making diagrams overlap as marked at *X*, No. 4. The next diagram looked as if the cam had been put back in place, but the compression on the head end was just a trifle off. Diagram No. 4 shows that all trouble has been eliminated.

It will be observed that there is some load on this side of engine. That cam was approximately 72 deg. ahead, not 288 deg. back of the crank. We caught it on the way ahead as Nos. 1 and 2 prove. If an eccentric slipped ahead it would cause some discussion!

New York City. C. W. PETERS.

Trouble with Split Eccentric

On a certain engine the eccentrics *A* and *B* are set close up to the end of the main pillow block. The governor pulley *C* was made a part of the exhaust eccentric, and all three were of the split type so that they could be taken off the shaft at will. They were held in position by two setscrews *D* without a key to keep them from slipping, a common occurrence unless the setscrews were tightened every week.

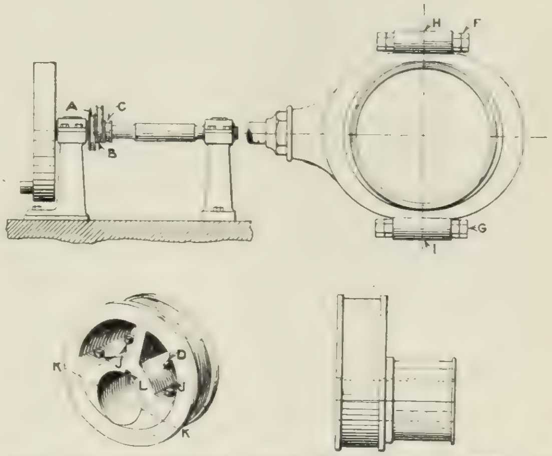
The real cause of their becoming loose was that the shaft was out of level about $\frac{3}{16}$ in. and had an end thrust of $\frac{3}{8}$ in., which caused the eccentrics, which also served as a collar to prevent the end thrust, to bump hard against the main bearing. This threw a strain on the bolts holding the two halves of the eccentrics together, which caused the nuts to give slightly until the setscrews were loosened. One not familiar with this action would naturally tighten the setscrews to hold the eccentric from turning on the shaft. This left the rim bolts still loose, and in the revolution the eccentric would rock on the setscrews.

The steam eccentric caused the most trouble, as it not only carried the heavier load, but was between the exhaust eccentric and the end of the bearing, and but one setscrew could be tightened with a wrench; with care the other was tightened with a cold chisel, but the rim bolts had not been tightened and of course the eccentric was expanding, so to speak, until the eccentric strap ran hot. Someone had loosened the bolts *F* and *G* until there was a looseness at *H* and *I*, and this space grew wider and the eccentric continued to run hot. It was thought best to put a shim in the strap at *H* and *I*.

Other troubles made it necessary to remove the eccentrics from the shaft, and when the faces of the rims were cleaned the bolts *J* were easily tightened while the cap was off the bearing. When the setscrews *D* were set up tight, it was found that the eccentric strap could be clamped tight and still swing loose on the eccentric, and shims at *H* and *I* were not needed.

The split at the center line of the shaft is represented by *KK*, and dirt prevented the bolts *JJ* from bringing the two surfaces together properly. Had a keyway been cut at *L*, the eccentric could not have turned on the shaft.

The end thrust of the shaft reached its greatest throw during heavy loads for the reason that at such times it would get in phase or step with the pull and push of the piston on the crankpin, which added force to the thrust and caused sledgehammer blows of the crank disk and eccentrics alternately against the ends of the bearings. Had there been a slight shoulder turned on the shaft to fit against the end of the bearing, the setscrews would not have been hammered loose in their spot position on the shaft, and the rim bolts would not have worked loose so easily. The end thrust was removed by leveling the shaft and setting the eccentrics closer to the main bearing. R. A. CULTRA.



HOW THE ECCENTRICS WERE MADE AND PLACED ON ENGINE SHAFT

Cambridge, Mass.

Fuel Waste Causes Failure of Central Heating Station

A certain central-heating station, supplying steam and hot water heat, had been in operation for eight years. In spite of the fact that the plant was well designed, that capable engineers had been in charge of the operation and that the location was ideal for a heating plant, it had never paid. No less than eight engineers had been in charge. Each one had gone away thoroughly disgusted, leaving the plant in a worse condition than when they assumed charge. Finally a combustion engineer was employed and placed in charge of the operation and management. He was told of the failure of his predecessors and asked to locate and remove the cause of the previous failures. He was assured that he would have the full co-operation of the management in his efforts to right things. With this assurance and a strong determination to succeed where others had failed, the combustion engineer assumed charge. To locate the trouble was a very simple matter, but to remove it was a different undertaking.

The steam-generating equipment consisted of three 400-hp. vertical water-tube boilers, each having 4,000 sq.ft. of heating surface, and one 600-hp. water-tube boiler having 6,000 sq.ft. of heating surface. Three boilers were set in a single battery and were served by side-feed stokers, each having a grate area of 88 sq.ft. The other boiler was served by a chain-grate stoker having an area of 96 sq.ft. Coal was furnished to the side-feed stokers from bunkers directly on top of the furnaces in the usual way. The coal was supplied to the chain grate from an overhead bunker. Coal was delivered to the bunkers by a drag-chain conveyor, which was in turn supplied by a track hopper 200 ft. from the boiler room. Feed water was heated by a 3,000-hp. open feed-water heater and delivered to the boilers by two 9 and 10 by 12-in. duplex pumps, without governors or regulators. No means were provided for controlling the drafts except by hand.

Upon examination of the boilers it was found that the scale was no less than $\frac{3}{16}$ in. thick and in some instances the tubes were completely stopped up with mud and scale. The tubes were burned and blistered until it would not do to try to scale them as the turbine would cut through the metal, the tubes were so thin. It was evident that new tubes would have to be put in.

The flue-gas temperatures were found to range around 1,000 deg. F., owing to the scale in the tubes, the broken-down baffles and the soot on the outside of the tubes which was $\frac{1}{16}$ to $\frac{1}{4}$ in. thick and on the tubes next to the fire ashes were fused on them until the gas passage was almost stopped up. No mechanical means for cleaning tubes had been provided, a hand lance being depended upon. This was seldom if ever used, as the condition of the tubes proved.

The side-feed stokers were found in a dilapidated condition, the bearing bars were burned until they had sagged and allowed the grate bars to slip off of the upper bearing bar, thus allowing coal to fall from the coking chamber directly into the sifting pit. The grate bars were badly burned and warped, and the arch plates had warped and sagged to such an extent that the feeding mechanism would not operate; consequently coal had to be fed by hand, using a rod to poke it down. This, of course, required extra labor. After thorough examination it was seen that to repair these stokers would cost as much as new ones and then the plant would not be very well off in so far as stokers was concerned.

Next, the chain grate was examined, and it was found to be in but little better condition than the other. A large number of the links were broken out of the chain which allowed coal to fall into the sifting pit in large quantities. The front driving-sprocket shaft was bent so badly that the stoker engine would hardly drive the chain, and the driving gears would hardly stay in mesh. This was caused by allowing the center bearing to become loose and fall out. One of the side frames was broken as well as one of the cross-braces.

The settings were next examined, and they were found full of cracks and holes, which allowed excess air to get into the furnace where it was not wanted. The furnace linings were all loose from the outside walls and were leaning over against the boiler. No less than 250 leaky flanges and joints were found in the steam piping.

The records showed that the average life of an arch for the side-feed furnaces was three months, even though the boilers were not worked over rating. The coal for these boilers was supported by these arches, which at times amounted to as much as twenty tons.

After a thorough examination of the equipment and an analyses of the conditions had been made a report was sent to the management who had pledged their co-operation. The engineer was asked what he was going to do about it. After due reflection and consideration, an estimate of the cost of rehabilitation of the boiler plant was made, together with recommendations for improvements which were necessary to make before anything like economical operation could be obtained. It was shown that the cost of the improvements, which included three new stokers to replace the side-feed and repairs for the chain-grate stoker, mechanical soot cleaners, draft-control apparatus and other necessary supplies would be paid for in less than one year by the savings effected in fuel and labor.

The engineer was informed that until the plant had been made to make its own way, no money would be spent for improvements. It was found that the labor had been cut down until not enough men were employed to keep up the necessary work about the plant. The engineer then put some extra men on the payroll to clean up the boilers and make the best out of what he had on hand. These extra men were to scale the tubes and put in new tubes where necessary, keep the tubes blown clean and do whatever was required around the plant. The management then offered their assistance again and informed the engineer that no extra men would be allowed as the plant was not paying expenses.

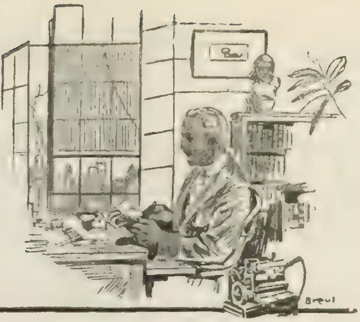
The engineer tried to explain that a $3 per day man who would save several tons of $8 coal per day was a good investment and was a good way to make the plant pay dividends. The engineer was told that he was just like those that had come before him, that he was wasteful, extravagant and that his ideas were all wrong.

Seeing that the task was hopeless unless the management would allow him to spend the necessary money to put the plant in condition, he appealed to them numberless times and meeting with the same rebuff each time, finally became disgusted and went away.

Three months later the company went into the hands of a receiver. The management is wondering why.

Logansport, Ind. WILLIAM M. MCNEILL.

INQUIRIES OF GENERAL INTEREST



Heat of Water and of Steam—Does a pound of water contain as much heat as a pound of steam in the same boiler? R. R.

The water and the steam in presence of the water are of the same temperature, but a pound of the water does not contain as many heat units as a pound of the steam, because conversion of the water into steam requires addition of the latent heat of evaporation.

Changing from Condensing to Non-Condensing—What changes of valve setting should be made when changing from condensing to non-condensing? J. R. S.

For running non-condensing the exhaust valves should be closed later because less compression of the higher-pressure exhaust will be necessary for obtaining the same cushioning effect. With a Corliss valve gear less compression should be obtained by setting the exhaust eccentric backward. With a single-eccentric engine it will be necessary to set the eccentric backward, and to preserve the same lead, the steam valves must have less lap when the wristplate is in its central position.

Scaling-off of Poor Galvanizing—What preparation can be used as a coating to prevent galvanizing from scaling-off iron pipes? J. J. C.

Ordinary galvanizing is a coating obtained by dipping the pipe or other article in a bath of molten zinc. If the zinc shells off, it is because the article when galvanized was not properly prepared or the temperatures were not suitable, and no preparation applied as a coating over the zinc that is already loosened could be of benefit for increasing its adhesiveness. A coating like paint or asphaltum would act as a binder until it became dry and brittle, but would be thrown off along with the galvanizing in places where the zinc has not taken good hold on the pipe. For improvement of appearance of the exterior and protection from rusting, remove all galvanizing possible to be rubbed off with a sharp coarse file and give the pipe a coat of aluminum paint.

Allowance for Moisture in Rating Engine Economy—In determining the economy of reciprocating steam engines expressed in pounds of steam per indicated horsepower-hour or per brake horsepower-hour, how is allowance to be made for the quality of the steam supplied? A. E. M.

Unless otherwise particularly specified, reciprocating-engine economy is assumed to be based on a supply of commercially dry steam, that is, steam containing not over 2 per cent moisture, and the quantity of steam charged as consumed is determined by deducting the moisture, if any, found by calorimeter test, from the total amount of air-pump discharge or complete condensation of exhaust discharged. If the steam is superheated, no correction is to be made for the superheat. When the steam supply is of poorer quality than 98 per cent dry, the moisture is more detrimental to economy than the percentage present, on account of reduction of the expansive force of the dry portion of steam by heat absorbed in evaporation of the moisture, and also because the losses from radiation are increased owing to greater conductivity of heat by wet steam than from dry steam coming in contact with the walls of the cylinder and steam passages.

Variation in Length of Indicator Diagrams—What causes difference in length of indicator diagrams taken with the same indicator and reducing motion from opposite ends of an engine cylinder? J. B. S.

Different lengths of diagrams may result from use of indicator cords of different diameter or a different winding or building up of cords on the reducing motion or sheave of the paper drum. There will also be a shortening of the diagrams due to stretching of the cord or insufficient drum-spring tension to overcome the drum and pencil friction.

Economical Limit of Vacuum for Reciprocating Engine—Why is more than 26 inches vacuum considered uneconomical for operation of a condensing engine? W. T.

Under ordinary conditions, when the exhaust is condensed to a pressure below 26 inches vacuum, which would be about 2 lb. absolute and 126 deg. F., the greater cylinder cooling due to the lower temperature of the exhaust, that must be compensated by heat abstracted from the initial steam, amounts to more loss than the increase of m.e.p. obtained by the further reduction of back pressure, aside from additional cost of obtaining a higher vacuum.

Alternators in Parallel—We have two crude-oil engines, each rated at 25 hp., which we want to belt to alternating-current generators of whatever size the engines will drive. It is desired to operate the alternators in parallel. Can this be done? Would there be any advantage in belting both engines to a lineshaft and driving the alternators from this shaft using clutches on the engine pulleys? W. L. H.

It would not be good practice to belt the two oil engines to the same lineshaft. This has been tried a number of times but without success. There is no reason why an alternating-current generator cannot be belted to each oil engine and have the generators operate in parallel. Alternating-current generators, to operate in parallel successfully when driven by these oil engines, will require squirrel-cage windings in the pole faces.

Unstayed Heads of Steam Drums—Why are not heads of steam drums of water-tube boilers stayed? J. N. R.

When unstayed, the heads are bumped. When a head is bumped or dished to the form of a spherical segment, most of the material is subjected only to a tensile stress such as would occur if the segment were part of a complete hollow sphere of the same radius of curvature and subjected to the same pressure, without requirement of stays to preserve a spherical form. However, when the pressure is on the concave side and the head is not a complete hemisphere, the pressure tends to distort the material to a hemispherical form at the periphery where the original form is a sudden change of shape from the spherical form to the cylindrical form of the flange. This gives rise to a dangerous bending action which must be prevented by staying or more usually is met by the thickness of the material. To guard against this weakness, where the heads are assumed to be of the same thickness throughout, conservative formulas for determining the thickness of unstayed bumped heads for a given working pressure result in providing greater thickness of material than would be necessary for obtaining sufficient strength for the central spherical portion of the head.

The Storage of Bituminous Coal*

By O. P. Hood†

THE general subject of coal storage gives one a large field within which to wander. The best current storage practice is well illustrated in a publication issued by the Engineering Experiment Station of the University of Illinois under the title, "The Storage of Bituminous Coal," by H. H. Stoek. A short résumé of the subject is given by the same author in Bureau of Mines Technical Paper 235, copy of which forms an appendix to this paper.

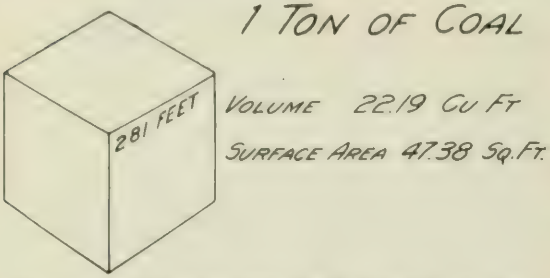
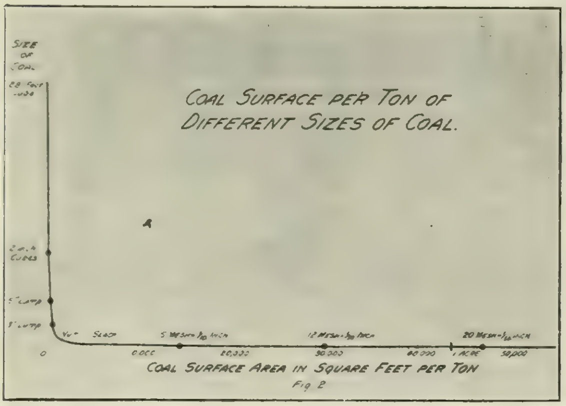


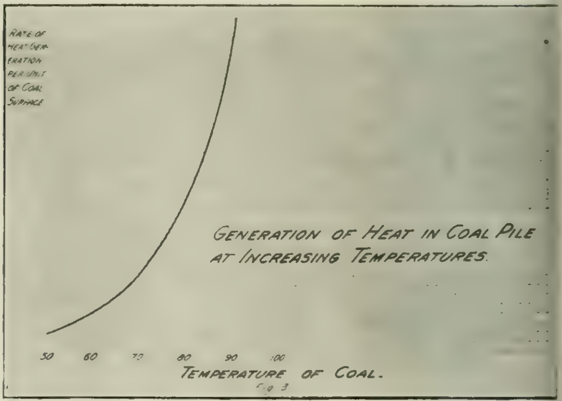
FIG. 1. VOLUME AND SURFACE OF ONE TON OF COAL

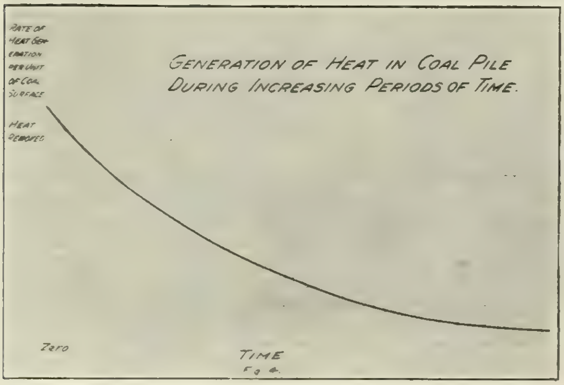
The spontaneous combustion of coal lies at the bottom of the subject of storage. Every engineer is familiar with the phenomena of the self heating of coal. For all that, the phenomenon is a relatively rare one. If we counted the times a portion of coal was stored where it would be undisturbed for a few weeks, the number of such storage operations in any one year would mount into the millions. Of these a relatively small number show the phenomenon of spontaneous combustion and the risk per ton is very small. In the smaller operations involving but few tons it is extremely rare that there is any heating of coal. There is no spontaneous combustion of anthracite, and very rarely does the domestic consumer of bituminous coal find troublesome heating.

The main interest in the subject lies in the large piles needed for reserve for public-service utilities and the industries.

Everyone desires to have a perfectly simple direction for storage which will insure against loss. Unfortunately, the matter is too complicated for a simple solution. Many of the factors involved are difficult to determine, as we have no practical means of quantitative measurement. The factors involve chemistry, physics and engineering, and the man who is in close contact with the problem of stored coal is not always a good observer in these several lines. The result is many incorrect theories, opinions and prejudices. It will be my attempt to try to picture to you some of the main factors in the problem so that a working theory may be held and observation centered on the essential factors.







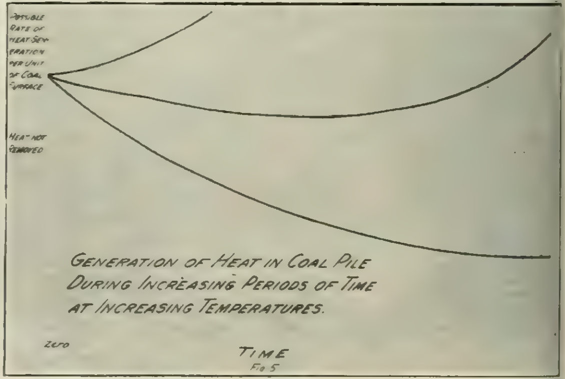


FIG. 2. COAL SURFACE PER TON OF DIFFERENT SIZES OF COAL. FIG. 3. GENERATION OF HEAT IN COAL PILE AT INCREASING TEMPERATURES. FIG. 4. GENERATION OF HEAT IN COAL PILE DURING INCREASING PERIODS OF TIME. FIG. 5. GENERATION OF HEAT IN COAL PILE DURING INCREASING PERIODS OF TIME AT INCREASING TEMPERATURES

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*Address before Pennsylvania Electric Association, Bedford Springs, Pa., Sept. 10, 1920.

†Chief mechanical engineer, United States Bureau of Mines.

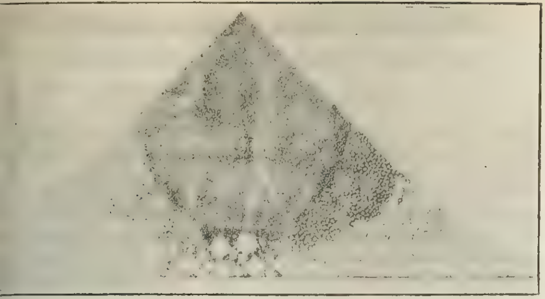


FIG. 6. SEGREGATION OF DIFFERENT SIZES OF COAL IN A CONICAL PILE

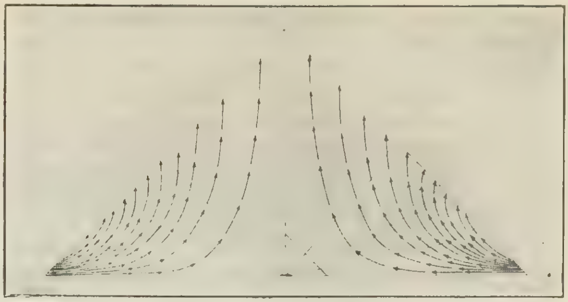


FIG. 7. LINES SHOWING INCREASINGLY DIFFICULT PATHS FOR AIR CIRCULATION

remember reviewing a case involving spontaneous comoustion on shipboard where in the hearings everything had oeen investigated from the pennant on the mast to the oarnacles on the rudder, but the observations that had a eal bearing on the heating of the coal were extremely few ind formed a very unpretentious part of a formidable lookng document. It is necessary to know what to look for in rder to draw reasonably accurate conclusions.

The heating of coal is believed to be a surface phenomenon. If a ton of bituminous coal could be delivered in a ingle cube, Fig. 1, each dimension would be about 2.8 ft. f the coal heats, it is due to something that goes on with espect to the surface and not something that happens inide of the piece. So far as we know, this is true no matter ow small the piece is divided. We are, therefore, interested n the amount of exposed surface in a ton of coal. If this ube, having originally about 47 sq. ft. of area, be coninuously subdivided, the rate of increase in the exposed urface is shown in Fig. 2. If the size is reduced to somehing about 16-mesh screen, there is an acre of exposed oal surface. It is perfectly obvious from this why it is hat trouble from spontaneous combustion originates in fine oal, because the great increase in extent of surface does ot begin until we get below 1¼ nut. If fine coal is kept ut of the pile, the heating is so relatively small as to renove the cause of spontaneous combustion. This remark pplies not to the fact that one may buy lump coal, but o what actually gets into the storage pile. Coal bought s lump at the mine and handled with modern disregard or breakage may be far from lump coal when in the pile.

Heat Generated Depends on Temperature of Coal When Stored

A unit of area of this coal surface generates a certain mount of heat provided it can find combining material. he amount of heat generated depends upon the temperaure of the piece of coal. That is to say, coal put into torage at a temperature of 80 deg. will generate very nuch more heat per unit of surface than if put into storage t the temperature of 60 deg., Fig. 3. I cannot say just how nuch more, but the chemists tell us that in general the rate f chemical reaction doubles for every 10 deg. rise in emperature, and if that applies in this case, beginning at 0 deg. higher in temperature means a fourfold increase in he amount of heat generated. It has already been a mater of observation that coal stored during the hot months f summer and in heated areas is much more liable to pontaneous combustion than coal stored in colder climes nd in cooler portions of the year.

Another important factor is the freshness of the broken urface. A freshly broken surface of coal has a rate of eat generation that is a function of the kind of coal. It is ractically zero with anthracite and is largest with the ounger coals. The quantity of oxygen contained in the oal seems to be the fairest measure of this rate, although y no means reliable. The high-oxygen coals of the Middle Vest and the sub-bituminous coals and lignites of the West how increasingly active rates of heating.

The coal surface apparently becomes satisfied in time, and he heat produced falls to practically zero. The rate of heating then follows along a curve somewhat like that given in Fig. 4. This means that for the first few days or weeks a freshly broken surface is very much more active than after a few weeks or months. This fact must be borne in mind when the question is considered as to whether it is wise to crush coal immediately before putting it in storage. Fires rarely occur after surfaces have been exposed for three months.

Since the rate of heating increases with the temperature, it is evident that if the heat generated is not removed, the process becomes a self-aggravating one, in which case the rate of heat generation, instead of falling as in Fig. 4, may rise with time according to some curve as shown in Fig 5. If the temperature of the pile reaches 140 or 150 deg. and continues to rise, there is a very considerable probability that within a few days or a few weeks, a destructive temperature will be reached and the coal must be moved. Immediately the question of getting rid of the heat is presented.

A coal pile is cooled by radiation and by movement of air through the pile. Air moves rather freely through a coal pile. In a certain case a partial cargo of coal was loaded into a bottom at New York and proceeded under sail to Norfolk. The general temperature of the pile at loading was known and on arrival at Norfolk the coal had so increased in temperature as to make it dangerous to add further cargo. Knowing the rise in temperature of this mass, it was possible to roughly figure the exchange of air that must have been made within the coal pile, in order to supply the amount of oxygen represented by the heating effect. The general order of magnitude was that all of the air in the interstices between the pieces of coal must have been changed from twenty to thirty times during the time of heating. This coal was, of course, protected from winds, and Fig. 6 shows the amount of the natural ventilation within a coal pile, due to differences in temperature and the daily variation of barometric pressure. In many cases this natural change, or breathing of air, is enough to carry away the heat generated.

Smaller Pieces in Central Core of Pile

Suppose that coal was delivered in four uniform sizes and put in a conical pile by dropping at a single point. The granular arrangement of parts would be such as to furnish a foundation, over nearly the whole pile, of larger-sized pieces, and the lower flanks of the pile would be of the larger sizes. Nearly all of the smallest pieces would be in the central core of the pile. If one were to draw lines bounding the regions of these several sizes they would be something like those shown in Fig. 6. In the region of large pieces air would move freely and the coal surface exposed would be a minimum; hence there would be little likelihood of heating. In the center of the pile the movement of air would be small, while the amount of heating surface would be great. If the fine coal is so densely packed as to prevent an exchange of air, there will be no heating because there will be no supply of oxygen to combine with the active surfaces. Somewhere between the two extremes of the central core of fine coal and the large-piece region, there may be areas where the ventilating current is just sufficient to supply oxygen for a maximum rise in temperature and insufficient to remove the heat as generated. In Fig. 7 lines have been drawn showing in general progressively difficult paths for the movement of cooling air.

Some observers have stated that in general, fires in large coal piles are found in the region from five to eight feet below the surface on the flanks of the pile. The rise in temperature of a coal pile is then intimately connected with a very complicated ventilating problem, and we have no means of observing or measuring these small and wayward ventilating currents.

We know that if coal can be sealed tight, as in a glass jar, the oxygen soon disappears and the coal cannot continue to heat because of lack of oxygen. In Fig. 8 horizontal distances represent the amount of ventilation of any portion of a coal pile and vertical distances represent rise in temperature. With no ventilation there will be no rise in temperature and the zero point will represent the condition of coal sealed from the air or so densely packed that air cannot circulate. If, on the other hand, there is sufficient ventilation, the heat is all carried away as fast as generated and some point, as at *B*, on the zero line must represent this condition, as in the case of coarse coal. At some point, as at *A*, between these two extremes there may be a condition of ventilation that will supply just oxygen enough to provide for a maximum rise in temperature.

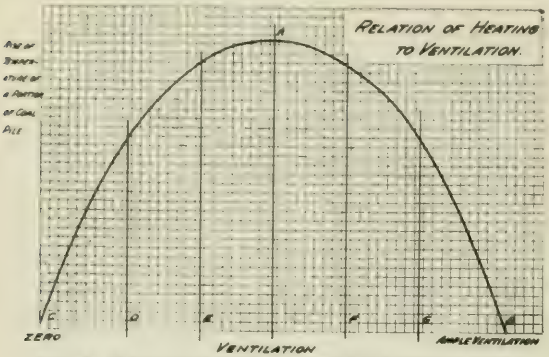


FIG. 8 RELATION OF HEATING TO VENTILATION

What sort of a curve represents all the intermediate conditions between *C*, *A* and *B*, we do not know, but that the curve must first ascend and then descend is perfectly evident. This curve teaches that if we have a condition of ventilation as at *D*, an increase in the ventilation to *E* will produce a more favorable condition for a temperature rise. On the other hand, if the original condition is as at *F* and we increase the ventilation to *G*, we can expect a reduction of temperature. Since we have no means of knowing just what the ventilation is in any given portion of a pile, there is great hesitancy in advocating ventilating schemes for coal piles, as we are as likely to make trouble as to prevent it unless extreme and uniform ventilation is assured.

The curves shown have illustrated the tendencies of what are believed to be the principal factors in the problem of spontaneous combustion.

There are many more minor factors. One of the troubles has been that undue attention has often been given to minor factors, such as sulphur, height of pile, volatile matter, etc., while main factors, such as initial temperature, breakage in handling, freshness of coal and coal screening before storage, have been overlooked or minimized.

On account of the unusual demand for electric energy, due in part to coal shortage, the Societa Adriatica di Elettricita and the Societa del Cellina in the territory of Treviso, Italy, are working to transform their plants and increase their production from 28,000 hp. to 280,000 hp. When completed, the plants will be able to dispose of 700,000,000 kw. of energy compared with 32,000,000 kw. at present, which would mean a saving for Italy of about 1,000,000 metric tons of coal per annum.—*Commerce Reports.*

Thirty-ninth Annual Convention New England Water Works Association

The New England Water Works Association held its 39th annual convention Sept. 7-10 at Holyoke, Mass. Hotel Nonotuck was the official headquarters, and the business and professional sessions were held in the City Hall auditorium, President Henry V. Macksey presiding.

The fame of Holyoke as a center of development and practice of hydraulic engineering and an attractive convention program of professional papers and entertainments contributed to the encouragement of attendance of over 300 members and guests to one of the most successful conventions ever held by this association.

A paper entitled "The Holyoke Water Works and Its Rainfall and Stream Flow," presented by Patrick J. Lucey, gave a good technical description of the local water works and was especially appreciated by those who were desirous of inspecting the plant during their presence in the convention city.

At Tuesday evening's session, Col. Charles R. Gow read a paper entitled "Experiences with Quicksand," which was well illustrated by lantern slides showing how troubles from so-called "quicksand" may be avoided by diversion of ground water from excavations.

The final report of the Committee on Charges for Private Fire Protection was received and approved to the effect that such protection is a valuable special service for which water companies should be compensated.

PUMPING ENGINEERING

Wednesday morning's session was opened by the reading of a paper on "Further Tests of a Unaflow Pumping Engine," by D. A. Decrow, who stated that more recent tests than those previously reported by him gave a steam consumption of 11.4 lb. per i.hp.-hr. operating condensing. In commenting on this paper, the president took occasion to express regret that the association had never specialized on pumping engineering and thought that a determined effort should be made to get more pumping engineers into the association. The president made an earnest appeal to the members to solicit membership of this class of men, of whom he declared the association was much in need.

The Dexter Brackett Memorial Medal for the best paper of the year 1919 was awarded to Robert E. Horton, of Albany, N. Y., for excellence of his paper presented on "Measurements of Rainfall and Snow."

A paper entitled "Loss of Head in a 12-in. Gate in a 16-in. Pipe," by Thomas E. Lally, described experiments made by the water department of Boston, Mass. Discussion brought out the fact—not generally appreciated by laymen—that the obstruction to flow offered by gate valves is so small as compared with loss of head from pipe lines that it is usually practicable to maintain a gate-valve opening equal to 50 per cent of the cross-sectional area of the pipe line.

OPERATION OF PUMPING STATIONS

A paper entitled "Instructions to Employees at Pumping Stations and Filter Plants," by Dow R. Gwinn, described methods of communicating instructions to waterworks employees for maintenance of good discipline and efficient operation of the plants.

A paper presented by Reeves J. Newsom entitled "Modern Pumping Station Design and Operation," described radical changes that had been made for obtaining better plant efficiency for the three pumping stations of Lynn, Mass., water works. The improvements consisted in replacing a low-lift steam-driven pump used only during the winter and spring months by an electric-motor-driven centrifugal equipment installed in a more favorable location for pumping; the replacement of another low-lift unit that consisted of an electric-motor-driven centrifugal by a more modern outfit of superior efficiency; and changing over the main pumping station, which pumps into the mains and equalizing reservoir, from use of coal at present costing about $16.50 per ton to oil-burning at the equivalent of about $9 per ton of coal. The oil-burning installation consists of

35,000-gal. storage tank and complete equipment of two 75-hp. boilers.

Whist parties at the Holyoke Country Club and at the otel Nontuck and auto rides to Amherst and Smith Colges and other local points of interest were arranged for e lady guests, and on Thursday afternoon the Water orks Manufacturers Association tendered all members nd guests an excursion to Mt. Tom with dinner at the ountain House and an evening theater party at Mt. Tom asino.

On Wednesday many members and guests made visits to e works of the International Steam Pump Co. and also the testing flume of Holyoke Water Power Co. At the tter place the visitors witnessed a test of a 27-in. turne and were permitted to make inspection of the power easuring apparatus and the complete facilities and applinces for conducting power and efficiency tests of turbine aterwheels.

Industrial Load in California

In order to determine the extent and distribution of the dustrial electrical load in California, questionnaires were nt to 1,289 industrial concerns employing fifty or more eratives each. Answers were received from 299 compaes which were so distributed among various industries as give a very definite idea of the industrial power situation. r shortage, unsettled labor conditions and seasonal variaon in illumination requirements were factors tending to wer the output of central stations, but despite these adrse conditions the average daily output gradually increased om 8,832,000 kw.-hr. in January to 9,030,000 kw.-hr. in pril.

The survey indicates that the iron and steel industries (inding foundries and machine shops), shipbuilding, cement ants, food (including canning and preserving plants), ming, paper mills, chemicals and lumber are the principal anufacturing industries using electrical power. The companying table gives data on the utilization of electric wer in these industries as well as other industries of les portance.

The Food-Preparation Industry

The food-preparation industry is the most important in lifornia in value of products. There are 316 plants of is general class in the state employing more than fifty eratives each. Reports received indicate that about 21 r cent of the electrical energy used in these factories is nerated in private plants and that the amount of energy ed in an average factory of this type is in the neighbord of 221,400 kw.-hr. per annum. In the ninety-six facies reporting, 2,207 motors were installed with a total ting of 32,968 hp. Of the total number of motors 35 per nt are under 5 hp. and the largest is rated at 500 hp. The all motors range between ⅛ hp. and 1 hp. The usual voltage is 440 and 220 and ranges as high as 2,000. Belt-driven machines total 73 per cent and 22 per cent are direct-connected, the remainder being chain-driven.

The iron and steel industry ranks fourth among the manufacturing industries of the state. There are about 208 plants of this class. In amount of electrical energy used it ranks first among California's industries. Returns received indicate that 31 per cent of the industrial load used in that state is utilized by foundries and machine shops. There are 5,262 motors employed by the sixty companies reporting, with a total installed rating of 81,616 hp. The average rating of the larger motors is between 15 hp. and 20 hp. The usual voltage is 220. More than 63 per cent of the machines are direct connected and 36 per cent are belt-driven.

Shipbuilding an Important Industry

Shipbuilding now ranks among the primary industries of California. The thirteen shipbuilding plants from which reports were received consume 41,116,484 kw.-hr. of electrical energy per year; 1,941 motors are installed by the reporting companies, with a total rating of 46,100 hp. The average rating of the larger motors is between 280 and 290 hp. Nearly 71 per cent of the machines are connected directly to the motors, 28 per cent are belt-driven, while only fourteen chain drives were reported.

Electric drive in stone, clay and glass plants has been generally adopted. One large cement mill reported an annual consumption of 20,866,970 kw.-hr. This plant uses more than 150 motors with a total installed rating of 7,478 hp. Eighty-seven per cent of these machines are belt-driven, and 12 per cent are direct-connected.

Lumbering and lumber manufactures constitute one of California's principal industries. The manufacturing end of this industry is practically all electrically driven at the present time. The logging operations, which could be worked electrically to great advantage, are handicapped in California by the scarcity of power-transmission lines. The thirty-nine lumber companies reporting consumed a total of 7,092,114 kw.-hr. per year of which 51 per cent was generated in private plants. The number of motors used was 1,051, with a total rating of about 17,536 hp. The most widely used motor in the operation of woodworking machinery is the constant-speed squirrel-cage induction motor, and the usual voltage is 440 or 220. The companies reported that 32 per cent of the machines are belt-driven, 17 per cent direct-connected and 5 per cent chain-driven.

A total of 6,272 hp. from hydraulic sources is being obtained by Greek industries. The estimated total available power from waterfalls in Macedonia is 66,000 hp. At present less than one-tenth of the total available power is being utilized, but growing interest is being manifested in the possibilities of harnessing the wasted power.

SUMMARY OF INDUSTRIAL SURVEY FOR CALIFORNIA AS OF JULY 1, 1920

		Water Wheels		Internal Combust'n		Steam Engines		Steam Turbines		Electric Generators D. C.		Electric Generators A.C.		Energy		Motors Installed			No. of Drives		
ndustry	Number of Companies Reporting	Number	Rating, Hp.	Number	Rating, Hp.	Number	Rating, Hp.	Number	Rating, Hp.	Number	Rating, Hp.	Number	Rating, Hp.	Generated, Kw.-Hr	Purchased, Kw.-Hr	Number	Rating, Hp.	Under 5 Hp.	Belt	Chain	Direct or Geared
and steel.	60			2	70	2	205	1	600	2	175	5	570	591,467	59,205,327	5,262	81,616	569	1,873	59	3,267
tor trucks d accessories	11														524,840	130	1,502.5	43	88	1	29
tiles	23					1	55			3	21.5				207,627	275	2,204	70	151	27	83
er	9	1	300			3	637			1	65				6,230,760	100	1,672	25	58		10
ther	8														137,805	34	250	7	22	2	
d	96			4	1,200	58	5,382	9	2,320	32	1,610	14	3,498	4,386,080	16,867,864	2,207	32,968	784	1,946	137	599
e, clay and ass	10			1	20	4	220								38,570,116	257	16,713	29	155	2	55
ing	4	1	1,300							1	275	1	1,000	897,520	11,742,690	121	7,707	14	23	3	8
building	13														41,116,484	1,941	46,099.5	360	516	14	1,285
trical equipment	3														633,290	288	860	197	92		5
ber.	39					37	11,020	13	5,988	11	*435.5	17	5,070	3,619,720	3,472,394	1,051	17,535.5	195	637	5	129
micals	16			2	40	3	390			3	112.5				4,314,732	392	6,624.5	81	[illegible]	14	[illegible]
cellaneous	7														516,877	283	1,226.5	191	144	7	[illegible]
otals...	299	2	1,600	9	1,330	108	17,900	23	8,903	53	2,694.5	37	10,138	9,494,787	183,540,606	12,341	214,979	2,565	5,974	271	5,567

* This is the total of only four of the direct current generators.

Operation of a Modern Gas Producer

A new producer, before being started, should be dried out several days with small fires. This precaution, if properly carried out, will add considerably to the life of the lining. The producer should then be filled to a depth of at least twelve inches over the top of the blower. It is best that a few large clinkers be placed around the openings of the blower to keep them from becoming clogged by the fine ashes. The ashes are necessary to protect the metal parts of the producer and also act as a diffusing medium to distribute the blast over the entire fuel bed, thus insuring even combustion.

To start the producer, it is necessary only to level off the ashes, throw in several armfuls of small dry wood, saturate with kerosene and light with a piece of waste. After the wood was burned for a few minutes, turn on about ten pounds of blast and blow until the wood is burning briskly. A small amount can then be dumped and the fire built up gradually. Care should be taken to see that the coal is not fed too fast. Allow a good bed of coke to be formed before any attempt is made to crowd the producer. It takes several hours to get a producer fire built up properly to where it makes good gas. No special attempt need be made at this point to get the fire distributed over the fuel bed. It will spread itself, and it is better to have a good fire burning at one place than to have several small ones. In case it is necessary to stop the producer at any time, the blast should be turned off.

The various zones of the producer are three in number. They consist of the ash, the incandescent or fire zone and the green-coal zone. The last consists of the coal that has received unsufficient air to become incandescent. This is also termed the distillation zone. The existence of these three distinct zones is a point often overlooked.

In measuring the fires, it is usual to determine merely the distance from fuel bed to producer top. This method is wholly inadequate because no attention is given to the depth of the fire zone, which is the most important point of all in producer operation. If the ash zone exceeds a reasonable limit, the fire zone is reduced. The tendency of the ashes to crowd out the fire zone makes it possible for the top of the fuel to be at the proper height, and yet the fire may be so thin that the gas will be of exceedingly poor quality. The depth of the ash bed, as well as the distance between the top of the fire zone and producer top, should be measured.

Some coals have a tendency to become soft and pasty under the action of the heat in the producer. This restricts the passage of the gas and, owing to the fact that this pressure accumulates under the steady blast, the gases will seek channels to break through the resistance of the fuel bed. These places become excessively hot, melting the ashes and other foreign particles in the coal, resulting in the formation of clinkers. If the coal is of this nature, close attention must be given to the poking and the regulating of the blast. It may be necessary to change the mixture of the blast, increasing the percentage of steam. The increased steam will lower the temperature of the fire and thus considerably reduce the clinkering tendencies of the coal. It should not be carried to the point where the CO_2 content of the gases becomes excessive. This entails a certain loss, but often the trouble due to clinkering more than offsets the loss due to maintaining a lower CO_2.

It is not necessary to discontinue the operation of the producer during the cleaning process. The fire should never be lowered more than eight to ten inches during one cleaning period, and coal should be dumped as during the regular period, although in smaller amounts. The blast pressure should be lowered. During the cleaning period attention should be given to the clinkers that often form on the side walls.

The proper dumping of the coal has an important influence on the operation. It should be dumped in as small quantities as can be arranged. Strict attention should be paid to the color of the gases, which shows whether the fuel bed is of the proper thickness.

In starting a new producer, the top plate has a tendency to run hot and will require all the water that can be applied through the connections. After a few days the plat becomes coated with carbon and a small water supply i needed.

In most installations there are periods when the furnac is down for repairs. This time should be taken to clean th producer completely. The side walls should be cleaned, th blower and blast boxes cleaned out and any part needin attention should now be repaired. This procedure, i carried out, will not entail much labor and the operat will be repaid by increased reliability of the machine.

The quality of producer gas depends upon its combus ibles. The quantity and character of these are affected b the operating conditions within the producer. During th ordinary operation of a battery of Wellman producers a steel mill, 75 tests were made. Briefly stated, the conclusions drawn from the tests were as follows:

To make a rich gas, high in heat units, the ashes shoul be carried at a height of twelve inches above the blast cove

The combustion zone should be confined to a thin fir approximately six to eight inches in thickness.

The green-coal zone, in which distillation by hydrocarbons occurs, should be kept from twelve to eighteen inche thick.

Under these conditions the pressure of the steam use for the blast should be twenty-three pounds per squar inch.—*The Blast Furnace and Steel Plant.*

Chemical Society Discusses Water-Supply Problems

The Chicago meeting of the American Chemical Societ on Sept. 8 included one session of the Division of Wate Sewage and Sanitation. At these meetings A. H. Behrma reported on lime softening of water for the manufacture o raw-water ice. This report pointed out a large increase i the manufacture of raw-water ice, which in many cases i superseding the use of distilled water for this work.

W. D. Collins presented a paper on "Hardness of Surfac Waters in the United States." He presented a tabular summary of typical analyses of waters for various states, o districts within states. This table gives the total solids an the hardness of the water typical of these regions, summarizing the results of the United States Geological Survey studies for a large number of years. These data ar not immediately available for publication, but informatio on particular districts can be secured from the Geologica Survey offices in Washington if immediately needed. Othe papers presented at this session were by Harry E. Jordon on "Specifications for Glassware for Water-Works Laboratories," and by Edward Bartow, describing "The New Sewage Station of the Illinois State Water Survey Division.

National Convention of Steam and Operating Engineers

Four hundred delegates, representing as many loca unions in the United States and Canada, attended the opening sessions of the Seventh Biennial Convention of the International Union of Steam and Operating Engineers a the Fort Pitt and William Penn Hotels, Pittsburgh, Pa during the week beginning Sept. 13. Owing to the fact tha another convention was scheduled at the Fort Pitt Hotel the sessions of Tuesday and Wednesday were held at th William Penn.

Addresses of welcome and reports of various committee were heard at the opening session. Among those wh addressed the delegates were the Mayor of Pittsburgh, E. V Babcock, who presented the "key" to the city to the engineers; County Commissioner A. C. Gumbert; W. K. Heck president of the Pittsburgh Central Union; and Harr Sadler, business manager of the Steam Engineers' Union a Pittsburgh. Milton Snelling, general president of the International Union, presided.

The afternoon session, during which the Hon. John Herron, president of the Pittsburgh City Council and the Hon William J. Brennen, laborers' attorney, were to deliver addresses, was postponed and merged into the Tuesday morning business session at the William Penn.

Routine business was transacted at the Tuesday sessions. The afternoon session was adjourned at 3:30 o'clock, and the delegates and their friends were taken on an automobile drive and sight-seeing trip to points of interest in Pittsburgh and vicinity in machines provided for that purpose by the entertainment committee.

During the Wednesday morning session convention business was discussed, and in the afternoon there was an excursion and sight-seeing trip down the Ohio River. Music and dancing became the order of the day, and refreshments were served. Convention business was forgotten and everyone had a jolly time.

On the afternoon of Thursday, Sept. 16, there was a theater party for the ladies at the Davis Theater, and in the evening the men enjoyed a stag entertainment at the Moose Temple.

Friday was given over to the closing of convention business and election of officers.

Federated American Engineering Societies Announce Meeting Program

The first meeting of the American Engineering Council of the Federated American Engineering Societies is scheduled to be held Nov. 18 to 20 in Washington, D. C. Headquarters will be at the New Willard Hotel. The program follows:

Thursday Morning Session—Registration; opening session of American Engineering Council; call to order, Richard L. Humphrey, chairman, Joint Conference Committee, consulting engineer, Philadelphia, Pa.; election of temporary chairman; election of temporary secretary; appointment of temporary committees including: program, credentials, constitution and By-Laws, nominations, plan and scope, budget, resolutions.

Thursday Afternoon Session—Address, "Engineering Council," J. Parke Channing, chairman, consulting engineer, New York City.; discussion of the field of activity for the Federated American Engineering Societies.

Friday Morning Session—Report of Committee on Nominations, election of permanent officers, report of Committee on Constitution and By-Laws, formal ratification of constitution and by-laws and report of Committee on Plan and Scope.

Friday Afternoon Session—Report of Committee on Budget and report of Committee on Resolutions.

Friday Evening Session—Introductory remarks by presiding officer, the president of American Engineering Council; address by Herbert C. Hoover, president, American Institute of Mining and Metallurgical Engineers, New York City.; informal reception and smoker.

Saturday Morning Session—Organization meeting of the executive board of the American Engineering Council, of the Federated American Engineering Societies.

French Coal Resources

France consumed before the war over 63,000,000 tons of coal annually, of which she produced, roughly, 42,000,000 tons, leaving 21,000,000 tons to be imported. By the terms of the peace treaty, France acquired control of the Saare Basin, containing coal deposits estimated at 12,500,000,000 tons. Actual production from these coal fields in 1913 was 17,000,000 tons. This new source of coal will take care of the additional demand on France from the industries of Alsace-Lorraine and will lessen the French normal shortage, but will not offset the loss of output in the damaged mines of the departments of Nord and of Pas de Calais.

To make reparation for the damage done to the mines and to other property, Germany was to deliver approximately 25,000,000 tons annually to France for ten years. As a matter of fact, up to May 31 last, France had received only 4,611,000 tons of coal from Germany. However, as a result of the Spa conference held in July France is to receive 1,600,000 tons monthly of the 2,000,000 tons to be delivered to the Allies, beginning Aug. 1. To obtain even these shipments France is obliged to pay Germany 200,000 000 francs monthly for six months for the feeding of the Ruhr workers. But France is doing more than patiently waiting for German coal. She is making every effort to hasten the work of reconstruction in the damaged mines in order to bring their production as soon as possible up to the pre-war figure of 26,000,000 tons. The result of these efforts is shown by the fact that the June output of coal in the two departments of Nord and of Pas de Calais increased 104 per cent and 75 per cent respectively over the previous month.

James Watt Memorial

The James Watt Executive Committee, of Birmingham, England, appointed at a centenary commemoration of James Watt held in England last fall, has collected a part of the £150,000 sterling which it is trying to raise for the purpose of establishing a memorial to perpetuate the name of James Watt. It is the intention to endow a professorship of engineering to be known as the James Watt chair, at the University of Birmingham, for the promotion of research in the principles underlying the production of power.

A memorial volume will be published, and a James Watt Memorial building will be erected to be used as a museum for examples of the work of Watt and his contemporaries, Boulton and Murdock. The building will also serve as a meeting place and library for scientific and technical societies.

Hearings on Boiler Code in California

At the public hearings on the tentative revised boiler safety orders for California, which have been held in San Francisco, objections have been raised by those interested in boiler operation to some of the revisions proposed by the committee appointed by the Industrial Accident Commission of California. A further hearing has been scheduled for October 7 in San Francisco, to continue where that of August 19 left off.

For new installations the commission is at present following the 1914 boiler code of the American Society of Mechanical Engineers, and it proposes to adopt that society's 1918 code to bring makers up to date.

The difficulty arises principally on the proposed code as applied to existing installations. Objections have been filed on the rules that shall apply to calculating the safe working pressure on staybolted surfaces (378,b) and on factors of safety for lap-riveted construction. It is objected that a factor of safety of 4½ should be set as a minimum and let it apply to a boiler regardless of its age, making it higher if conditions of the boiler called for it. Sec. 380,a, proposes from 4¼ to 5 for boilers ranging up to twenty years old, where lap-riveting is employed and the shells are exposed to the direct products of combustion. Where the shells are not so exposed, the commission proposes a factor of from 4 to 5 for the same range, and objectors have recommended the same figure of 4½.

A further factor of safety of 6 is objected to as too high in the case of second-hand stationary lap-seam boilers within the state on Oct. 1, 1920, where both ownership and location have changed (sec. 381,a). It is expected that other objections will be submitted at the Oct. 7 hearing.

The personnel of the boiler-revision committee is quite representative of the interests concerned with boiler operation, and takes its members from gas and electric-power stations, electric railways, machinery dealers' associations, lumber associations, insurance companies, oil companies, operating engineers' unions, the Industrial Accident Commission, iron works, merchants' and manufacturers' associations and a board of public works.

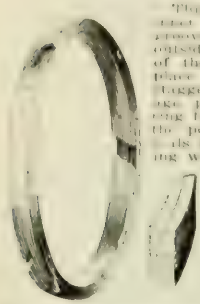
Unsuitable bearing materials and bearings which are not large enough to carry the loads brought upon them are often the cause of heating, and are all the more annoying because they do not readily suggest themselves as the root of the trouble.

Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Ring, Zelnicker "Ever Tyte" Piston

Ever Tight Piston Ring Co., 1620 Kingston Ave., St. Louis, Mo.
"Power," August 31, 1920



The ring is constructed with three parts. The steel or keeper ring, is the width of the ring groove of the piston and is grooved on the outside surface, which groove takes the flanges of the two outside rings. These are held in place by a dowel pin so that the joints are staggered, thus reducing the amount of leakage past the ring. The construction of the ring forms a right-angle interlock, which closes the point of contact between the member and seals all gaps and compressions thus preventing waste of power past the ring at any point.

This ring is designed for use in internal combustion engines, ammonia compressors and steam engines.

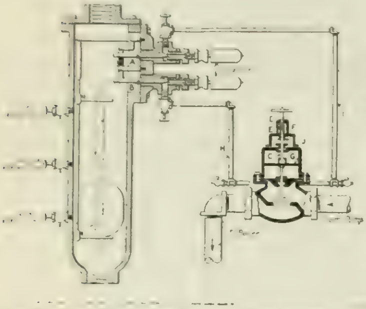
Pyrometer, Wedge Optical

Rohde Laboratory Supply Co., 17 Madison Ave., New York City.
"Power" 1920

This instrument consists of a brass tube, furnished with a small achromatic telescope, so arranged that the objective of the telescope focuses the image of the heated body on a movable prism placed inside the tube. The eye-piece of the telescope then reveals the magnified image on the prism to the observer. A suitable shield is provided to prevent exterior light reaching the the eye. At one side of the tube is a milled head, actuating a rack-and-pinion which moves the prism through the field of vision. The prism is made of dark glass arranged to cut off the light emitted by a heated body at different temperatures. For example, in looking at a heated bar of iron, as the thicker part of the prism comes gradually into the field of vision, the bar appears gradually a darker color, till at a given point the image entirely disappears; this point gives the actual temperature. On looking at the scale on the side of the instrument, the pointer will be seen at (say) 1,000 deg. C. A similar operation takes place in every estimation.

Controller, Kelly Automatic Feed Alarm

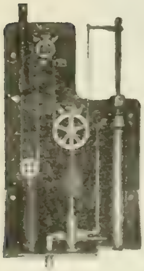
Kelly Controller Co., 175 West Jackson Boulevard, Chicago, Ill.
"Power," July 13, 1920.



This feed-water controller is designed for intermittent or continuous feed and is combined with a safety water column having high- and low-water alarm. It also acts as a pump governor. A float operates the alarms and indirectly controls the position of the feed-water valves. When the water rises to the high-water line, the float opens and comes in contact with a stop and opens a needle valve. A slot in the stem of another valve allows it to remain closed.

Combustion Control, Carrick Graduated

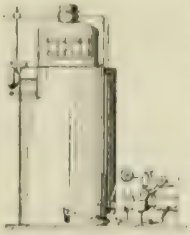
Carrick Engineering Co., Chicago.
"Power," May 11, 1920.



This device is designed to meet the requirements of automatic control so as to graduate over a predetermined range and to hold the damper in a floating position; that is, in a definite position or a definite set of conditions and move the damper to a new position for a change in any of the variables, such as flow of steam, feed-water supply or furnace condition, the coal feed and air supply being changed simultaneously. Owing to a graduated movement it takes and holds any intermediate position that is required for the load carried and moves to a new position if there is a slight change in the load or steam flow or in furnace condition. The system is designed to maintain the proper relation between fuel and air supplied by individual control on the stoker engines or motors.

Softener, International "Hot Flow"

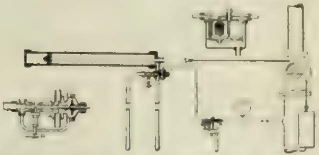
International Filter Co., Chicago, Ill.
"Power," June 22, 1920



This water softener is made with two chambers of equal holding capacity and an open-type exhaust-steam feed water heater which is placed on top of the softener. Water flows from the heater to a series of cast iron trays, and the entering exhaust steam after passing through an oil separator comes in contact with the finely divided water. Hydrated lime and soda ash is fed to the water from a chemical mixing tank and feeder. A float controlled by a change of water level in the float control moves a cutoff shield over the collector funnel in the chemical tank so that at any rate of operation the proper proportion of chemical mixture is admitted to the water. The softeners are made in capacity per hour ranging from 900 to 1,800 gallons. Special sizes capable of taking care of 10,000 boiler horsepower are built.

Regulator, Area Pressure and Temperature

American Galco, Inc., Grand Central Palace, New York City
"Power," July 27, 1920.

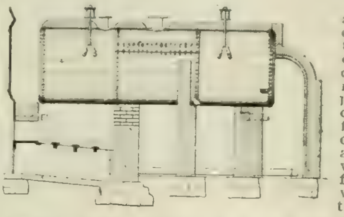


This regulator depends for its operation upon water under a reasonably constant pressure between 15 and 90 lb. It operates a globe valve of the usual type, by means of a sprocket and chain. The valve is opened in one direction by a piston sliding in a cylinder to which water is admitted by a piston valve. The valve is closed by a weight when the water is released from the cylinder. The operation depends upon a relay, which is extremely sensitive and produces close regulation regardless of the fluctuations on the high-pressure side or the variations and the demand of the steam on the low-pressure side.

If the pressure drops on the low-pressure side of the valve, a spring moves the arm and disc toward a nozzle which reduces the flow of the water from the nozzle and thus causes the pressure to build up under a diaphragm, thereby moving a valve piston and admitting water to the cylinder.

Furnace, Preheated Air

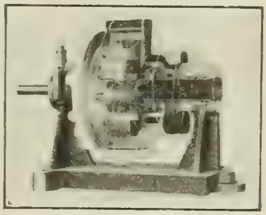
I. W. Foltz, Jackson Blvd., Chicago, Ill.
"Power," August 10, 1920.



Air is admitted to the ashpit as usual, and much of it passes up through the fuel bed. A portion of this air, 10 to 18 per cent, depending upon the resistance of the fuel bed, passes through an airtight channel embedded in the floor of the combustion chamber. The entrance is at the face of the bridge wall, if conditions are favorable, or in the side wall farther forward in the ashpit. The duct then comes out into the combustion chamber floor back of the bridge wall, passes to the rear of the setting, returns by way of the bridge wall into the side wall, and then passes forward and out over the fire near the front of the furnace. A duct of this character made up of firebrick or tile and high-temperature cement, is placed on either side of the furnace. The air is heated to 750 degrees.

Pump, Crescent Roto-Piston

Crescent Sales and Engineering Co., Detroit, Mich.
"Power," 1920.



The pump consists of two cylinders, one, the roto-piston, being inclosed in the other and touching it at only one point, as they are mounted on different axes. The inner one is revolved at the same angular speed as the outer by cranks connecting the two cylinder heads. The throw of the cranks allows the roto-piston to maintain contact with the outer case in an apparently eccentric motion, which is balanced. This crescent working chamber remains fixed in revolution; the cylinders roll past it and the vane moves with them, displacing the space, although the motion is rotary and continuous. It has a sliding area of a little over one inch on the outer case. The pumps weigh 150 lb., although guaranteed for ½ in. of the barometer or 15 or more pounds to the square inch.

New Publications

HANDBOOK FOR HEATING AND VENTILATING ENGINEERS. By J. D. Hoffman, M.E., Professor of Practical Mechanics, Perdue University. Published by McGraw-Hill Book Co., Inc., New York City. Fourth edition. 478 pages, 201 illustrations. Price $4.50.

In this handbook of heating and ventilating the author has compiled the essential data required by the student of heating and ventilating. The volume is in the main devoted to descriptions of the various systems of heating, etc. This matter, along with the computations given, should be of benefit to the engineer as well as the student.

ACCOUNTS IN THEORY AND PRACTICE. By Earl A. Saliers, assistant professor of accounting in the Sheffield Scientific School of Yale University. Published by the McGraw-Hill Book Co., Inc., 239 West 39th St., New York City. Cloth, 9 x 6 in.; 301 pages.

The purpose of this book is to afford a first course in the principles of accounts. An attempt has been made to work out an effective combination of theoretical discussion and practical application. The material is so arranged that, if desirable, the order of study may be varied and some parts may be omitted. For reference purposes a bibliography has been inserted at the end of each of the six parts of the book. To facilitate review work an appendix containing a series of questions on each chapter has been added. The six parts of the book consist of: Fundamental principles of accounting, partnership accounting, expansion of accounting records, corporation accounting, financial statements, and special application of principles.

Personals

C. O. Foss, St. John, N. B., Canada, has been appointed a member of the Hydroelectric Commission of New Brunswick.

Edmond S. Turner has joined the engineering department as estimator of the Pacific Power and Light Co., Portland, Ore.

Cloyd M. Chapman has severed his connection with Dwight P. Robinson & Co., Inc., and opened an office at 171 Madison Ave., New York City, as a consulting engineer.

Dr. Arthur M. Buswell has been appointed chief of the Illinois State Water Survey, Urbana, succeeding Dr. Edward Bartow. Dr. Bartow has left this work to become head of the Chemistry Department at the Univerisity of Iowa, Iowa City. Dr. Buswell comes to this work from Columbia University, where he has been engaged in teaching and investigational work in the Department of Sanitary Engineering.

Society Affairs

A Chicago Section of the American Welding Society was organized at a meeting of members of the welding trade in Chicago on Aug. 3. The secretary-treasurer of the new section is L. B. Mackenzie, 608 South Dearborn St.

The Ninth Annual Safety Congress of the National Safety Council will be held at Milwaukee, Wis., Sept. 27. to Oct. 1. The meetings and exhibit will be held at the Milwaukee Auditorium, and the convention headquarters will be at the Hotel Wisconsin.

The American Institute of Electrical Engineers will meet in Chicago on Nov. 12, under the auspices of the Protective Devices Committee. D. W. Roper, chairman of the committee, will read a paper on "Lightning Protection."

The Michigan Section of the National Electric Light Association, selected at the recent annual convention at Ottawa Beach the following members to the executive committee: W. M. Lewis, Muskegon; H. A. Fee, Adrian; S. B. Tuell, Houghton; R. E. Keller, Kalamazoo; and B. E. Waltz, Ludington.

The American Institute of Electrical Engineers will hold its first regular fall meeting in Philadelphia, Oct. 8. Two papers will be presented, as follows: "Economic Study of Secondary Distribution," by P. O. Reyneau and H. P. Seelye, Detroit Edison Co.; and "Electrical Demand Measurements," by P. A. Borden, Ontario Power Commission.

The American Electric Railway Association will hold its thirty-ninth annual convention at Atlantic City, Oct. 11 to 15. "Problems of Fuel Supply" will be the subject of an address by Eugene McAuliffe, president of the Union Colliery Co., St. Louis, and formerly manager of the Fuel Conservation Section of the United States Railroad Administration.

A Committee on Hydraulic Research has been appointed by Engineering Foundation. This committee will endeavor to formulate problems to which it may be possible for Engineering Foundation to devote some of its efforts. It will also collect information about existing hydraulic laboratories and other places in which hydraulic experiments can be conducted. J. Waldo Smith and S. H. Woodard have consented to serve as the committee.

The American Association of Engineers in efforts to make its employment service more intensive locally and supplementary to its national service, has appointed local employment representatives throughout the country. The eight paid secretaries of the associations in New York, Washington, Pittsburgh, Detroit, Minneapolis and St. Paul, Chicago and Seattle are handling placement services in the territories under their jurisdiction. In addition, 40 of the 150-odd chapters are giving local employment service in conjunction with the service department activities in the national headquarters at Chicago. As a means of determining how such free employment agencies can best serve employers of engineers and engineers themselves, the American Association of Engineers is sponsoring a national convention of free employment representatives to be held in Chicago on Nov. 12. All engineering societies and other agencies maintaining free employment service will be invited to attend this convention and contribute to the discussion expected.

Miscellaneous News

The Dunwoody Institute, Minneapolis, Minn., will conduct a course in boiler-room operation beginning on the evening of Oct. 5. The course, which will cost $6, will consists of 50 lessons, two to be given each week.

The Bureau of Mines is co-operating with the Emergency Fleet Corporation in tests of the Scottish marine boilers. The tests are being conducted at Chester, Pa. One of the objects of this work is to try and obtain results that will be comparable with tests run on the Emergency Fleet Corporation's design of water-cooled boilers.

Business Items

The Mono Corporation of America announces the removal of its main office from Buffalo to 25 West Broadway, New York City, where its complete line of automatic continuously recording gas-analyzing instruments will be displayed.

Trade Catalogs

The Page Boiler Co., of Chicago is issuing a 6-page pamphlet mentioning the possibilities of utilizing waste heat and bringing out the distinctive features of the Page boiler. It contains photographic reproductions of the boiler and of typical waste-heat installations.

The Royal Manufacturing Co., Rahway, N. J., manufacturer of cotton and wool waste, has ready for distribution a 25-page catalog describing the various operations involved in the manufacture of this product. The text is illustrated by photographs. A copy may be obtained upon application.

The Yarnall-Waring Co., Chestnut Hill, Philadelphia, has ready for distribution a new 16-page booklet entitled, "Yarway Blowoff Valves." The text describes the seatless valves manufactured by this company. Illustrations and line drawings are also given. A copy will be sent to anyone interested on request.

New Construction

PROPOSED WORK

Me., Baugot—The Keyes Fibre Co., Waterville, plans to build a 40 ton capacity mill here, electrically operated for grinding wood pulp.

Mass., Cambridge—J. R. Worcester & Co., Archt. and Engr., 79 Milk St., Boston, will soon award the contract for a 1 story, 70 x 400 ft. printing plant addition including a steam heating system on First St., for Ginn & Co., 15 Ashburton Pl., Boston. About $250,000.

Conn., Cromwell—William Suda is in the market for 20 or 30 hp. boiler and engine (used preferred).

Conn., Middletown—The New England Enameling Co., River Rd., plans to build a 1 story power house addition. Westcott & Mapes, Inc., 207 Orange St., Archt. and Engr.

Conn., Waterbury—The Lux Clock Mfg. Co., 105 Sperry St., will soon award the contract for a 4 story, 25 x 105 ft. manufacturing building including a steam heating system on Sperry St. About $50,000.

N. Y., Buffalo—The R. E. Dougan Co., 66 Oak St., is in the market for ½ or ¾ hp. d.c. motor

N. Y., Buffalo—The Phoenix Beverage Co., 835 Washington St., is in the market for 2 boilers, coal crusher, elevator and conveyor for power house.

N. Y., Jamestown—The city received bids for the installation of heating and plumbing equipment in the Falconer St. School, from James Bresnahan, $24,990; Chatfield & Sharpe, $20,249.

N. Y., Long Island City—The Allied Printing Association of Manhattan, c/o William E. Austin, Archt. and Engr. 46 West 24th St., New York City, is having plans prepared for a 9 story, 80 x 400 ft. printing plant including a steam heating system on Jackson Ave. near Harold St.

N. Y., New York—The Bd. of Welfare received bids for installing a low pressure steam heating system in pavilions B and D, Blackwell's Island, from Collins & Horan, $5,914; Chute, Thornton, Bailey, 2 East 13th St., $5,970; P. J. Larkin & Co., 331 East 55th St., $6,944.

N. Y., Portchester—William H. McElfatrick, Archt. and Engr., 701 7th Ave., will receive bids until Sept. 25 for a theatre including a steam heating system for Ponty & Wein. About $350,000.

N. Y., Rochester—Otto Han, 321 Champlain St., is in the market for a 2 to 3 hp. a.c. motor.

N. Y., Rochester—Tatlock Bros., 183 Tremont St., is in the market for one 50 hp. marine type boiler and 1 closed heater.

N. Y., Yonkers—The Hudson Tire & Rubber Co. is having plans prepared for a 3 story factory and power plant. About $300,000. The Osborn Eng. Co., 2848 Prospect Ave., Archt. and Engr.

N. J., Bayonne—The Tidewater Oil Co., Constable Hook, plans to build a 147 x 150 boiler and pump house. About $86,000.

N. J., Glassboro—The State rejected all bids for the installation of a heating system in the proposed 3 story 125 x 301 ft. school. Noted Aug. 31.

N. J., Hightstown—The Borough will soon award the contract for building and equipping proposed waterworks pumping station. About $70,000. W. S. Coulter, 111 Liberty St., New York City, Engr.

Pa., Philadelphia—The Benjamin Franklin Hotel, c/o Frederick Weber, Archt., Morris Bldg., is having plans prepared for a 16 story, 191 x [illegible] ft. hotel including a steam heating system on 9th and Chestnut Sts.

Md., Baltimore—Samuel T. Williams, 123 North Calvert St., is in the market for two 300 to 400 kw. 2,300 volt, 3 phase, 60 cycle generating units, preferably turbine, water tube boilers, condensers, pumps, etc.

D. C., Washington—The United States Engineer's office is preparing plans for pumping facilities consisting of electrically driven pumps, etc., for the Key Bridge here. About $100,000.

Va., Norfolk—The Office of the City Mgr. will soon award the contract for a dam, pumphouse and road diversions.

Va., Petersburg—James Posey, Consult. Mechanical Engr., Fidelity Bldg., Baltimore, is preparing plans for a central heating plant consisting of boilers, smoke tank, stokers, etc., to all buildings for the Virginia Normal and Industrial Institute. About $100,000.

Va., Richmond—The Richmond Auto Shop, 13 North 18th St., is in the market for motors, etc. J. B. Cullingworth, Purch. Agt.

O., Cleveland—The Belmore Co., c/o M. B. Sharfeld, 206 Society for Savings Buildings, plans to build a 20 story, 99 x 300 ft. commercial and office building including a steam heating system on Superior Ave. between East 6th and East 9th Sts. About $5,000,000.

O., Cleveland—S. Bohm, Archt. and Engr., Williamson Bldg., will soon award the contract for a 1 story, 30 x 50 ft. boiler room including two 225 hp. boilers on West 49th St. and Lorain Ave. for the Jacob Laub Baking Co., 4919 Lorain Ave. About $25,000.

O., Cleveland—The Lillian Realty Co., c/o W. B. Cohen and Albert Koblitz, The Arcade, has purchased a site on East 17th St. north of Euclid Ave. and plans to construct an 8 story, 40 x 120 ft. commercial building including a steam heating system on same. About $350,000.

O., Springfield—The Bd. Educ. will soon award the contract for a 3 story, 119 x 138 ft. grade and high school including a steam heating system on B'way. About $300,000. O. D. Howard, 8 East Broad St., Columbus, Archt.

Ind., Indianapolis—The Bd. of School Comrs., Meriden and Ohio Sts., will receive bids until October 1 for heating, ventilating, plumbing and gas fitting, power house installation, boilers, etc., in buildings at the Arsenal Technical Schools. Noted June 15.

Mich., Detroit—The Detroit Public Health Dept., City Service Bldg., plans to build a 3 story hospital including a steam heating system on Taylor Ave. About $3,000,000. A. Kahn, Marquette Bldg., Archt.

Mich., Detroit—Horace H. Lane, Engr., Dime Bank Bldg., will soon award the contract for a 3 story, 128 x 150 ft. warehouse including a steam heating boiler, etc., on Dequindre St., for the Western Electric Co., c/o F. J. Whitney, Kirby Ave. and Dequindre St.

Mich., Monroe—Reed M. Dunbar, Archt., will soon award the contract for a 1 story, 90 x 210 ft. foundry including electric motors for power, for the Monroe Auto Equipment Co., East First St. About $100,000.

Wis., Beaver Dam—The Wisconsin Power Light & Heat Co. plans to build a 60 x 150 ft. power house on Main St. Huttel Constr. Co., 128 Western Ave., Fond du Lac, Engrs.

Wis., Fond du Lac—The City is having plans prepared for a tuberculosis sanatorium near here. Plans include a separate power plant. About $300,000. J. E. Hentot, Archt.

Wis., Jefferson—Dan Rees is in the market for artificial ice making machinery.

Wis., West Bend—The Schmidt & Storck Wagon Co. is having plans prepared for a 1 story, 100 x 250 ft. wagon factory including a boiler and power house, etc., on Main St. About $70,000. Bremming & Guth, 521 Jackson St., Milwaukee, Archts.

Ia., Newmarket—The City Clerk will soon receive bids for a deep well pump and pump house, etc. About $36,000. E. T. Archer, Kansas City, Mo., Engr.

Minn., Faribault—The State Bd. of Control, Capitol, St. Paul, received bids for two building additions at the State school including a steam heating system from Edward Bjorklund, 786 Como Blvd., St. Paul, $86,507; H. J. Frandsen, 510 Rice St., St. Paul, $92,000; R. C. Elvin & Co., 852 Plymouth Bldg., Minneapolis, $95,890.

Tex., Ballinger—C. S. Guin plans to build an ice factory. A steam engine and boiler will be installed in same. About $50,000.

Tex., Crockett—The Crockett Brick & Tile Co. is in the market for a 60 hp. boiler and a 50 hp. steam engine. H. A. Fisher, Pres.

Tex., Dallas—The Pure Ice & Cold Storage Co., Manila and Harwood Sts., plans to build an addition to ice factory including equipment for same. About $20,000.

Tex., Dallas—The Rick Warehouse & Stores Co. will receive bids about November 15 for a 10 story, 178 x 321 ft. exposition building including a steam heating system and individual power plant at 2600 Elm St. About $1,000,000. A. C. Rick, Pres.

Tex., Dallas—The School Bd. will receive bids until November 15 for a 3 story high school including a steam heating system on Haskell and McKinney Sts. About $600,000. C. M. Moore, Secy. W. B. Ittner, St. Louis, Mo., Archt.

Tex., Italy—The Watson Gin Co. will soon award the contract for a cotton gin plant including several buildings. A steam boiler, engine etc. will be installed in same. About $30,000.

Tex., San Benito—The San Benito Electric Light & Power Co. plans to build an electric light plant.

Col., Fleming—The Bd. of Trustees will soon receive bids for the construction of a power plant for water and light service. About $50,000.

N. B., Fredericton—The New Brunswick Electric Power Comn. plans to construct earth dams in connection with the development of the power projects at Shogomoc and Musquash. Henry Holgate, 285 Beaver Hall Hill, Montreal, Engr.

Ont., East Sandwich—The city plans an election to vote on $200,000 bonds to construct an intercepting sewer, pumping station and sewage disposal plant. Centrifugal motor driven pumps will be installed in same. Morris Knowles Ltd., Heintzman Bldg., Windsor, Engr.

CONTRACTS AWARDED

Mass., Boston—The Massachusetts Bonding & Insurance Co., 77 State St., has awarded the contract for an 8 story, 90 x 125 ft. office building including a steam heating system on Arlington St., to L. P. Soule & Sons Co., 80 Boylston St., at $500,000.

Mass., Fall River—The Amer. Printing Co., 56 Water St., will build a 1 story, 100 x 119 ft. factory and a 1 story, 44 x 132 ft. power plant on Water St. About $165,000. Work will be done by day labor.

N. H., Manchester—The Bd. Educ. has awarded the contract for the installation of a steam heating system in the Franklin St. school to the Stone Underhill Co., at $57,024, in the West Side high school to P. A. Dolan, 237 B'way, Boston, at $89,998, and in the Practical Arts high school to John H. Stevens, at $139,017. Noted Aug. 17.

N. Y., Buffalo—The Buffalo General Electric Co., Electric Bldg., will build an electric distributing station. About $7,500. Work will be done by day labor.

N. Y., Buffalo—The city will build a 1 story, 26 x 40 ft. addition to power plant at 835 Washington St. About $15,000. Work will be done by day labor.

N. Y., Buffalo—The Rome Wire Co., Clyde Ave., will build a 1 story, 50 x 80 ft. power house. About $15,000. Work will be done by day labor.

N. Y., New York—The Bronx Society for Prevention of Cruelty to Children, 355 East 137th St., has awarded the contract for a 7 story, 96 x [illegible] ft. home including a steam heating system on Park Ave. and 16th St., to Niewenhons Bros., 316 East 161st St. About $350,000.

N. Y., New York—The Standard Oil Co. of New York, 26 B'way, has awarded the contract for the 5 story extension to office and a 12 story addition at 18 B'way, to C. T. Mills, 286 5th Ave.

N. J., Bridgeton—The Illinois Glass Co. has awarded the contract for a group of buildings, including a 3 story, 330 x 700 ft. main plant, 2 units, 50 x 150 ft. producer building and a 2 story, 50 x 100 ft. engine and boiler room on North Laurel St., to the Keeley Bros. Constr. Co., 507 Federal St., Camden, at $3,000,000.

N. J., Trenton—The Cook Linoleum Co., East State St., has awarded the contract for a 1 story, 72 x 140 ft. boiler house, to the J. H. Morris Co., Broad St. Bank Bldg., at $100,000. Four boilers, etc., will be installed in same.

N. J., Hoboken—The Bd. Educ. has awarded the contract for installing a heating and ventilating system in the proposed school 2, to J. A. Cooney, at $112,494.

Pa., Marcus Hook—The Viscose Co. has awarded the contract for a 3 story, 60 x 110 ft. boiler house, to H. L. Morris, Chester. Noted April 20.

Pa., Philadelphia—The Pennsylvania R. R., Broad and Market Sts., has awarded the contract for a 1 story, 320 x 32 ft. sub-station on 30th and South Sts., to Fred A. Havens, 845 North 19th St., at $38,000.

Ill., Chicago—The Lawrence Ice Cream Co., West 21st St., has awarded the contract for a 2 story, 219 x 250 ft. ice cream factory including a boiler room, to E. F. Weigel, 1624 West 63rd St.

O., Cleveland—The Variety Iron & Steel Co., East 40th St. and Hamilton Ave., has awarded the contract for a 1 story, 21 x 77 ft. power house, to the Hunkin-Conkey Constr. Co., Century Bldg., at $10,000.

Pa., Philadelphia—The Ferguson Carpet Co., Rockland and Stenton Sts., has awarded the contract for a 1 story, 40 x 74 ft. power house including equipment, to Fred A. Havens & Co., 845 North 19th St.

Tex., Corsicana—The Central Texas Grocery Co. will build a cold storage plant. About $20,000.

Ont., Toronto—The J. A. Harrison Coal Co., Ltd., 57 Brock Ave., has awarded the contract for a coal elevating and storage plant to J. B. Nicholson & Co., 36 Toronto St., at $35,000. Electrically operated elevating machinery will be installed.

Ont., Ottawa—The Famous Players Film Co., Temple Bldg., has awarded the contract for a 1 and 2 story motion picture theatre including a vacuum steam heating and mechanical ventilation system to the Atlas Constr. Co., Ltd., 37 Belmont St., Montreal. About $350,000.

See Pages 96 to 112 **Need Competent Help?** See Pages 96 to 112

POWER

Volume 52 New York, September 28, 1920 *Number* 13

Everybody Works but ——?

THE almost universal shorter day resulting from reconstruction conditions finds the country no more depressed than when the hours of labor were reduced from sixteen to twelve and from twelve to ten per day.

Production per employee may have decreased but there are more people engaged in useful occupations and more labor saving methods. Hence, in the aggregate there is greater production per capita of population, notwithstanding scattered interruptions in certain industries which people are often too quick to regard as an index of general conditions.

Are the calamity howlers contributing their share of material production, or are they spending their time reading each other's essays?

Springdale Power Station, West Penn Power Company

By G. G. Bell

Manager Power Generating Department

The generating equipment consists of two 25,000-kva. turbo-generators. Eight double-end stokered boilers are arranged in two rows, each equipped with 13-retort stokers. Boilers are designed for 350-lb. pressure and will be operated at a maximum of 250 to 300 per cent. Coal is delivered directly from the company's mine to the bunker in the boiler house after passing through a tipple where it is screened, picked and crushed. Fans are driven by alternating-current brush-shifting motors with direct-current characteristics. Ashes fall into tank filled with water from which they are removed by a crane-operated bucket. Condensing circulating water arranged for recirculating during winter months to prevent ice formation. By the adoption of a 2,500-kw., house turbine, 19 auxiliary turbines and 14 reduction gears have been eliminated.

THE West Penn Power Co. serves seven counties in the southwest part of Pennsylvania. The territory served is about one hundred miles long and has an extreme width of ninety miles. This territory centers around Pittsburgh, which, together with the greater part of Allegheny and all of Beaver County, is served by the Duquesne Light Co. The West Penn also serves the Panhandle district of West Virginia from a point about ten miles north of the city of Wheeling. The territory served includes the great coal-producing fields of western Pennsylvania, and the power company's largest customers are the coal companies. There are about four hundred mines connected, one company having 33 mines and a monthly consumption of 2,800,000 kilowatt-hours. Next in importance to the coal mines are the steel mills, particularly the steel furnaces. There are 70 furnaces, ranging in capacity from very small to those of ten-ton capacity having a gross demand of 25,000 to 30,000 kilowatts.

The company has grown out of the amalgamation of fifty-seven companies serving individual small groups of communities. At the present time the company is operating nine steam, two water-power and two gas-engine stations. With the exception of two these stations are small and inefficient and will be shut down as soon as the capacity is available to take care of the load. The main source of power is the Connellsville power station, which is 60,000-kw. maximum capacity and is located in the center of the Connellsville coke region. The construction of this plant began in 1902. Three 1,000-kw. vertical engines, 25 cycle, were installed at that time and seven turbines ranging in size from 1,000 to two units of 18,000 kw. capacity have since been installed. In addition to these the West Penn Power Co. also runs 30,000 kw. of the capacity of the Windsor station. This is a modern station, having four 30,000-kw. units and sixteen boilers. The original installation was described in the Feb. 12 and Feb. 26, 1918, issues of *Power*. The two major sources of power at present are located in the southeastern and western sections of the company's territory.

The outstanding feature of the policy of the West Penn Power Co. is its acquisition and operation of coal fields in connection with its power houses. The owners of the Windsor power houses have 11,000 acres of Pittsburgh coal, having an average workable height of 58 in., or a total of about 60,000,000 tons. This is sufficient to last the plant for one hundred years at its present rate of consumption, or, as the plant is laid out for an ultimate capacity of 250,000 kw., the life of the coal field will be between fifty and sixty years.

For a long time the growth in the Allegheny Valley district has been hindered by lack of proper power-generating facilities. In 1917 two 25,000-kw. units were contracted for; but on account of war financing conditions, the construction of the power house was held up until the fall of 1918, when a contract was closed with the United States Government for the erection of these two units on the basis that the Government would advance 40 per cent of the cost of the power house and of a few main transmission lines which were necessary to tie the power house into the present 27,000-volt transmission system, the total cost of which was then estimated to be $6,000,000. The contract called for a valuation three years after the close of the war as declared by proclamation of the President, and required the return to the Government of the difference betwen the 60 per cent invested by the company and the appraised value of the plant at that time.

The company had previously secured a power-house site near Freeport and had options on a large acreage of the thin coal in that district. However, on the advice of its consulting engineer, S. A. Taylor, negotiations were entered into with the Y. & O. Coal Co. for the purchase of its block of 3,734 acres of twin-vein Freeport coal close to the town of New Kensington. This coal has an average thickness through the field of 7 ft. 5 in. as against 42 in. in the upper field; and the company was advised that the difference in the cost of mining would more than offset the increased capital cost of the thicker-vein coal. On approaching the owners of the tract of coal, it was found impossible to purchase the coal, so a lease of the coal acreage was concluded, calling for an initial rate of mining of 200,000 tons per year, to increase in twelve years to 750,000 tons, which minimum is to continue until the field is exhausted. This will provide in excess of 50 years' coal supply for a power house of 150,000 to 200,000 kw. capacity. Fig. 1 shows a general plan of the Springdale power plant and mine section.

The company was fortunate in securing one of the last large tracts of land available for manufacturing purposes on the Allegheny River. The tract was of 83 acres and was covered with about seventeen feet of silt, below which is about 50 feet of gravel overlying the rock formation. In addition, the ground is low-lying, according considerable ash storage. The site is served by the Conemaugh Division of the Pennsylvania R.R. and by the Allegheny Valley Street Railway Co., an affiliated company of the power company, which provides street-car service up and down the river from this point. The site is within two miles of New Kensington.

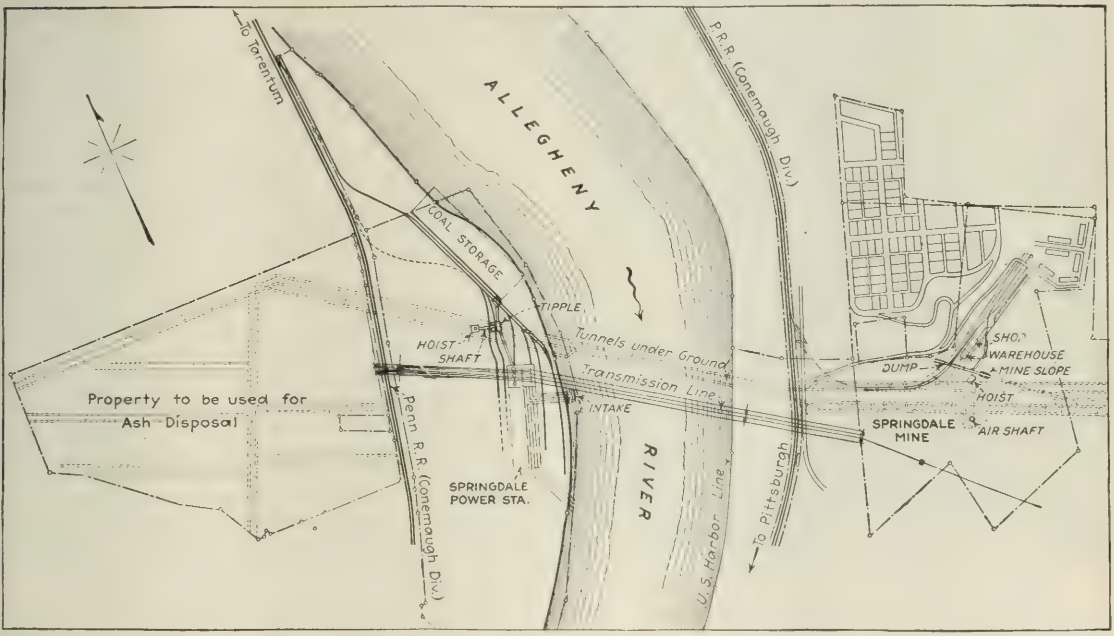


FIG. 1. GENERAL PLAN OF SPRINGDALE PLANT SITE AND MINE LOCATION

The drainage area of the Allegheny River at this point is about 11,500 square miles. The minimum flow is about 900 cu.ft. per sec., which, without recirculation, should be good for a plant of 250,000 or 300,000 kw. capacity. At this point the Allegheny River has a maximum rise of about thirty-two feet. The turbine-room floors are 7 ft. above the highest flood on record. By increasing the height of the light wells an additional three feet protection can be obtained.

Fig. 1 shows the relation of the mine to the power house, the tunnels and present mine development being in dotted lines. The coal is 90 ft. below the river, and tunnels are being driven in and below the coal to transport the coal from the mine to the power house. A typical section of the Freeport coal has a total height of 7 ft. 5 in. About 4 ft. 6 in. from the bottom occurs a 10 in. band of a high-ash coal. Analysis of this coal shows about 10,000 B.t.u. and about 30 to 35 per cent cent ash. The fusing point of the average including the high-ash band the B.t.u. would be reduced to 13,250, but the average fusing point of the ash would be increased about 30 deg. and the percentage of ash in the coal would be increased to 12.2 per cent.

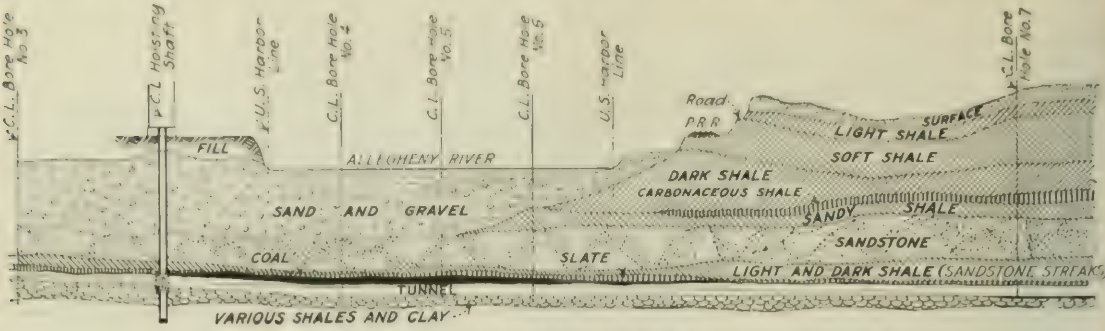


FIG. 2. PROFILE SHOWING STRATA ABOVE PROPOSED RIVER TUNNELS

ash in the coal is 2,500 deg. F., and that of the ash in the bone coal alone is about 2,600 deg. F. The coal is covered by a carbonaceous slate, having a heating value of about 8,000 B.t.u. This is left up as a roof.

A typical analysis of the coal excluding the 10 in. of high-ash coal is as follows: Moisture, 91 per cent; volatile matter, 33.35 per cent; fixed carbon, 56.06 per cent; ash, 9.68 per cent; total, 100 per cent. Sulphur, 0.79 per cent; phosphorus, 0.036 per cent; B.t.u. dry basis, determined by bomb calorimeter, 13,866.

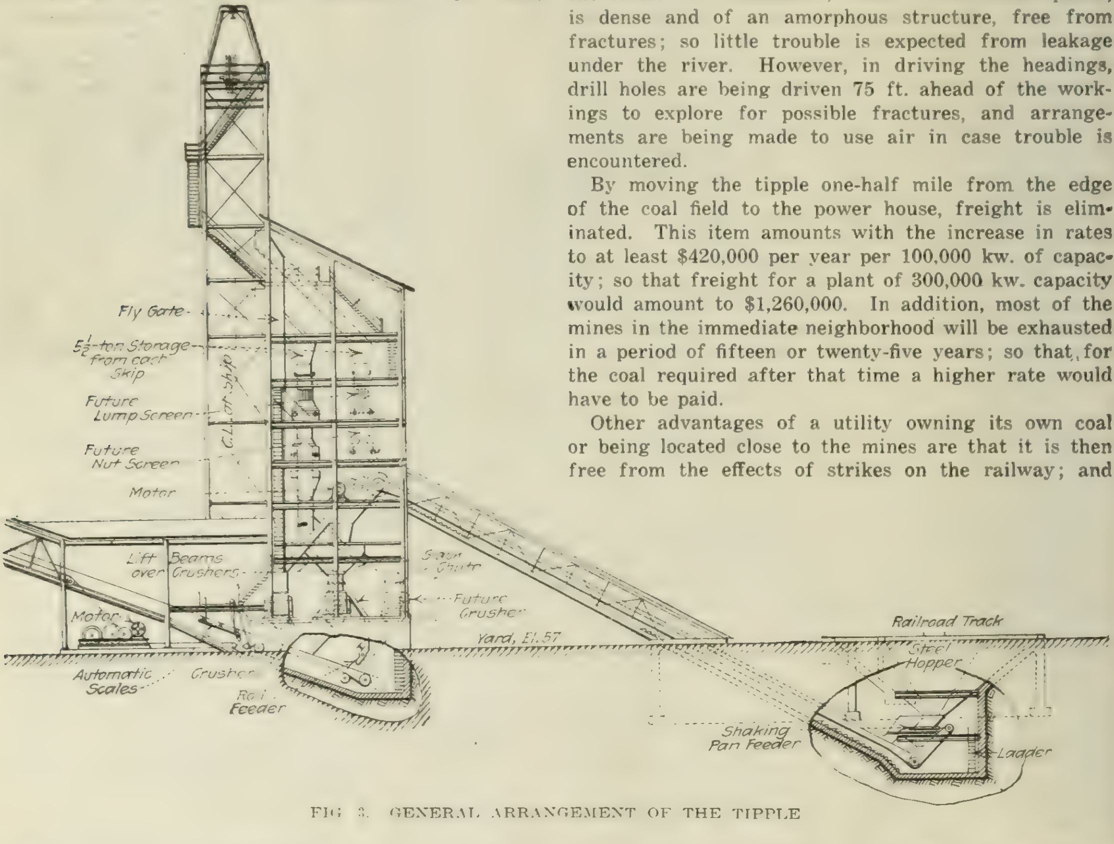


FIG. 3. GENERAL ARRANGEMENT OF THE TIPPLE

Above the carbonaceous slate is a bed of sandstone, about 25 ft. thick, above which is a thick bed of gravel. Extensive drillings have been made in the river. These are plotted on the diagram shown by Fig. 2 and show that the thickness of coal and cover are uniform, with the exception of a thinning of the coal in the middle of the river. The sandstone, where it has been opened, is dense and of an amorphous structure, free from fractures; so little trouble is expected from leakage under the river. However, in driving the headings, drill holes are being driven 75 ft. ahead of the workings to explore for possible fractures, and arrangements are being made to use air in case trouble is encountered.

By moving the tipple one-half mile from the edge of the coal field to the power house, freight is eliminated. This item amounts with the increase in rates to at least $420,000 per year per 100,000 kw. of capacity; so that freight for a plant of 300,000 kw. capacity would amount to $1,260,000. In addition, most of the mines in the immediate neighborhood will be exhausted in a period of fifteen or twenty-five years; so that, for the coal required after that time a higher rate would have to be paid.

Other advantages of a utility owning its own coal or being located close to the mines are that it is then free from the effects of strikes on the railway; and that the coal is delivered at a more or less uniform price, which is an important matter, as it is difficult for a utility to change its rates with increasing costs and particularly with a fluctuating coal market.

The most economical results in operation demand that the firemen be supplied continuously with the same type of coal, preferably of a high grade, as stoker adjustments depend upon experiment and experience, and it takes considerable time to make these adjustments. The coal received from the mine at Springdale will be of a constant grade and of a superior quality.

THICK- VERSUS THIN-VEIN COAL

During the war the Government placed a differential of 60 cents a ton in favor of coal mined in the thin-vein district, with a price of $2.95 for this coal instead of $2.35 as for the thick-vein coal.

Another matter affecting the selection of the thick-vein site over that in the thin vein was the matter of mine-car capacity. Car capacities in the thin vein are small; probably 1¼ to 1½ ton capacity would be an average-sized car which could be used in the 42-in. vein. This would mean that, including 10 per cent for rock, 2,400 cars would have to be handled each day, or 400 an hour, which would mean a 30-car trip arriving at the shaft bottom every 4½ minutes. This requires a very high state of organization and would probably mean a double opening.

The power-house tract includes 80 acres of level land having an average elevation of about 5 feet above the pool level, or 20 ft. under the yard level. A yard level of from 4 to 6 ft. above high-water mark is being established. This should furnish sufficient ash and rock disposal to burn at least 10,000,000 tons of coal. There is a ravine back of the power house, which can be filled to a depth of 200 ft. and will furnish sufficient additional refuse storage to take care of the entire field of coal.

The privilege of dumping ashes on the tracts of ground in the neighborhood of the plant is bringing as much as 15 cents a ton at the present time. The railways have charged 80 cents a ton on the old rate schedules for disposing of refuse, so the ash-disposal privileges controlled by the company are valuable.

On the general ground plan is shown a yard about 250 ft. in width extending between the railway track system and the river. This tract is from 1,000 to 1,500 ft. long and will provide the coal storage for the plant. It is intended ultimately to place a coal-handling bridge over this yard, the bridge being so designed that coal can be loaded from railway cars or from the river into storage and from storage to a belt conveyor handling the coal to railway track hopper. The practice of the West Penn Power Co. is to store sixty days' requirements. The initial storage will be 50,000 tons and ultimately four to five times this amount.

The sources of coal supply for the power station are: First, the mine, which is laid out for a capacity of 3,000 tons a day; second, the railway, for which a double-track hopper is provided on which a rotary dump for railroad cars can be placed if advisable; third, from storage; and fourth, river coal.

MINE EQUIPMENT—ARRANGEMENTS FOR CLEANING COAL

Mine cars will have an average capacity of from three to four tons, and will be of the solid-end type. Two will be placed at a time in an electrically operated rotary dump, the coal being dumped into an upper and a lower chute from which, by opening a double gate, it is discharged into a double-pocket Lepley-type skip, one pocket being above the other. There are two tandem skips, the empty partly balancing the loaded one. When the skips are raised to the top of the tipple, the two pockets in the skip each discharge on separate picking tables. The coal is then separated by a screen, the lump passing over an upper picking table, the coal under 4 in. passing over the lower table, the slack being placed in the center and the nut lumps on the side, permitting of further picking if advisable. The coal is then discharged from the double table into a common weigh basket, the coal to be crushed being placed in one pocket and the slack in a separate pocket. From the weigh pan the coal can be delivered either to the power house or to railway cars, the tipple being so arranged that either run-of-mine, lump or slack can be loaded out, the remainder of the coal being delivered to the power house. At the present time only one picking table is installed, so the initial capacity of the coal-handling apparatus will be 250 tons an hour. Fig. 3 shows the general arrangement of the tipple.

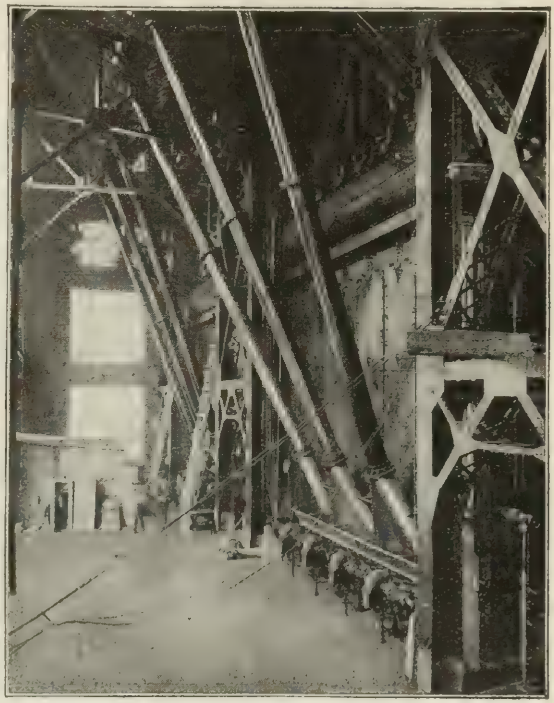


FIG. 1. PARTIAL VIEW OF BOILER ROOM

The lump coal to the power house passes through three crushers, any two of which have sufficient capacity to handle the output of the mine. The coal is elevated to the power house by means of a 42 in. belt having an ultimate capacity of 500 tons per hour, the slack being fed to the belt first and the crushed coal dropped on top of it, thus reducing the wear on the belt.

Coal received by railroad or from storage is dumped into a double-track hopper 32 x 40 ft., the coal being fed on to a pan conveyor having a capacity of 500 tons an hour and delivered to any of the three crushers.

Where it is desired to handle river coal directly to the power house, it will be unloaded by a coal bridge directly into this track hopper, and from there through the crushers to the power house.

At the top end of the belt elevator the coal is either discharged directly into the large center bunker of the power house or fed to either of two conveyors running along the end of the power house, which deliver the coal in turn to the belts over the side bunkers. These latter five belts have a capacity of 250 tons an hour each.

The bunkers are of the suspension type, lined with concrete. Their capacity is about 800 tons per boiler, or about five days' supply for the plant when running under ordinary conditions. By reducing the load factor on the plant and conserving coal in the bunkers, the plant could probably run ten days on its bunker coal. At the end of the 42-in. inclined conveyor is a sampler crusher, which takes a continuous sample of the coal being delivered to the power house and crushes it, retaining it for analysis if desired.

The coal to the power house is measured as received from the miner, or on a weightometer on the 42-in. inclined belt. Coal to the individual boilers is measured by stoker counters. While not so accurate as the individual weighing devices, it is much simpler and less expensive to maintain. The bunkers will be screened off from the boiler room to reduce noise and dust.

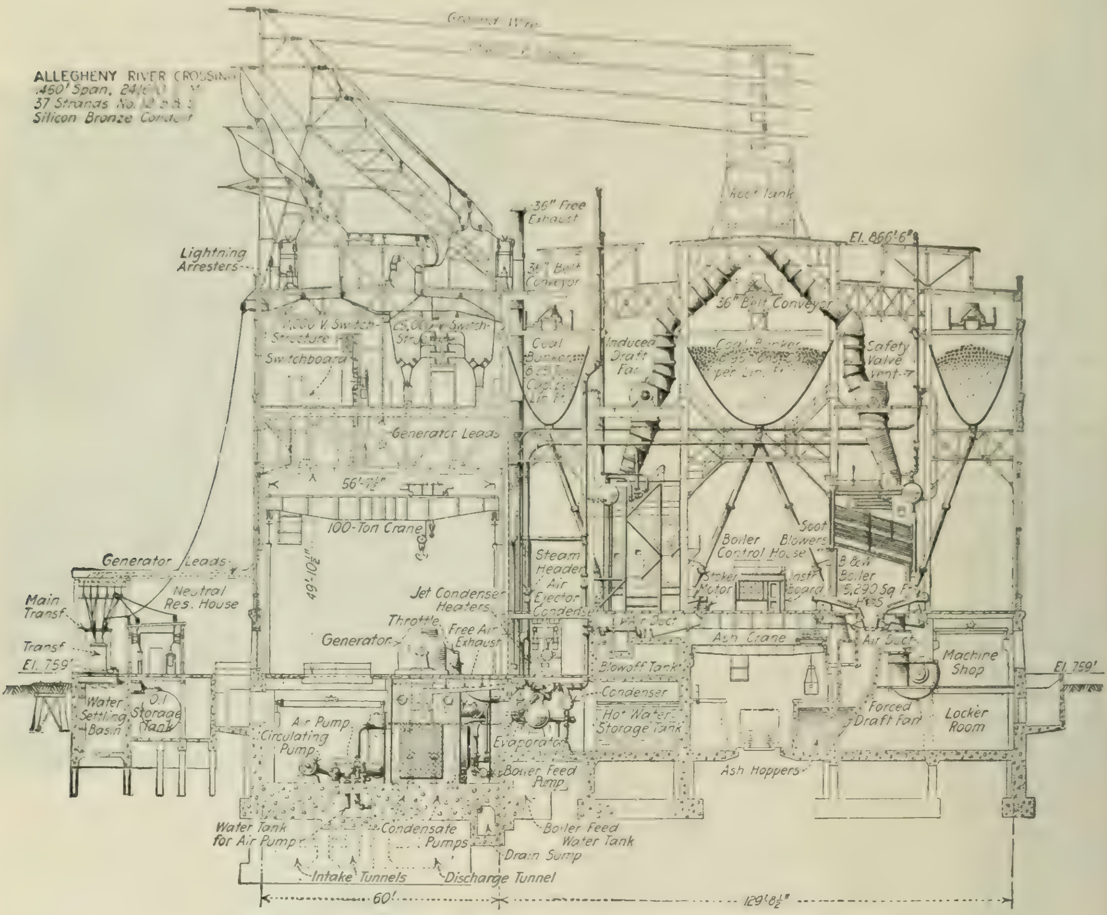


FIG. 5. CROSS-SECTION THROUGH BOILER AND TURBINE ROOMS

There are two rows of boilers in the plant, Fig. 4, arranged with a large central overhead coal bunker and a smaller one on each side. Each boiler is equipped with two 13-retort underfeed stokers, the coal being fed by three 16-in. spouts on each end of the boiler. The spouts are staggered so that the boiler tubes can be pulled either on the front or on the back of the boiler without moving the spouts. The boilers are of the cross-drum type, 16 tubes high, built for a pressure of 350 lb., and stokered so that with an average grade of coal having about 10 per cent ash they can deliver a maximum of 185,000 lb. of steam per hour. Under these conditions the drop through the superheater and dry pipes is 25 lb. and the superheat is 235 degrees. Fig. 5 shows a cross-section through the boiler and turbine rooms. Each boiler contains 15,290 sq. ft. of heating surface.

The boilers are equipped with soot blowers, having nine elements on each side. One element is placed under the bottom row of tubes near the front header, and another just above the two lower rows of tubes near the baffle, so as to remove the slag from the bottom of the first pass. Elements placed in these locations are in use in the boilers in the company's other plants and have done a great deal to lengthen the periods between cleaning on Stirling boilers at the Connellsville plant. The installation of soot-blower elements in the corresponding locations lengthens the period of actual service of the boiler 300 per cent, it being necessary, without this soot-blower arrangement, to take the boilers off once a week to have the tubes scraped, and only once a month with the elements installed as outlined. The life of these elements depends on the proper protection. The practice in vogue in West Penn plants is to place the soot-blower element in a brick or a tile pocket, permitting air from the forced-draft system to blow through and cool the element, except when the tubes are being cleaned; under the latter condition the pressure of the steam closes the check valve. The experience of the West Penn is that the proper protection and cooling of these two units is of much more importance than the material of which the blower is made.

Platforms are being provided, giving accessibility to the various inspection holes and valves. The boilers are covered on the front, back and top with steel plate, but the side walls are not covered. The boilers are wide enough for a 14-retort stoker, but one retort was eliminated in order to thicken the walls at the bottom 11 in., thus giving a 32½-in. brick wall at the bottom and a 21½-in. wall at the top.

The stoker is divided into four sections. Three steel plates are placed in the wind box under the stoker, separating the wind box into corresponding divisions. Each section has its own air supply and valve, so the air admitted to any of the eight sections into which the stoker is divided can be regulated. The stoker is provided with a double clinker grinder similar to that in use in several other plants, the manufacturer guaranteeing that the coke in the ash shall not exceed 14 per cent.

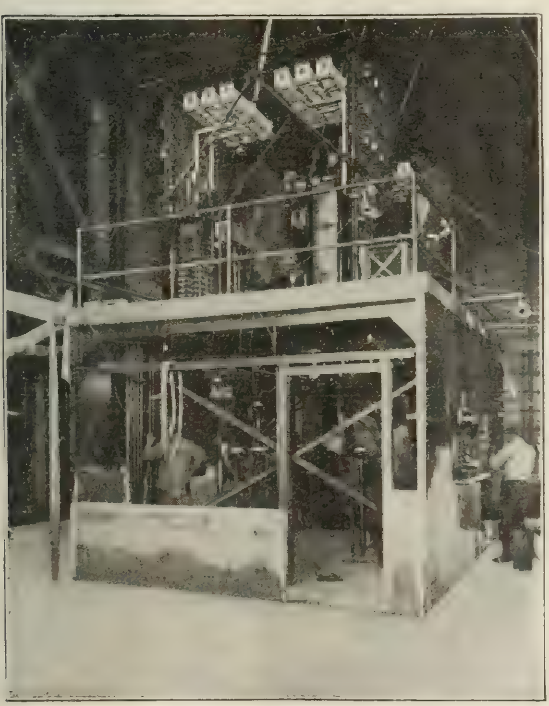


FIG. 6. BOILER-ROOM MOTOR CONTROL ROOM INSTRUMENT BOARD

The stoker on each side of the boiler is driven by a double-speed a.c. motor of the pole-changing type, a maximum range in speed of from 25 per cent to full speed being obtainable. The two motors are regulated by a double controller worked by a single pilot motor and arranged so that either stoker may be set a maximum of two notches ahead of the other.

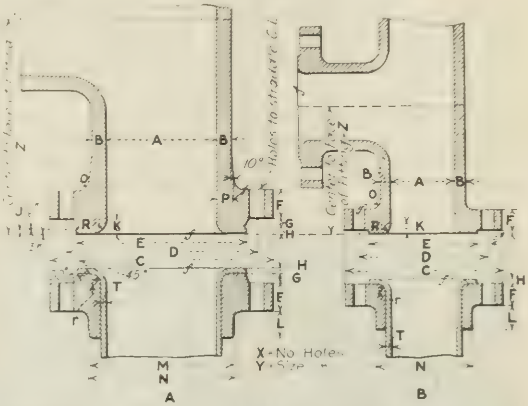


Fig.	Size	O.D. of Pipe	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	R	r	X	Y	Z	T
A	14	[illegible]	5¾	¾	2½	21¼	20⅜	2¾	15/16	½	¼	1⅜	2⅝	17⅝	17⅞	13/16	2 5/16	1½	⅞	20	1½	21½	0500
B	8	8.625	1¾	1/16	1½	15¼	11¾	2⅛		7/16		1 3/16	1⅛		10¾	9/16		1¼	¾	12	1¼	13½	0500

FIG. 7. DETAILS OF 400-LB. STEAM- AND WATER-PRESSURE FLANGES AND FITTINGS

Each boiler has its own forced-draft fan. These fans take the air from the generator discharge on the turbine side of the boiler room, getting what additional air they require from a duct running between the turbines to the east wall of the turbine room The air for the fans on the west side comes in through the lower basement windows under the machine-shop floor. The air is forced by the fan into a duct supplying both sets of stokers under the boiler. The ducts for the various boilers are separated by dampers, which can be opened in case of failure of any of the forced-draft fans, thus providing breakdown capacity. They have a maximum capacity of 105,000 cu.ft. of air a minute at 7 in. pressure, sufficient to operate the boilers at 450 per cent rating. The fans are driven by a.c. brush-shifting motors with d.c. characteristics.

The boilers will ordinarily be operated at a maximum of from 300 to 350 per cent, and the average will be 200 to 250 per cent. The losses at these partial loads for the straight a.c. motor are excessive; although this can be partly overcome by using two motors. The brush-shifting motor, however, is more efficient and has considerable advantage where automatic regulation is contemplated. The efficiency, for instance, at 250 per cent rating of the boiler is estimated at 47½ per cent for the slip-ring motor, as against 80 per cent for the brush-shifting motor. These motors are of 175-hp. capacity, and curves indicated that there was an average reduction in the losses of 21 kw. by using the brush-shifting motor.

Each boiler is equipped with two single fans with two motors, one of 175-hp. and one of 400-hp. capacity, the whole set being interconnected by flexible couplings.

Ordinarily, the two fans will be driven by the 175-hp. motor, which has sufficient capacity to operate the boilers at 300 to 350 per cent rating. If it is desired to have more draft than can be furnished by the smaller motor, the 400-hp. motor is brought up to speed, the magnetic clutch closed, and the current supplied to the 175-hp. motor is disconnected, its rotor being turned by the larger motor. With this combination, in case of any one unit going down, considerable capacity can still be obtained from the boilers. Either half of this unit will operate the boiler up to 300 per cent rating, but not so efficiently as the two fans will together.

The induced-draft fans are located on a concrete platform some distance above the boiler, there being sufficient space between the boiler and the induced-draft fan to permit of the installition of an economizer. The characteristics of the fan are such that with the cooler gases that would be obtained from an economizer, they will operate the boilers at the same rating. The maximum draft required to operate the boilers at 400 per cent rating is 5 in.; with economizers this would be increased to 7 in. Flues and fans are lined with Vitrobestos.

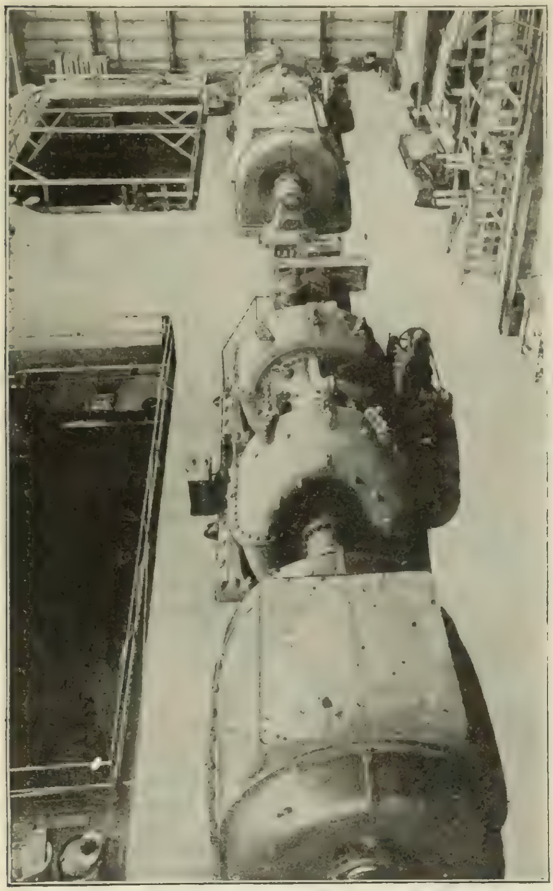


FIG. 8. VIEW OF THE TWO 25,000-KV.-A. TURBO-GENERATORS

The controls for the stoker and two 175-hp. fan motors are of the clapper type, the dials being operated by pilot motors controlled either by hand or automatically. The 400-hp. induced-draft fan motors are arranged to operate by hand only; the automatic regulation and then be on stoker and forced-draft fans only

In order to eliminate the vapor rising from water leakage from the ash hopper gates, gases rising from the quenched ashes and shooting flames from the ash-pit doors, due to the air pressure, an ash-handling system, modeled after that installed at the power house of the Kansas City Power and Light Co., has been installed. It is modified, however, in that there are two ash-handling galleries in that plant, whereas in the Springdale plant both rows of boilers discharge to a single gallery, so that a single railroad track and crane runway handle the ashes. The ashes in falling from the boilers drop into a large tank of water, are immediately quenched and fall to the bottom of the pit. Sprays are placed at the elevation of the stokers, so that with the large pocket above the clinker grinders, the ashes and clinkers should be dead before being discharged by the clinker grinders. Doors are provided to give access to the chute to remove clinker in case the ashes bridge in the chutes. One crane operator with a train crew of two men will handle the entire ash output from the plant. A continuous cableway system can be run through the ash tunnel and loaded by the crane, at a very slight expense for modifications. The ashes can also be dredged out by a centrifugal pump and delivered by a pipe line in an emergency.

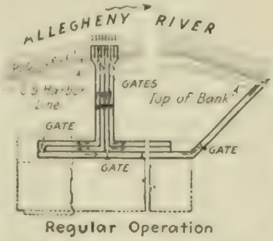


FIG. 9. NORMAL OPERATIONS OF INTAKE AND DISCHARGE SYSTEM

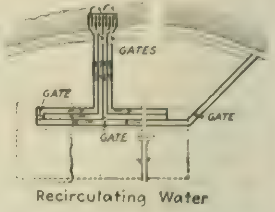


FIG. 10. WATER BEING RECIRCULATED THROUGH TWO OF THE INLET TUNNELS

The control for the four boilers is centered in a room in the main firing aisle of the boiler room, Fig. 6. The switches controlling the supply of current to the various motors are inside the room, and the instruments and controls for the motors for four of the boilers are on the outside. The piping will all be in the inside of the room, which will be steam-heated, to prevent freezing of the instruments in winter. The instruments for each boiler are boiler meters, recording the steam flow, air flow and pressure in the furnace; four-in-one draft gages and three-in-one recording gages, recording the steam temperatures and pressures, degree of superheat, etc. The stoker and fan motors are arranged for automatic boiler control.

The steam piping is of steel, with Van Stone welded flanges; the hot-water piping, of wrought iron with welded flanges. On account of the high-pressure the 800-lb. hydraulic flange was adopted for steam and water piping. The flanges on the steam piping were modified to permit of welded joinings. Fig. 7 shows details of the 400-lb. steam- and water-pressure flanges and fittings.

On account of the auxiliaries being motor driven, the amount of small steam piping is practically negligible. The total cost of the steam piping in place, covered, will not exceed 1 per cent of the cost of the plant; and the total piping contract, about 3 per cent of the cost of the plant.

The steam piping is covered with a 3-in. covering of Nonpareil. This is to be covered with a couple of turns of building paper and a final covering of 8-oz. canvas sewed on, the canvas to be given two coats of paint. Where steam pipes are exposed to injury, they are to be covered with sheet metal.

The boilers are equipped with feed-water regulators and boiler-feed pump governors. On the motor-driven unit the feed-pump governor acts as an excess-pressure reducing valve. All steam and water valves were tested to three times the working pressure.

The generating equipment of the turbine room consists of two 25,000 kva. Westinghouse generators, three-phase, 60-cycle, designed for a maximum of 12,000 volts, Fig. 8. The condensing equipment consists of a single 32,000-sq.ft. condenser per unit, having 1-in. tubes about 20 ft. long. The condensers are hung from the turbine foundation. On account of taking care of the longitudinal expansion of the turbine, copper expansion joints have to be provided between the condensers and the turbines. Large openings are left in the floor in front of the units, to light and ventilate the condenser pit. Windows are provided under the turbine-room floor. These are protected from high water by means of concrete areaways.

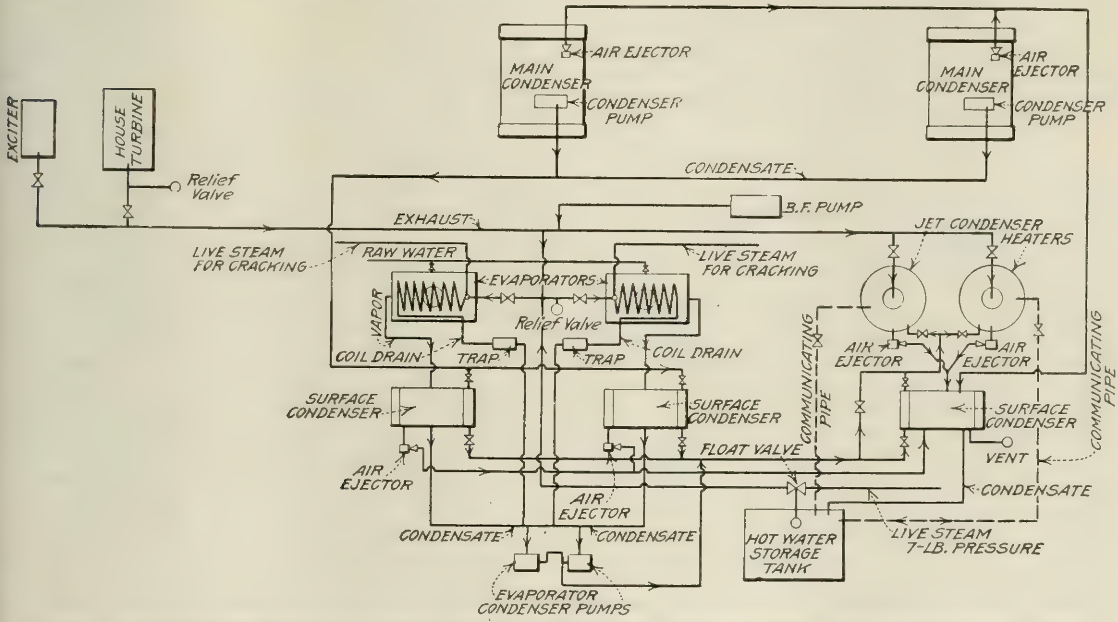


FIG. 11. ARRANGEMENT OF HOUSE TURBINE JET CONDENSER, HEATER, EVAPORATOR AND STORAGE TANK

There are two motor-driven circulating pumps per unit, each having a capacity of 17,500 g.p.m. at the maximum head. Each pump, when run by itself, will furnish from 60 to 65 per cent of the amount of water that the two pumps together will furnish, on account of the reduced friction head. The condensate pumps are motor driven and in duplicate, each being of 100 per cent capacity. One Le Blanc air pump of 100 per cent capacity is provided, and two steam air ejectors are provided for use in case of excessive leakage or for breakdown service. Three different sources of water are supplied for the Le Blanc pump; First, directly from the river; second, in case of flood, from the tank if the discharge pressure on the Le Blanc is higher than it will work under successfully; third, from the circulating system, in case the dam located approximately one-half mile below the plant should fail, and the suction head on the pumps should become too large.

As the power for the motor-driven auxiliaries is supplied by a house turbine, and the exhaust steam from it is used to heat the feed-water, there is an advantage in the Le Blanc pump in that it requires less steam than the steam air ejectors. However, the cost of the tank and the complication of the piping and floor space required add considerably to the expense of the Le Blanc air pump. There is not much complication in the steam exhauster, provided the steam discharged into an open heater. This means a possible difficulty in getting proper air separation. Where jet condensers are used for heaters, as in the Springdale plant, and it is desired to reduce the amount of air in the condensate and makeup to a minimum, it is necessary to provide a surface condenser, into which the exhaust steam and air from the ejector are discharged. These gases are cooled by the condensate before it enters the heater. The additional cost of this surface condenser and the piping will offset the increased cost of the tank and piping required by the Le Blanc air pump.

The plant is located about half a mile above the Springdale dam. The intake tunnels are placed low enough to insure that the power house will be able to operate in case of failure of the dam, provided ten or twelve feet of gravel is dredged away from the intake. The main intake trouble is from ice and leaves. This is overcome by the installation of rotary screens and arrangements for recirculating the discharge water, permitting it to be cooled by the ice and recirculating it through the condensing system. A modification of this idea has been tried out at the Connellsville power station, and at one or two other power stations that are subjected to similar trouble; and it has been found satisfactory wherever tried. The rotary screens are of link-belt design. They are 6 ft. wide and arranged for motor drive, the top of the screens being above the maximum high water on record.

Figs. 9 and 10 show the arrangement of the intake and discharge system. Fig. 9 shows normal operation, and Fig. 10 shows the gate in the discharge tunnel closed and the water being recirculated through two of the four inlet tunnels. There are two tunnels supplying circulating water to each unit in the power station. One circulating pump on each unit gets its water supply from each of the two tunnels, so either tunnel may be shut down for repairs and still permit operation of all units at full or nearly full capacity. The double intake tunnel system and means of recirculating the water also has the advantages of permitting the cleaning of the condensers while in operation. One circulating pump can be shut down and the dirt from the condenser washed through it into the tunnel by a partial reversal of flow in the condensers.

AUXILIARIES ARE ALL MOTOR-DRIVEN

All the auxiliaries in the plant, with the exception of one boiler-feed pump and one exciter set, are motor driven. The station was originally laid out with the intention of putting in dual drives, in order to maintain a heat balance. However, an investigation of the relative merits of turbine and motor drive, using a 2,500-kva. 2,200-volt house turbine to produce the power for the auxiliaries, showed that by adopting the house turbine, nineteen turbines ranging in size up to 400 hp. and fourteen reduction gears could be omitted, and that the initial cost was less for the house turbine; that is, when the dual drive for the more important units, such as circulating pumps, has been provided. The house turbine also increases the over-all economy of the station by 2 per cent, as it produces a kilowatt of power for from 50 to 60 per cent of the amount of steam that a small turbine would take, considering the increased steam consumption at part loads and at reduced speed on the smaller machines. There is at least an equal saving in the capacity of the large turbines, which would be required to supply power to the auxiliaries so that the net station capacity is increased.

In order to heat the condensate to 210 deg., it requires that about 13 per cent of the condensate be available as exhaust steam. The amount of power consumed by the auxiliaries at the Windsor power station is 5½ to 6 per cent of the total power generated; and the amount of power required by the Springdale units should be about the same percentage, as the house turbine requires 125 per cent more steam per kilowatt-hour than the large units do. This figure would indicate that about the correct amount of exhaust steam is available.

One of the chief sources of trouble to electrically driven auxiliaries is lightning or other surges on the line; and it has been customary in some stations to install motors of approximately 50 per cent excess capacity, in order that the motors might not kick off under such conditions. With a house turbine and dual auxiliaries and with a duplicate 2;200-volt bus system to feed the auxiliaries, the house turbine is connected to one bus, the other bus being connected to the large units through a bank of house-service transformers, and where there are duplicate auxiliaries, one is connected to each bus. In case of failure of either source of supply the other auxiliary continues to operate. If it is desired to keep a uniform feed-water temperature, the house turbine can be run parallel with the main units and the load on the house turbine controlled thermostatically, or the load can be transferred by hand from one bus to another in case the house turbine is run separately.

There is also the advantage of the house turbine that in case of a complete station interruption, the house turbine can be put on the line and be ready for service much quicker than one of the big units. A motor-driven auxiliary plant has the additional advantage that on account of the elimination of the leaks in steam piping and around the governors on the smaller units, the amount of makeup is much less. Data in this respect are limited, but practice in first-class plants seems to be about 2 per cent makeup in the motor-driven plant as against 6 per cent in the steam-driven.

ACID CONDITIONS IN THE RIVER

When the flow in the Allegheny River is very low, there are traces of acid. This probably will increase as manufacturing increases up the Allegheny Valley. To take care of the water requirements of the plant, a 1,000,000 gal. per day filtering system was provided. This was worked in at a comparatively small additional expense with the foundation of the transformer house. This water will be used in the lower service system to prevent corrosion of piping through the plant and cooling coils in transformers and turbines. The makeup for the boilers is taken from the same source and is evaporated in two horizontal evaporators that work between the pressure of the exhaust steam from the house turbine (two pounds) and a 23½-in. vacuum, which is about the highest vacuum that can be maintained in the evaporator when working at full capacity and using condensate from the main turbo-generators as cooling water. By this arrangement the condensate is heated to about 125 deg. F. in the evaporator condensers; and it is then given a final heating in two jet condensers. Both evaporators and jet condensers are provided with single-stage air exhausters to maintain a vacuum in the evaporator condensers and heater condenser, if desired. It also serves the purpose of extracting the air from the makeup and gives a water supply for the boilers that should as nearly as possible eliminate corrosion. This is particularly important where steel economizers are contemplated. As far as is known, this is the first application of the low-pressure evaporator for power-plant purposes, although they have been employed in the sugar and other industries extensively. It has the additional advantage that at the low temperature in the evaporator there is little tendency to form scale. An evaporator after being in service for six weeks at a little higher temperature than it will work under, upon examination was found free of scale, the only foreign matter being a fine powder on the walls and coils.

Fig. 11 shows an arrangement of the house turbine, jet condenser heaters, the evaporator and storage tank.

Rebabbitting Engine Parts—II

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

BABBITTING a bearing on the shaft can, of course, be recommended only for an emergency. The proper way to do this is to use a mandrel of cast iron or steel instead of the shaft, according to the size. A piece of pipe screwed into a flange may answer the purpose, and after babbitting the bearing should be bored to fit the shaft. If the bearing consists of four boxes, the process will be as follows: The mandrel, which is usually a hollow casting provided with a flange, is set on end on the floor or bench, and the boxes, one at a time, are clamped to it, using wooden blocks and boards for distance pieces and for confining the metal. Fig. 13 shows a lower box clamped on a mandrel, the lower end of the box resting on the flange; a gate and riser are built on the top of the box, and the metal is poured in a steady stream. This method will prevent shrinkage holes, which are almost unavoidable on bearings of larger size, if the babbitt is poured with the boxes in a horizontal position. Instead of a mandrel a curved plate, as shown in Fig. 14, may be used; this does away with the wooden blocks. In these methods allowance must be made for boring the boxes. After the babbitt has been poured it is generally expanded in place by hammering, the object of this being to make the metal fit tightly all around the recesses and in the grooves. The metal is struck lightly with the ball end

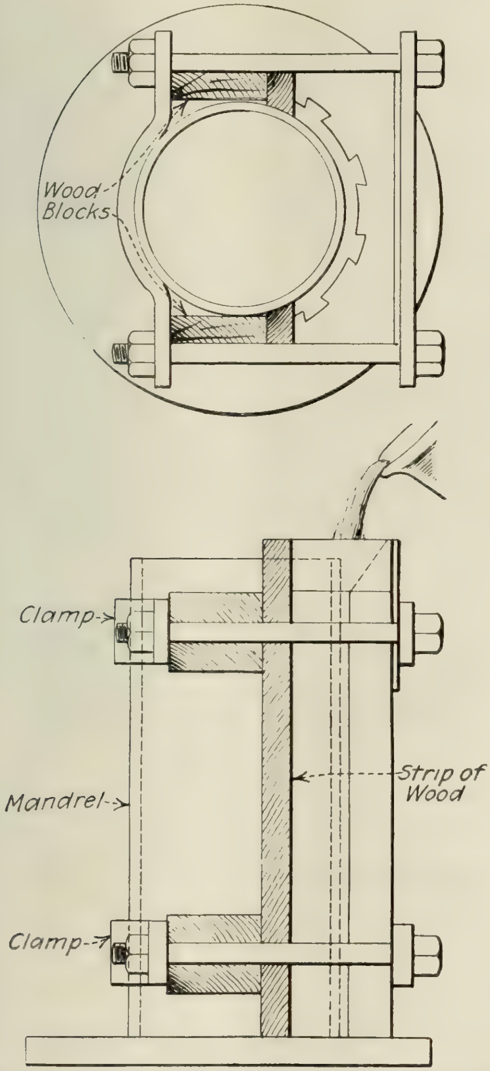


FIG. 13. THE BABBITT IS POURED INTO THE LOWER BOX, WHICH IS CLAMPED ON A MANDREL

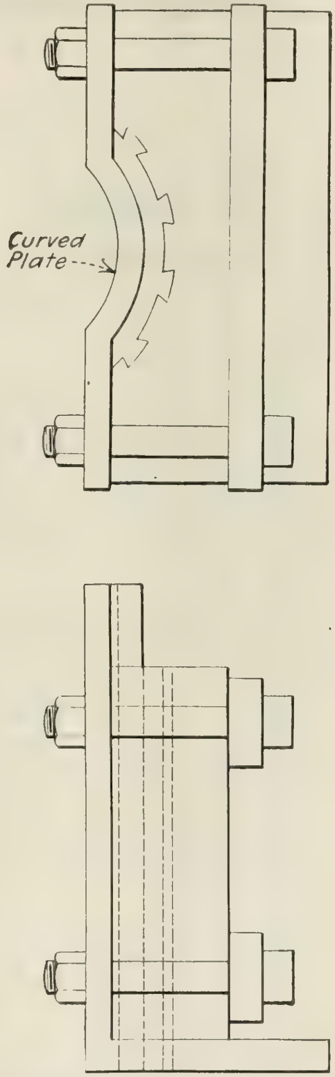


FIG. 14. CURVED PLATE FOR USE IN BABBITTING MAIN BEARING

of a hammer uniformly all over. The blows leave marks on the babbitt, as shown in Fig. 15. Care should be taken not to strike the metal too hard, otherwise it may become brittle and crack, especially at the edges.

The next operation will be the boring of the boxes, for which purpose they are clamped together. If no machinery is in the place, the work can be done by hand, provided a boring bar and some boxes are available. The bearing may be clamped down on a suitable plank, on which also the stands or boxes for the boring rig are fastened, as shown in Fig. 16. The bar is turned by means of a hand crank at one end, while the feeding is done at the other end with a screw and handwheel or a wrench.

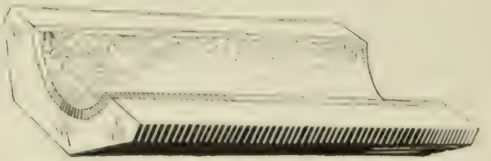


FIG. 15. BABBITT EXPANDED BY HAMMERING

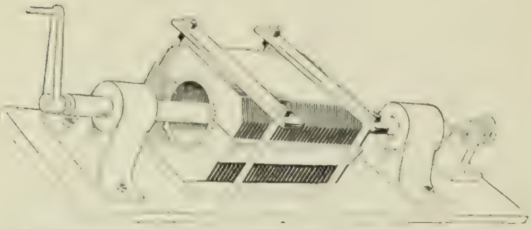


FIG. 16. HAND BORING MACHINE FOR BORING OUT BEARING BOXES

While the pressure in the main bearing rarely exceeds 150 lb. per sq.in., that in the crankpin boxes may run close to 1,000 lb., and for the crosshead-pin boxes pressures from 1,200 to 1,600 lb. are allowed. It is not wise to use babbitt linings for pressures much over 1,000 lb. per sq.in., as the metal will not stand such high pressure; it has a tendency to spread, even if extremely well secured. Some manufacturers make the crosshead pin of the same size as the crankpin and are, therefore, justified in using soft-metal lining; this is a great advantage, since it prevents the pin from getting scored in case of a hot-box. Genuine babbitt has been proved to be the best wearing material for these boxes, and no other should be used.

The same as in the main bearing, the crankpin boxes may be chambered for the lining as shown in Fig. 17-A, or the babbitt may run clear through as in Fig. 17-B. If the boxes are made of cast steel, it is essential that part of the faces should be babbitted to protect the boss on the crank or the crankpin washer from coming in contact with and getting cut by the hard metal of the boxes. This method is illustrated in Fig. 17-C.

In case of emergency the crankpin boxes may be rebabbitted directly on the crankpin. If the pin is overhung with a loose washer, as shown in Fig. 18, both halves can be babbitted at the same time, taken off and cut in two, but with a solid flange at the end or on a center crank each half must be babbitted separately. The better method, however, is to babbitt the boxes on a special mandrel with an allowance for boring.

The process of rebabbitting the boxes for a crosshead pin is simple. The boxes can be clamped between two suitable boards and placed over the pin, which is fitted into a hole cut in the lower board, as shown in Fig. 19. Strips of wood can be fitted in the slots of the boxes. Each half may be poured separately, or both halves can be cast together and cut in two afterward. For rebabbitting the boxes on old-time crossheads with solid pins, a mandrel must be used and the boxes must be bored to fit the pin, which is usually provided with large fillets.

The wear on the crossheads of horizontal engines running over is all on the lower shoes; if the engine runs under, there is also some wear on the upper shoes. The lower shoe, therefore, needs the principal attention. The pressure allowed on crosshead shoes should not be over 75 lb. per sq.in. An engineer can easily check the pressure on the crosshead shoe in the following manner: Multiply the area of the piston by the steam pressure and divide by the ratio of the length of the connecting rod from center to center to the stroke; the quotient divided by the projected area of the crosshead shoe will give the pressure per square inch. Take, for instance, a 16 by 36-in. engine with an initial pressure of 100 lb. per sq.in.; the maximum pressure on the piston will be $201 \times 100 = 20{,}100$ lb. This, divided by the ratio of connecting rod center to center to the stroke, which we will assume to be 3 to 1, will give $\frac{20{,}100}{3} = 6{,}700$ lb. as the maximum pressure on the shoe. Suppose the crosshead shoe to be 16 in. long by 6 in. wide, with a projected area of 96 sq.in.; the pressure per square inch will be $\frac{6{,}700}{96} = 69.8$ lb. This pressure will act on the shoe only when the engine is carrying a heavy overload; ordinarily, the pressure will not exceed one-half or perhaps two-thirds of the amount. From this

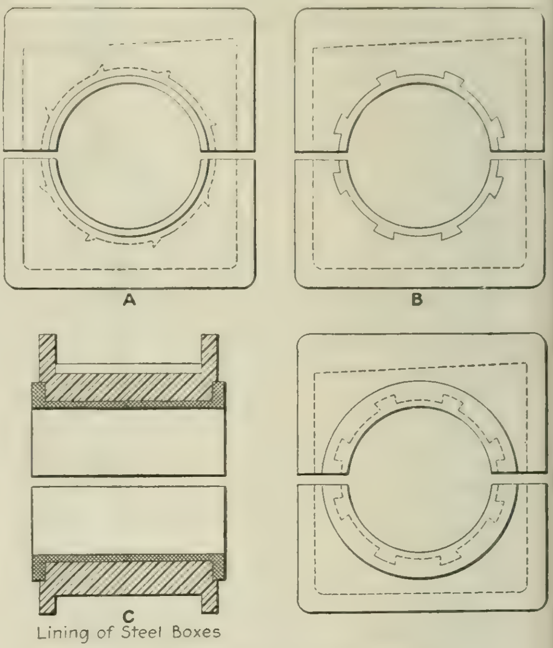


FIG. 17. BABBITT IN THE CRANKPIN BOX

simple calculation we gather that it cannot be the pressure alone which will make the shoes wear; there must be another element which enters into the performance. This is the velocity with which the shoe moves over the guide. The material with which a crosshead shoe is lined can, therefore, be of different composition from that used in the bearings or connecting-rod brasses.

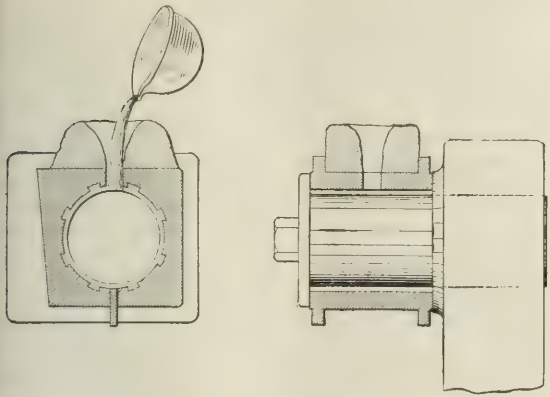


FIG. 18. BABBITTING THE CRANKPIN BOXES ON THE PIN

Lead and antimony in the proportion of 84 to 16 will make a good mixture for the purpose. The antimony with a melting point of 900 deg. must be melted first, and the lead, which melts at 600 deg., is added.

Some old-time crosshead shoes require frequent rebabbitting, owing to their limited area and disadvantageous shape; the V-shaped shoe is perhaps the most common among them. To rebabbitt one of these, a form has to be made, to which the shoe is clamped with a proper allowance for the metal; the babbitt is poured with the shoe placed in a vertical position, as shown in Fig. 20. The form to which the shoe is clamped may be made of wood, but one of cast iron is to be preferred. Shoes for bored or flat guides can be rebabbitted in a similar manner. The babbitt, after being poured, is hammered lightly and then machined and scraped to a good bearing on the guide. To save the machine work, for which few engine rooms have the necessary outfit, the shoes can be rebabbitted in the guides by blocking up the crosshead as shown in Fig. 21. A form made of wooden blocks and strips is built around the shoe on the lower guide. With the proper gates and risers arranged to suit conditions, there is not much difficulty in pouring in the metal, but there is a certain amount of danger in cracking the guide when the hot metal is poured onto it. It is strictly an emergency job, on which a man takes some chances.

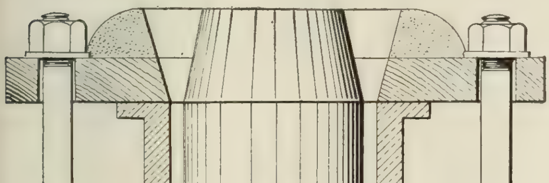
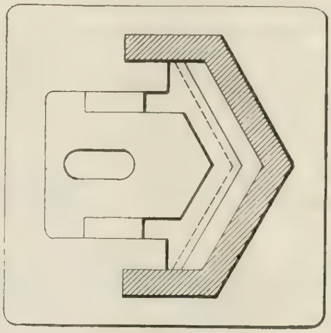


FIG. 19. CROSSHEAD PIN BOXES BABBITTED ON THE PIN



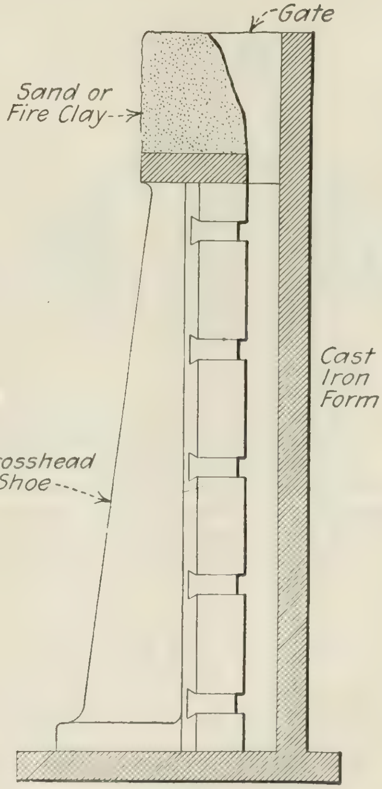


FIG. 20. BABBITTING THE CROSSHEAD SHOE

The question whether a babbitted eccentric strap is to be preferred to one without soft-metal lining has never been definitely settled. A babbitted strap, however, will not cut the eccentric if it gets hot; and it will get hot occasionally in spite of the most perfect oiling devices and careful watching. If the eccentric is split and can be taken off, it can be used for babbitting. For that purpose it is mounted on a board into which a block of wood of the size of the shaft is fitted, as shown in Fig. 22. Two boards, one for the top and the other for the bottom, are located on the main board to hold the strap in place, which is also secured by wooden blocks on the outside of the rim. The gates for pouring the babbitt are made of fireclay or other suitable material. Each half of the strap is poured separately, and if the strap is of large size the metal must be poured in two places. Since the babbitt has to travel a considerable distance through a narrow space, it is in this case of prime importance that both eccentric and strap be well warmed. If the eccentric is solid and cannot be removed from the shaft, a dummy of wood may take its place for babbitting, with sufficient allowance for machining.

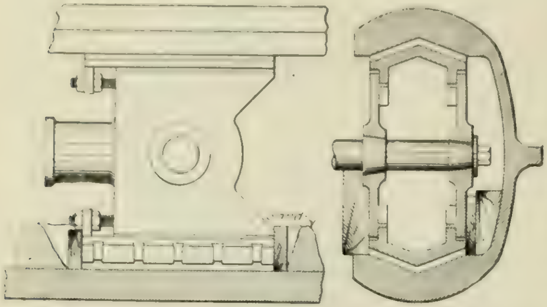


FIG. 21. REBABBITTING CROSSHEAD SHOE IN THE GUIDE

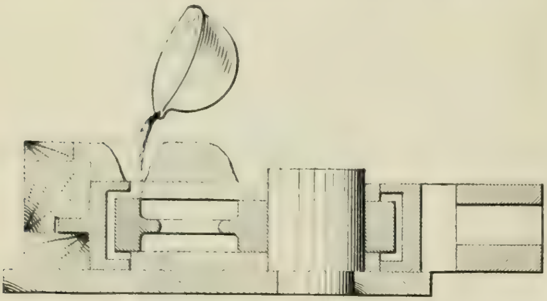


FIG. 22. BABBITTING THE ECCENTRIC STRAP

"The Story of Petroleum"

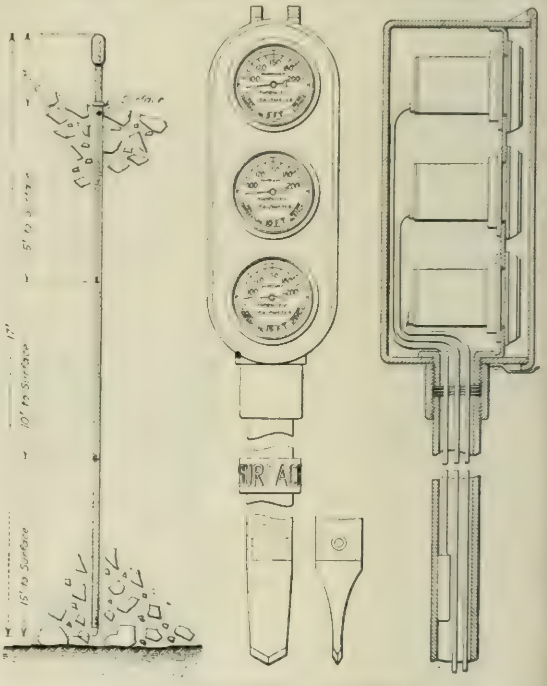
The United States Bureau of Mines in co-operation with the Sinclair Consolidated Oil Corporation has just completed a new four-reel motion picture film telling the complete story of petroleum. The film will be loaned for educational purposes to those desiring the same after Sept. 1, by applying to the Bureau of Mines, Washington, D. C.

This is one of a number of films that have been recently completed by the Bureau of Mines showing various phases of the mining and metallurgical industry. Those requesting the loan of "The Story of Petroleum," or any other films belonging to the Bureau of Mines, are expected to pay the cost of postage both from the Washington office and return.

Device To Show Thermal Conditions in Coal Pile

A device for measuring the temperature of a coal pile at various depths, to be known as the Thornley Coalometer, has been perfected by the Federated Engineers Development Corporation. The instrument was invented by A. W. Browne, professor of chemistry at Cornell University, and R. P. Nichols, of New York.

It consists of a set of temperature indicators incased in a long pointed steel tube, carrying at varying depths metal bulbs. These bulbs and pipes connecting them to pressure gages are filled with alcohol. At the upper end of the instrument is a set of dials with pointers which indicate under all atmospheric conditions the temperature of the bulbs which actuate them. The expansion of the alcohol in the bulbs and pipes under increasing temperature controls the pointers of the gages. The scale on each dial starting at 32 deg. F. runs upward. It is colored black until it reaches 120 deg., when it changes to red, indicating when the hand reaches this point that there is excessive heat in this zone, giving warning that this portion of the pile should be removed. The units are made in two lengths, 12 and 17 ft. These carry, respectively two and three temperature indicators, the bulbs being placed at five-foot intervals below the surface mark on the stem of the instrument.



THE THORNBY COALOMETER

Several of these devices are forced down into the coal pile at varying depths and at various localities. Collectively, they furnish accurate information of temperatures existing throughout the coal pile. To be effective, a complete installation of these units should be used, the number depending on the size of the coal pile.

Tests have shown that indicators placed at fifty-foot intervals in either direction will give efficient service and indicate temperature conditions throughout the entire pile.

Electric Welding Machines—Alternating Current Equipment

By L. W. Webb
Master Electrician, United States Navy Yard, Norfolk, Virginia

Welding from alternating-current circuits with either a resistance or a reactance is first discussed, and then three special types of welding transformers are considered.

ALTERNATING-CURRENT welding is done principally with metallic electrodes. Very little carbon-pencil or carbon-electrode welding has been done with alternating currents up to the present time. The power factor of alternating-current welding apparatus as at present furnished is low. This has been its greatest drawback and has prevented to a large extent its general use in places where otherwise it was excellently adapted, since in most cases welding can be done about as well with alternating as with direct current. In general, alternating-current welding is done as follows:

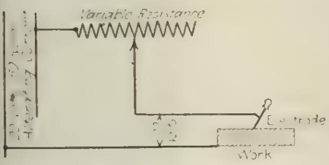


FIG. 1. WELDING CIRCUIT WITH SERIES RESISTANCE

1. With a voltage of 120 or higher a resistance is used in the circuit to reduce this pressure to approximately 20 volts at the arc (see Fig. 1). Welding under this condition is done by using coated or special electrodes of the various types. This method is very inefficient from the standpoint of power input to power delivered to the arc, and it is always necessary to ground one side of the circuit unless the work is insulated from the ground. Grounding is very undesirable, since there is always danger of the operator being burned or damage resulting to some electrical apparatus connected to some other part of the circuit. However, when welding has to be done in locations where circuits are not provided to care for the operation of motor-generator type machines, the foregoing method can generally be used to advantage and good welding can be done under these conditions.

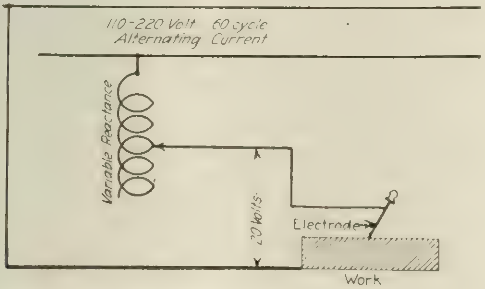


FIG. 2. WELDING CIRCUIT WITH SERIES REACTANCE

2. By the use of a simple reactance, Fig. 2, either from 110- or from 220-volt alternating-current circuit, usually sixty cycles (on circuits where the frequency is 25 cycles or lower, welding is very difficult). Welding by this method can be done and is especially desirable where the circuits contain sufficient copper to care for the low power factor under welding conditions, when the work is located at such points as cannot ordinarily be reached by a motor-generator type machine. It has, however, the same disadvantage mentioned in the foregoing; that is, unless the work is insulated it is necessary to ground one side of the circuit. On 110-volt circuits it is more difficult to do welding than when a 220-volt circuit is available, and it is very desirable to use covered electrodes when possible in welding from a 110-volt circuit, but with the 220-volt circuit any type of electrode can be used to good advantage.

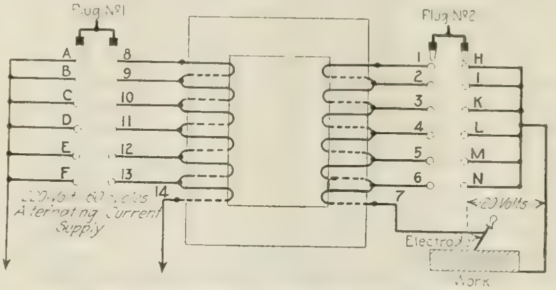


FIG. 3. WELDING TRANSFORMER WITH PRIMARY AND SECONDARY WINDING ON SEPARATE LEGS OF MAGNETIC CIRCUIT

3. Where specially designed transformers with independent primary and secondary windings are used, the transformer is usually of the high-leakage type to provide regulation from no-load voltage of approximately 75 to 110 to the arc voltage of 20 volts under welding conditions.

Fig. 3 shows a diagram of a General Electric Co.'s welding transformer. As can be seen, this is a single-phase transformer with primary and secondary windings, wound on separate legs of a closed-core magnetic circuit. Each winding is electrically insulated from the other and has its own separate combination of taps, so that all or part of the total turns can be used as desired to get various welding combinations of current and arc-striking voltage. The table given herewith shows the combinations for a 20-kva. 220-volt 60-cycle transformer while total voltage ratio of primary to secondary is two to one.

VOLTAGE COMBINATIONS FOR WELDING TRANSFORMER FIG 3
Rated Volts Applied on Primary

Plug No 1 in		Plug No 2 in H	I	K	L	M	N
A	Amperes welding circuit	80	90	100	110	120	130
	Striking voltage	110	100	92	85	80	75
B	Amperes welding circuit	90	100	110	120	130	140
	Striking voltage	120	110	101	93	88	83
C	Amperes welding circuit	100	110	120	130	140	150
	Striking voltage	131	119	110	102	96	90
D	Amperes welding circuit	110	120	130	140	150	160
	Striking voltage	141	129	118	110	103	97
E	Amperes welding circuit	120	130	140	150	160	170
	Striking voltage	150	136	125	116	110	103
F	Amperes welding circuit	130	140	150	160	170	180
	Striking voltage	160	145	133	124	117	110

With this type of transformer welding can be very easily done from 60-cycle alternating-current circuits and the power factor will be approximately 25 per cent. Owing to the multiplicity of taps it is very easy to obtain the various welding currents desired with different open-circuit striking voltages, so that even inexperienced operators can do satisfactory welding with this apparatus. It is compact and easily portable, and in locations where only single-phase circuits are available, it can be used to good advantage. The unit is of the air-cooled type by natural ventilation, and no fan to provide forced cooling is necessary. Welding currents from 80 to 180 amperes can be obtained. As the coils are on independent legs, the regulation is obtained by magnetic leakage while the current is flowing, which changes the voltage ratio fixed by the coil-turn ratio on open circuit.

A wiring diagram for an Electric Arc Welding Company's welding transformer is shown in Fig. 4. This transformer has two legs of a closed core each containing windings and one leg a movable core. The primary and secondary coils are so wound on the first leg as to have very little flux leakage between them. On the other leg is another secondary winding in series with that on the first leg and also in series with coils having three turns each on the horizontal part of the core between the two legs. The open-circuit voltage on this transformer is made variable by a combination of taps on both secondary coils.

Regulation from open-circuit voltage to welding-arc voltage is obtained by flux leakage through an adjustable core and also by the coils wound on the horizontal path assisting in causing leakage. The primary coils are provided with taps to take care of a 5 to 10 per cent drop in the supply voltage. Welding-current combinations variable from 75 to 150 amperes can be obtained by the use of the various taps on the windings.

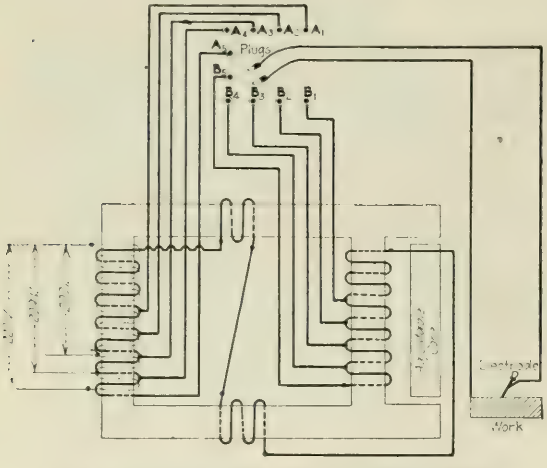


FIG. 4. TRANSFORMER WITH ADJUSTABLE CORE

Experienced operators can do good welding with this type of transformer either with bare, coated or covered electrodes, but it is very difficult for anyone except an experienced operator to obtain satisfactory results when bare electrodes are used, especially on overhead work. However, with covered electrodes ordinary operators can obtain good results.

There is an auxiliary secondary coil, not shown, having 28 turns on the secondary leg, which serves the purpose of keeping down the open-circuit voltage across the electrode and work when welding is not being done, to about 30 or 40 volts, and thus prevent possible chance of the operator receiving a shock while changing the electrodes or before welding is commenced. When the welding operation is started, the current flowing through the auxiliary secondary winding causes the contactor to close the main welding circuit and at the same instant opens this winding; then the full striking voltage of the main secondary winding is available for welding. As soon as the arc is broken, the contactor opens the current circuit and again makes contact on the small closing coil on the auxiliary secondary windings so that the same operation will be repeated when the electrode is again touched to the work.

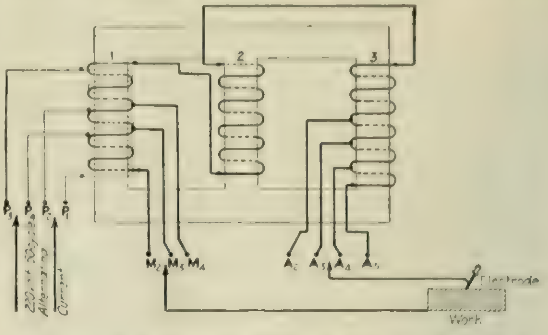


FIG. 5. TRANSFORMER WITH THREE-LEGGED CORE

The transformer built by the Arcwell Corporation, Fig. 5, is a single-phase unit of the three-leg type. Leg No. 1 has the main primary winding and the main secondary winding. Leg. No. 2 has an auxiliary secondary winding connected in series with the main secondary winding and another secondary winding on leg No. 3. The primary winding has taps provided to take care of supply-voltage variations of 5 per cent above and below normal. The secondary coils on leg No. 1 and leg No. 3 have taps so that various welding-current combinations between 70 and 200 amperes can be obtained. Regulation of this transformer is obtained by the winding on leg No. 2 being so wound as to cause high leakage when a current is flowing, which decreases the open-circuit voltage from approximately 75 or 110 volts to 25 volts at the welding arc, depending on the current setting of the particular open-circuit voltage.

With this type of transformer welding can be easily done with 60-cycle alternating current and give a power factor as high as 30 per cent.

Constant-current type of transformers may be used with one or more operators in series, and automatic cutouts provided at each operator, Fig. 6. This type of transformer is usually similar to that supplied for series arc lighting, with movable secondary coils and provided with automatic or hand regulation for the various welding currents and number of operators connected. With this type of control it is essential that each operator's work be insulated from the ground and also from each other. Furthermore, the regulation, when one of the operators starts and stops work, etc., must necessarily be very rapid so as not to disturb the must be rapid so as not to disturb the other circuits.

This type of welding transformer should show high over-all efficiency when conditions are such that a number of operators can be worked from the same transformer, and should have a power factor and efficiency much higher than the single-operator transformers now on the market. Its use as a portable welding appliance, however, will never be successful, especially where work has to be done on metal ships, etc., and therefore its application will always be restricted to shops where work can be properly insulated and where the current required by each operator is the same.

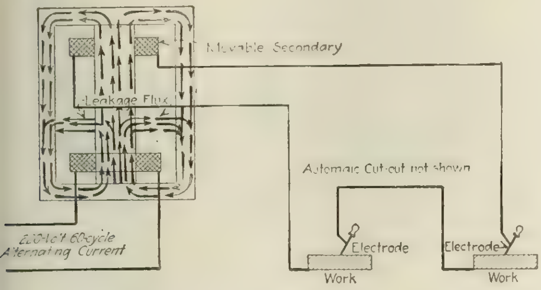

Movable Secondary
Leakage Flux
Automatic Cut-out not shown
220-Volt 60-cycle Alternating Current
Electrode
Electrode
Work
Work

FIG. 6. DIAGRAM OF CONSTANT-CURRENT TRANSFORMER

All the transformers described in this article are of the high-leakage type with power factors under normal-load conditions ranging from 20 to 35 per cent. This means that when a number of operators are working from the same circuit, it is necessary to supply more copper from the distributing mains than would be required from an ordinary circuit supplying power to the same number of operators working from motor-generators. But as these transformers are easily portable, do not require any special attention, and as their first cost is low compared with that of motor-generators, they can be used to great advantage in many locations. This is especially true in places where single-phase circuits only are available, from which it would be undesirable to operate any form of motor-generator of capacities that are as high as that required for welding machines.

While satisfactory welding can be done with these transformers, usually they are not capable of producing as much output as the motor-generator type of machine. But it is believed that when designs become more efficient no reason exists why equally good results cannot be obtained with them as with direct-current circuits from special motor-generators. However, until some form of power-factor correction is designed for use with these transformers so that the power factor of the current taken by them is much higher than that obtained at the present time, their use will be somewhat restricted.

Of course, in many cases where the work is located in places that are inaccessible to power supply, generators driven by gasoline engines of the portable type can be supplied, which can be readily transported from place to place. But the first cost of these gasoline-engine driven generating sets is high and likewise the maintenance cost, and they ordinarily require more attention than any other form of welding machine. The use of these transformers, therefore, will in many cases be the best solution and their application under these circumstances economical.

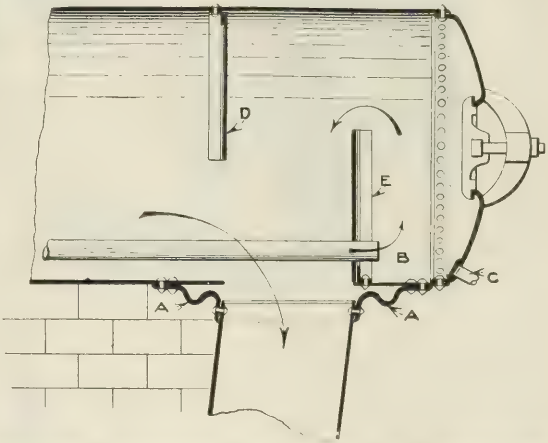
Corrugated Boiler Flange and Feed-Water Purifier

A steam boiler should be so constructed that internal strains due to unequal expansion are avoided. If a feed-water purifier can be embodied in the boiler construction, a desirable feature has been added. This is what the Union Iron Works, Erie, Pa., has done in the design of their water-tube boiler.

Expansion strains between the header and the drum are taken care of by the adoption of a corrugated flanged connection *A* from the drum to the header, which also provides an opening of large area for unrestricted water circulation; it requires no throat bracing. The illustration shows a sectional view of the rear portion of the drum and the corrugated connection between the drum and the heads. The flange connections are riveted.

A feed-water purifier that is out of the fire zone and path of circulation is made possible by carrying the drum well beyond the rear header and forming a separate purifying settling chamber, as at *B*, where practically all of the precipitates and solids are removed from the water before it passes into the drum proper. The purifying chamber is equipped with a blowoff *C*. The illustration shows the position and construction of this settling chamber.

Feed water is brought in at the front end of the drum and is carried through to the rear in an internal feed pipe that discharges at the boiling point into the purifying chamber, where the solids and other impurities readily precipitate and are blown out through the blowoff pipe at intervals.

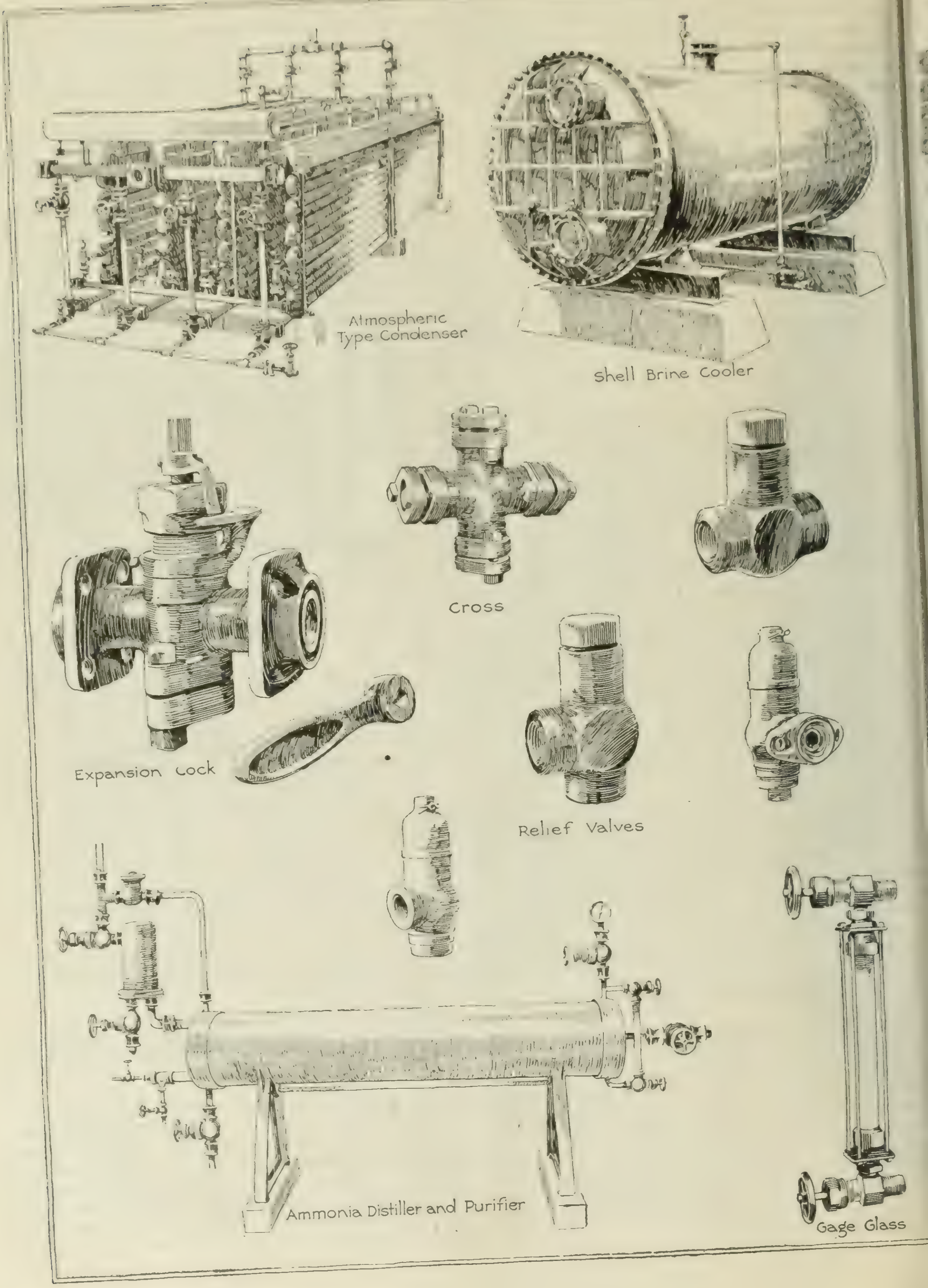


SHOWING CORRUGATED FLANGE AND WATER PURIFIER

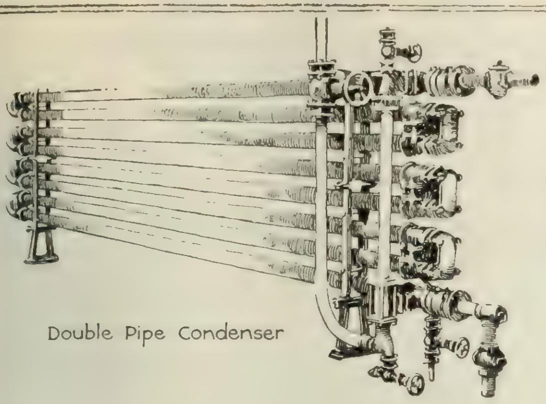
Baffles *D* and *E* isolate the purifier and conducting water from the rest of the drum without obstructing the circulation from the front to the rear of the drum.

According to the report of a French investigating committee the United States is rated as having 30,000,000 hp. in water power, Canada 25,000,000, Norway 7,500,000, Sweden 6,750,000, Austro-Hungary district 6,450,000, Italy and Spain about 5,500,000 each. Germany's water power is estimated at only 1,500,000 hp., and that of England is about 1,000,000 hp., but these two countries are richly compensated in coal.

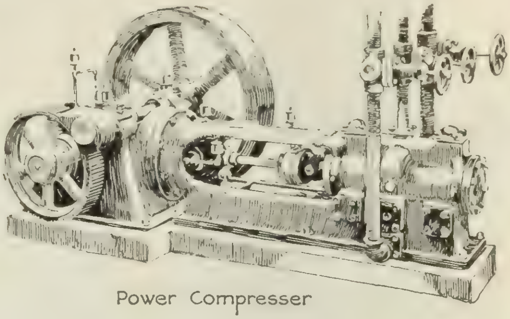
Views of Some Fittings and Apparatus That A



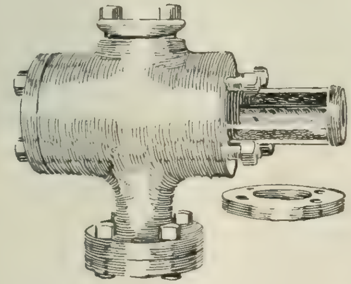
ommonly Used In Refrigerating Plant Practice



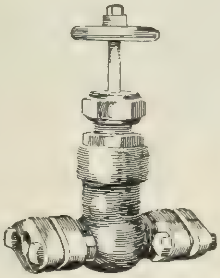
Double Pipe Condenser



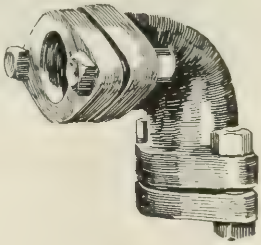
Power Compresser



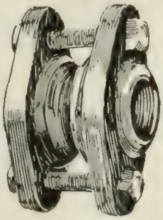
Liquid Ammonia Strainer



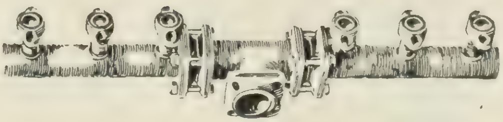
Expansion Valve



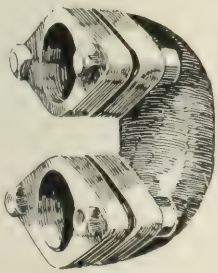
Elbow



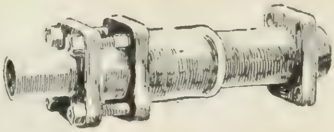
Flange



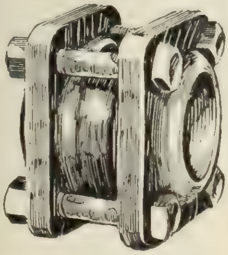
Header



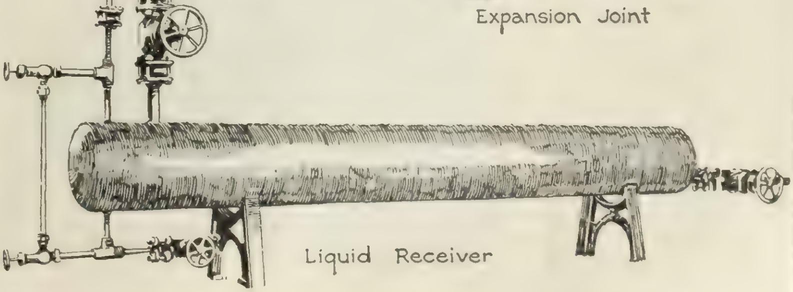
Return Bend



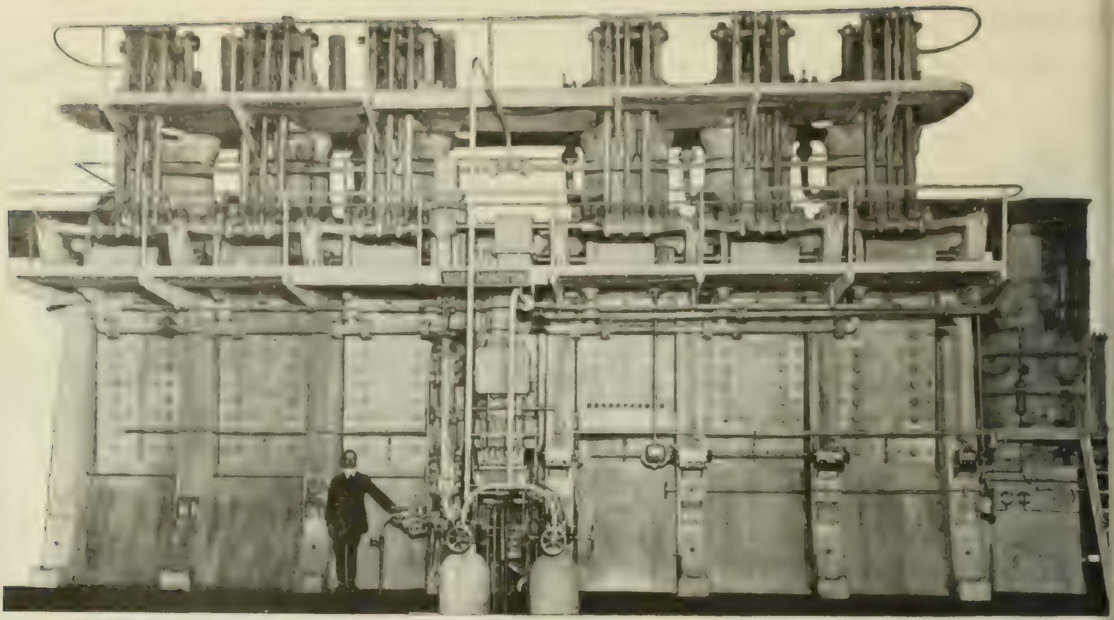
Expansion Joint



Flange



Liquid Receiver



Worthington 2,400-Horsepower Marine Diesel

THE Worthington Pump and Machinery Corporation has on the test floor at the Snow-Holly works a 2,400-hp. marine Diesel, which has been built from their own designs and which, incidentally, is the largest four-cycle marine Diesel yet built. The engine is of the vertical single acting crosshead type and has six cylinders mounted on cast-iron A-frames, which in turn are mounted on a bedplate, or base.

The bedplate is cast in two parts, which are held together by bolts passing through reamed holes. The transverse members of the base carry the housings for the crankshaft bearing; the housings are bored, so that the semicircular lower bearing valves can be removed by rolling them from under the shaft. The bottom of the base is cast solid, forming an oil pan. The frames, which appear in Fig. 1, are eight in number, and have a box section. The legs on the far side are solid, while each of the front legs has a gap at the base to allow the crankshaft to be removed for the yearly inspection. The gap is filled by a tapered block which is bolted and doweled into its place, thereby making the front legs as rigid as the rear ones. This feature, from the operating standpoint, is excellent. The frame, while it supports the cylinders and gives the necessary rigidity, is not called upon to bear any of the working stresses. These stresses are taken up by a series of tension rods that pass through the frames, tieing the cylinder bases to the bedplate.

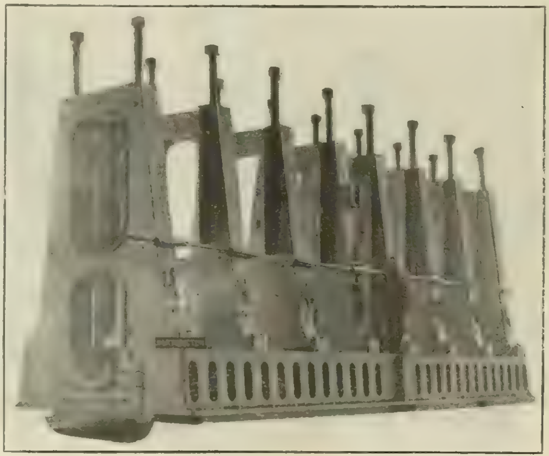


FIG. 1. ENGINE A-FRAMES

An unusual feature is the employment of bases for the cylinders. A casting is placed on the A-frames and in turn supports the cylinders. Each casting, or cylinder base, supports three cylinders and rests on four frames; stuffing boxes accommodate the pistons and prevent the ingress of water or fuel oil into the frame.

The cylinder, as will appear from Fig. 2, is made up of a cast-iron liner pressed into a cast-iron jacket, the jacket taking the axial stresses. The cylinder heads are of symmetrical design, openings being provided for the exhaust, admission, fuel and starting valves. The fuel-valve cavity is not located in the center, but is offset slightly. This gives more space for the cooling water. A copper thimble, or bushing, serves as the wall of the fuel-valve cavity.

Since a crosshead is incorporated into the design of the engine, the piston is short and rigidly connected to the piston rod, which is flanged at its upper end. The water for the cooling of the piston enters and leaves through telescopic tubes. The tubes are provided with caps and are of a length that effectually prevents leakage.

The crosshead guides are bolted to the rear legs of the frame. The slippers bear against the guides and are bolted to the square steel crosshead.

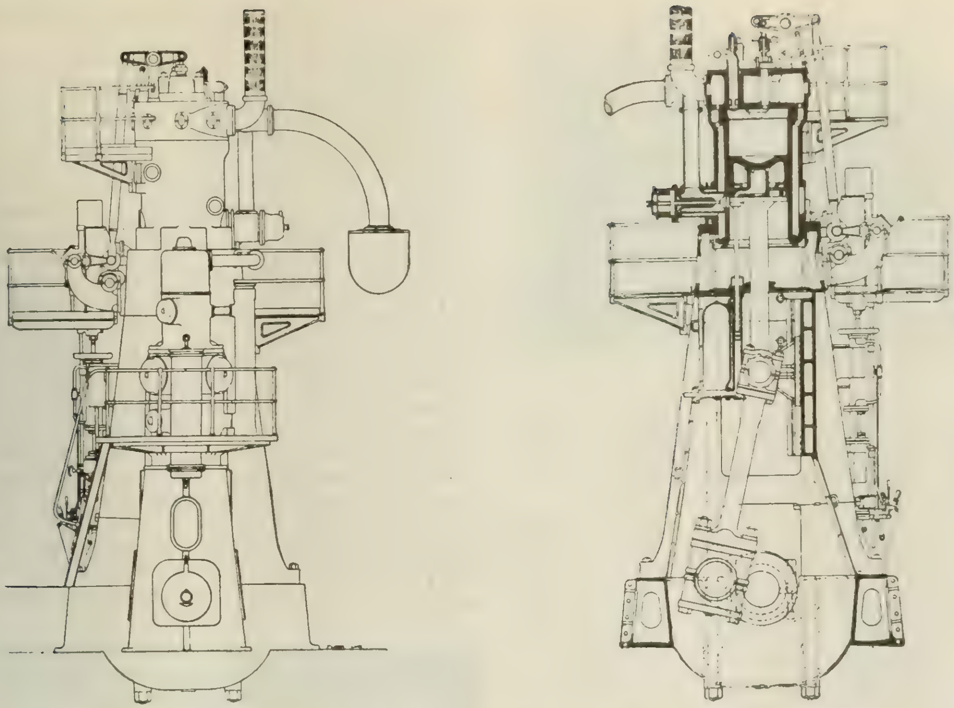


FIG. 2. SECTION AND END VIEWS

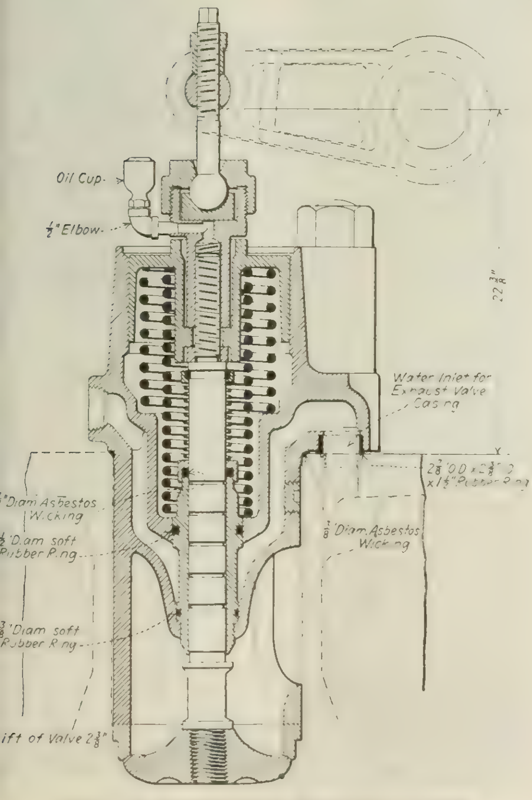

Oil Cup
$\frac{1}{2}$" Elbow
$22\frac{3}{8}$"
Water Inlet for Exhaust Valve Casing
$2\frac{7}{8}$" O.D. × $2\frac{3}{8}$" I.D. × $1\frac{1}{2}$" Rubber Ring
"Diam. Asbestos Wicking
$\frac{1}{2}$" Diam. soft Rubber Ring
$\frac{3}{8}$" Diam. Asbestos Wicking
$\frac{3}{8}$" Diam. soft Rubber Ring
ift of Valve $2\frac{3}{8}$"

FIG. 3. ADMISSION AND EXHAUST VALVES

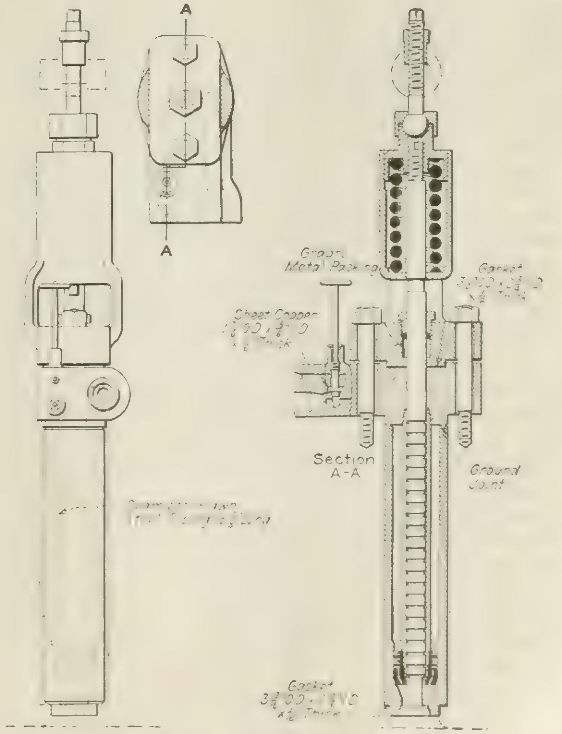


FIG. 4. FUEL, OR SPRAY, VALVE

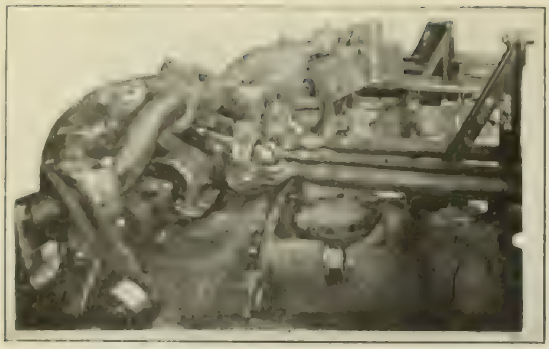


FIG. 5. VIEW OF THE CAMSHAFT

The cranksaft is in two sections, bolted together by means of flanges. The crankpin bearings are of a standard marine type, compression being altered by shims between the bearing and rod.

The admission and exhaust valves, with their cages, Fig. 3, are interchangeable and provision is made for watercooling, although only the exhaust-valve cage is connected up to the water system. The use of two springs with each valve is another attractive feature; stoppage of the engine because of a defective spring should be eliminated by this design. Stuffing boxes on the valve spindles seem unnecessary, but leakage is undoubtedly prevented. False seats for the valve cages are features that are worthy of remark. The valve stem is of steel and is screwed into the cast-iron valve and riveted over.

The fuel, or spray, valve, Fig. 4, is somewhat unusual in American design, having the valve opening inward; this is quite like the Burmeister & Wain plate and, it is claimed, gives a better shape to the valve. The design eliminates the customary flame oil spray as it enters the cylinder. The wiredrawing across the seat should effectually prevent any particles from being deposited on the valve seat. The valve cage has a copper gasket at the lower end. The upper end of the body has a ground joint with a flange which carries the air and oil connections. Above this flange is bolted a block carrying the valve-spring dashpot. The oil passes into the cage through a copper tube, covering the top and openings of the atomizer discs. The top flange is equipped with a bypass valve to clear the oil line of any air that might be present.

In addition to the main exhaust valve an auxiliary exhaust valve is placed in the cylinder barrel well toward the bottom end. The piston, as it nears the end of the power stroke, uncovers this valve. Since the spring holding the valve seated has but little strength, the pressure opens the valve, allowing the major part of the charge of hot gases to pass out through this valve. The main exhaust handles only a small part of the gases. On the compression stroke, the air has a very low pressure during the interval before the piston covers the auxiliary valve, consequently the valve remains closed. This feature should do much toward lessening the number of stoppages at sea to regrind valves.

The various valves are opened by rockers actuated by push rods. The rods are seamless steel tubing with welded forged steel ends. The lower ends, which bear rollers, are linked to the reversing shaft, as is shown in Fig. 5.

The fuel pump consists of a steel box with a plunger for each engine cylinder. Control is secured by limiting the lift of the suction valves, quite similar to the arrangement on a number of other Diesel engines. The plungers and the suction-valve tappet shafts are driven by two eccentrics mounted on the top wheel of the camshaft gear train drive. Fig. 6. shows the pump and control levers.

The reverse and control are obtained in a very simple and positive manner. An air cylinder *B*, Fig. 6, is provided with a piston and rod. The rod at its upper end is fitted with a rack and a cam plate. This latter bears against rollers fastened to the camshaft. The rack engages a pinion keyed to the reverse shaft. When the handle of the reversing valve *A* is thrown to "astern," the air enters the lower part of the air cylinder *B*. This forces the piston rod upward. The rack revolves the reverse pinion, which rotates the reverse shaft. The links connected to the valve push rod then pull the rollers out of contact with the cams. The cam plate on the reverse piston rod has moved upward during this period, and as the rollers clear the cams the curve on the cam plate engages the roller block and

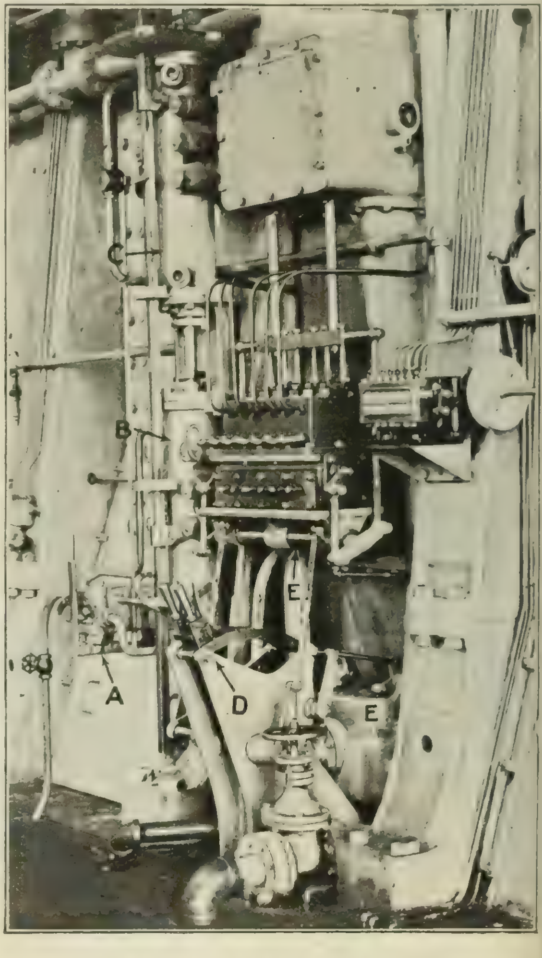


FIG. 6. FUEL PUMPS AND CONTROL

shifts the entire camshaft to the right, bringing the astern cams under the rollers. Further movement of the rack brings the push rod back onto the astern cams. An oil cylinder *C*, Fig. 6, equipped with a bypass valve actuated by the reverse lever, effectually locks the reverse in position. The engine is now ready to run astern.

Two control levers *D* are provided, thereby allowing three cylinders to be cut out when running at low speed. After the reversal has been accomplished, the control ever is moved inward. When the lever reaches its irst position, the air valve *E* is opened. As the engine comes up to speed under the influence of the air which s admitted into all the cylinders, the control lever is hifted farther inward; this cuts out the air and admits he fuel. The fuel pump is controlled by the shaft *E*, vhich alters the opening of the pump-suction valves.

The air compressor is located at the forward end of he engine frame, being driven by a crank on the main crankshaft. This serves to lengthen the engine; undoubtedly on larger units the compressor should be lriven by an independent engine. The compression valves are the well-known Laidlaw feather valves. Intercoolers and aftercoolers are provided.

Forced-feed lubrication is used on all the principal parts. A motor-driven pump draws the oil from a ump below the engine-room floor and discharges it at 5 lb. pressure into a fore-and-aft header on the outboard side of the engine. Branch pipes lead to all the nain bearings; the crankpin is fed through diagonal holes from the main bearing. From the crankpin the il flows up through the connecting rod, lubricating the vristpin and crosshead guides. The used oil drips lown into the engine, from where it is collected and passed through an oil filter.

Salt water is employed for cooling purposes. The ntire crankcase is sealed against the entrance of the vater, eliminating all danger of injuring the lubricating roperties of the oil. The general dimensions of the ngine are as follows: I.hp., 2,400; b.hp., 1,750; n.e.p., 85.5; mechanical efficiency, 75 per cent.; bore, 9 in.; stroke, 46 in.; compression, 500 lb.; injection, 00 lb.; main bearings, 17½ x 24 in.; crankpins, 18 x 15 n.; wristpins, 10½ x 9½ in.; length, 55½ ft.; height, 3¾ ft.; weight crankshaft, 36½ tons; weight engine, 39¼ tons; weight per i.hp., 327 lb.

Checking Four-Wire Three-Phase Switchboard Wattmeters

By H. C. Yeaton

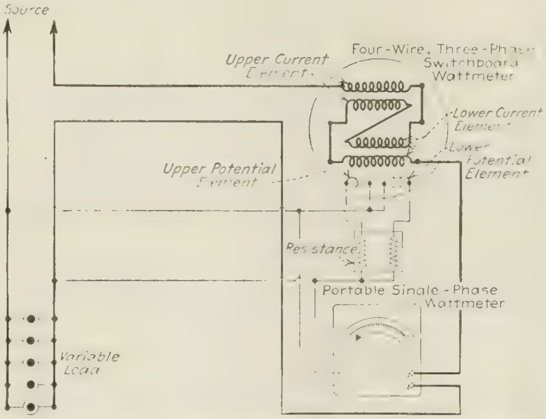
The accuracy of all switchboard instruments should e frequently checked to ascertain that they are unctioning correctly. The following explains the eneral method of checking a four-wire three-phase witchboard wattmeter:

Short-circuit the current transformers, if the instrument is used with current transformers, and then disconnect the wattmeter from the circuit. The switchboard wattmeter should then be connected, together vith a single-phase portable wattmeter, on a single-hase circuit, as shown in the figure. A variable load s shown in the diagram, which is for obtaining differnt readings. All current coils of the switchboard wattneter are connected in series, and the potential coils, toether with the instrument resistances, are connected cross the circuit.

The current winding of the single-phase portable wattmeter is connected in series with the current windings of the switchboard wattmeter, and the potential winding of the portable meter is connected across the circuit. It is therefore obvious that the current that passes through the current coils of the switchboard wattmeter also passes through the current coil of the single-phase portable wattmeter. The potential across the potential elements of the switchboard instrument is the same as that across the potential element of the portable meter.

The calibrating watts per element of a four-wire three-phase wattmeter are equal to *Scale Reading* ÷ *Current-Trans. Ratio* × *Potential Trans. Ratio* × 4. Therefore, by determining the calibrating watts of the switchboard four-wire three-phase wattmeter from the foregoing formula, its scale readings may be checked with the single-phase portable meter.

Suppose that the four-wire three-phase wattmeter is used on a circuit of 2,200 volts and 100 amperes. Each potential transformer has a ratio of 20:1 (that is, 2,200 to 110 volts), and each current transformer has a ratio of 20:1 (or 100 to 5 amperes). The watts of the circuit would be 2,200 × 100 × 3, or 660 kw.; but as a 660-kw. scale would have rather an uneven ending, a 700-kw. scale would probably be selected.



WIRING DIAGRAM FOR TESTING 4-WIRE 3-PHASE WATTMETER ON SINGLE-PHASE CIRCUIT

Connect the instruments on a 5-ampere 110-volt circuit as in the figure. If the pointer on the switchboard wattmeter indicated 600 kw., then the calibrating watts for this point would be equal to $\frac{600,000}{20 \times 20 \times 4}$ = 375 watts, and the switchboard meter would be correct if the portable meter read 375 watts. By substituting the readings 100,000, 200,000, 300,000, 400,000, 500,000, 600,000 and 700,000 in the numerator and dividing by the denominator 20 × 20 × 4, the following calibrating table is obtained:

Switchboard-Wattmeter Readings in Kilowatts	Calibrating Watts per Element of Switchboard Wattmeter	Portable Wattmeter Readings in Watts
100	62 5	62.5
200	125 0	125 0
300	187 5	187.5
400	250 0	250 0
500	312 5	312 5
600	375 0	375 0
700	437 5	437 0

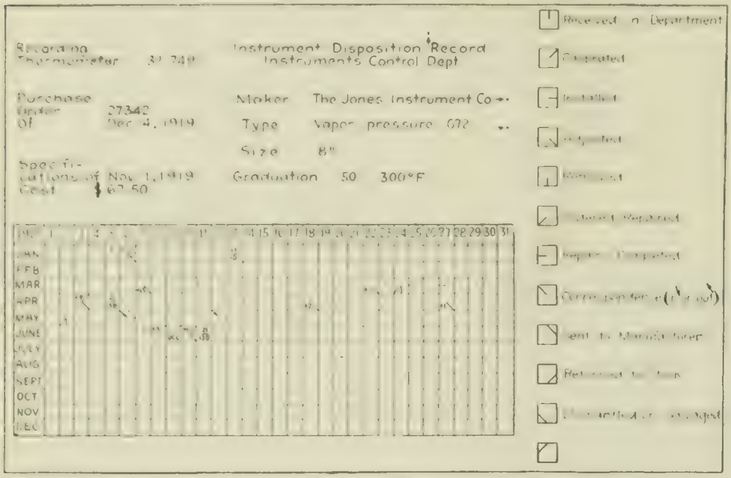
Other readings may be checked in the same way, if required.

An Instrument Record System

By Frederick J. Schlink

The card-record system herein illustrated is in the main a combination of the author's type of progress-of-work charting scheme, combined with some of his methods of card-index operation. The system to be described has provided the rather complex and minutely detailed information required of it so satisfactorily that it is thought that others having control of instruments or similar plant units in considerable numbers might find it useful.

The illustration gives the code of symbols used in the card form of record, each of these symbols being drawn within a square corresponding to the date on a printed and ruled 4 x 6-in. card form. The reverse of the card is cross-ruled to care for a second year's entries. By using a 5 x 8-in. or even 8½ x 11-in. card, four or more years could readily be recorded without using a second card for the same instrument. The specimen card, considered with the code, will be self-explanatory; the table, however, gives a complete enumeration of the significance of the symbolic entries in the date area.



INSTRUMENT RECORD SYSTEM AND KEY OF SYMBOLS

READING OF SYMBOLS AS INDICATED ON CHART

Jan.	5	Received in Instruments Control Dept
Jan.	6	Calibrated; error = +2.0°
		Adjusted
		Returned to stock.
Jan.	13	Installed on heater 10, Dept. 13.
Mar	7	Adjusted down (to agreement with mercurial thermometer) on account of a discrepancy of + 1.0 deg
	22	Adjusted down (to agreement with mercurial thermometer) on account of a discrepency of +1.0 deg.
	24	Removed
		Ordered repaired
	25	Completion of repairs promised
	27	Repairs actually completed
Apr	3	Calibrated; error + 0.8 deg.
		Adjusted
	5	Installed on heater 13B, Dept. 21
	18	Adjusted down (to agreement with mercurial thermometer) on account of a discrepancy of +2.0 deg
	27	Adjusted down (to agreement with mercurial thermometer) on account of a discrepancy of + 1.0 deg.
May	2	Removed from heater
		Ordered repaired
	6	Sent to manufacturer, with outgoing letter
	12	Incoming letter
June	7	Instrument (again) received in Instruments Control Dept
	8	Calibrated: error +0.5 deg.
	9	Special permanency test on the thermometric oscillator
	10	Calibrated again: error increased to +1.0 (as result of oscillator test)
		Adjusted
	11	Installed on heater 13B, Dept. 21

Arrows will be noted at points on the upper and right-hand margins of the card; the former has been applied to mark a black ink dot on the top edge of the card, which by its position alone (measured from the upper left-hand corner of the card) shows exactly on what plant unit and in what department the instrument was last installed. Each 0.02 in. from the left-hand edge of the card corresponds to a different numbered heater or press; a maximum of $\frac{6}{0.02}$ or 300 different plant units can be indicated in this way on the 4 x 6-in. card. On a larger card it would be advantageous to open up the scale somewhat, if possible, in order to facilitate finding of the dot; 0.03 in. or 0.04 in. would be a more desirable spacing. Finding the edge dots by means of a simple sheet-metal gage or master card which is run along the top edge of the record cards while they remain aligned in the file drawer, permits of the instrument card being located even when the identification number of the instrument is not known, but only the number of the production unit on which the instrument is used. The primary arrangement of the cards is in order of the serial or identification numbers of the instruments themselves. The two dots on the right-hand elge show that the instrument has been subjected to the regular monthly inspection during April and June, the month positions being measured from the upper right-hand corner of the card. When all inspections of a given month have been completed there will be a continuous line of such dots from front to back of the file of these cards in the appropriate position, which enables any instruments that have been missed by accident or other cause, to be at once detected without the necessity of handling the cards individually. For further information on this method of recording, the reference of footnote 2 should be consulted.

The writer sees no reason why this method, which has proved completely adapted to work on measuring instruments, should not be well adapted also to other plant equipment of which a performance history is kept, such as electric motors, elevators, etc. The general principles shown are capable of wide extension and modification in details for particular purposes.

Suggestions for the Semi-Diesel Engineer

The hot-bulb or combustion chamber should be cleaned very frequently. If a heavy oil is burned, a monthly cleaning is about correct.

Don't fail to close the water-injection valve when stopping the engine. If this is neglected, the cylinder may be flooded.

If the ignition device is hot, open the water-injection valve as soon as the engine begins firing. This will eliminate the danger of the cylinder-head joint leaking.

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[1] "An Improved Progress-of-Work Chart," *Journal* of the Franklin Institute, May 1918, p. 186.

[2] "Getting the Most Out of Index Cards," *Industrial Engineering*, Feb., 1918, p. 135.

EDITORIALS

Both Suffering from Past Ill Repute

SYNCHRONOUS motors in many industries have come to be recognized as an efficient means of driving various classes of equipment and have even been developed to the point where they may be started and stopped automatically, in a manner similar to the direct-current motor or induction motor. Yet the record of this machine during its early applications still remains and undoubtedly has acted as a deterrent to its more general use today.

When synchronous motors were first used, they were nothing more than alternating-current generators applied to motor service. These machines, when operated as generators, had characteristics that were far from satisfactory and, when applied as motors, gave all kinds of trouble. First, they had to be started by some auxiliary source and brought up to speed and synchronized before being connected with the source of power, after which the load was applied through a mechanical clutch or other means. After these early types of motors were on the line, they had a tendency to hunt and to try to adjust themselves to every disturbance on the circuit; as a result the operation was in general unsatisfactory. However, when these machines were designed as motors with squirrel-cage windings in the pole faces, they developed characteristics that compare favorably with other types of alternating-current motors and in some respects they are superior. But this type is still suffering from the ill repute it fell into in its early application.

The mechanical clutch that was used to connect these machines to their loads, and for many other applications, developed anything but an enviable reputation, its reliability being low and its maintenance high. Therefore as pointed out in the Electrical Development Committee Report of the Association of Iron and Steel Electrical Engineers, presented at the Fourteenth Annual Convention, "the magnetic clutch, purely by reason of its name 'clutch,' has fallen heir to the ill repute of the mechanical clutch." However, experience with synchronous motors applied to various heavy drives through magnetic clutches, in rubber and cement mills, has shown this combination to give entire satisfaction. The clutches are easy of application, have low maintenance charges, are simple to adjust and are readily adapted to remote control, which makes them adaptable as safety devices where necessary. Because of the current lag the clutch requires a considerable period to reach full strength. Thus the load is automatically applied gradually to the motor.

These clutches have been successfully applied to synchronous motors up to six hundred horsepower in size. Whatever the bad record of the predecessor of the modern synchronous motors and magnetic clutches may have been, modern designs have proved their reliability by several years' service in very heavy application, and the future should see a wider application of synchronous motors to heavy-duty applications.

A Field for the Gas Producer

DISCONTINUANCE of the natural-gas service to all industrial plants will be in effect very shortly in all the Central States. This action is absolutely necessary to insure a supply of gas to meet the domestic demand. As a result of this step several hundred power plants now using natural-gas engines are confronted with a decidedly serious problem. In many cases the rate quoted for electric power makes this service out of question; in other instances electric service cannot be secured at any price. The investment required for the installation of an entirely new plant would be a somewhat undesirable burden to many.

The gas producer offers the cheapest and most economical solution. As the plants now stand, nothing is required to change to producer gas beyond the installation of the producer and, in some cases, change of cylinder compression. Using buckwheat anthracite, a brake horsepower can be obtained from less than one and a quarter pounds of fuel. This economy will compare favorably with natural-gas at twenty-five cents per thousand cubic feet.

The gas producers of the past enjoyed a somewhat unfavorable reputation. In almost all cases of producer failure, it is a matter of record that bituminous coal was used. Even though the fuel expense is slightly higher, only anthracite should be burned in these small producers. The type of operator that is available is quite superior to that of past years. The present operators of the natural-gas engine should easily develop into high-grade producer men.

The natural-gas situation opens up to the manufacturer of small and medium gas producers a field that should not be neglected. Unlike in former years, the prospect has already been educated to the advantages of gas-engine power. It only remains to convince him that a particular producer meets the requirements.

Commendable Co-operation

THE controversy that waged so briskly a few years ago between the central station and the isolated plant now appears to be a thing of the past. Not that the central station, like the proverbial whale, has completely swallowed the isolated plant, for there are a goodly number of the latter still grinding out kilowatt-hours, nor has the central station fared badly, as is attested by the number of extensions and new plants of large capacity now under construction. Therefore, one must look farther for the reason. There are apparently several contributing factors:

In the first place the demand for power in general far exceeds the capacity to serve, and it behooves the central-station salesman to seek only the more desirable loads. Secondly, the high cost of fuel and labor has been responsible for the shutting down of many of the inefficient private plants and leaving those whose load conditions and exhaust-steam demands justify their independent existence. Thirdly, there appears to be a disposition on the part of many of the central station companies to recognize and co-operate with the latter class of plants.

One of the largest central-station companies in the Middle West has adopted a broad policy of co-operation with its industrial customers. It advises those that have private plants installed to retain and operate them in conjunction with the central-station service at such load as will secure the most economical heat balance, merely reserving the privilege, in cases of necessity, of cutting off service to the extent of the remaining capacity of the private plant. Thus both parties are benefited, the industrial plant by securing more economical operation and the central station by securing what amounts to the same as reserve capacity.

Now, when the attention of the engineering profession is centered on the interconnection of power systems and the elimination of fuel waste wherever possible, a wide application of the aforementioned practice would aid materially to achieve the results aimed at.

Brighter Economic Skies

WITHIN four or five days after the calling of the strike on the Brooklyn Rapid Transit Company's system, the company is reported to have had about three thousand strike breakers on the job. Some time previous to this the Pennsylvania Railroad astounded everybody by announcing that twelve thousand men on the eastern end of that system were to be laid off and transferred. In Akron, Ohio, recently, men to the number of thirty to ninety thousand are reported to have been laid off; rumor has it that so fast did men leave that town that the railroad office ran out of tickets. As other examples, we have seen what happened to the silk and shoe industries.

Contractors all over the country report an appreciable increase in output of the men engaged in the building trades. Textile workers here and there are reported to have sensibly accepted slight reductions in wages. Talk with employers about the country, particularly in industrial centers, and you learn that so many men now come in answer to advertisements for help, that employers can make happier selections than have been possible in years.

Reports from Italy tell of a million Italians ready to come to this country as soon as they can get passage and are allowed to clear.

Many industries in New England are again getting started, on part capacity at least, after a long period of idleness.

The conditions are not ominous. They are encouraging. They mean that business is at last beginning to get back on a sound economic basis—certainly more sound than we have known for the last few years. The break, which doubtless is here, simply had to come. Things could not longer have gone on as they were going. From now on one may reasonably expect that there will be fewer staggering demands by labor, fewer attempts at ruthless profiteering, less arrogance by the seller and greater confidence and equanimity on the part of the buyer. A department head may soon be able to talk freely with men who need it without fear of precipitating a crisis in his plant. It begins to look as if the dollar is soon to be, not what it was before the war, but a little more of its former self than it has been for a long time.

American labor and American business must not forget that Germany, which in the years before the war demonstrated remarkable commercial development, is burdened with a staggering debt, that she will soon be felt as a competitor in world markets. She must get the business. And a nation, like an individual, stimulated in an emergency, is likely to do things that would give the less agitated pause.

Let us get back to work.

Emergency Drills

IN MOST factories and industrial establishments fire drills have become an established practice. The fact that they are held is no indication that the premises are especially susceptible to fire. They are merely a precaution to insure that in such emergencies everyone will know just what to do and, as a result of repeated rehearsal, will do it almost involuntarily.

Just so with the operation of any large power plant or power station. Accidents and disturbances within or without the station are always a probability in spite of preventive measures. It is most important at such times that the operators think clearly and decisively in order to do just the right thing and prevent multiplication of the trouble or sustained interruption to service.

Considering the intricacies of the modern power station and electrical system it is a tribute to engineering skill and design that troubles are not more frequent. Notwithstanding protective and automatic devices nothing will take the place of an alert and properly trained personnel.

One of our large electric companies has long made it a practice to hold regular Sunday drills in handling anticipitated disturbances. It is understood that the results have been most gratifying. While it is imposible to estimate the saving thereby effected, it is undoubtedly large. The practice is worthy of application to all power plants.

During the war woman proved her capability in almost every industrial pursuit, and her services during those strenuous times were welcomed. However, it was not long after the signing of the armistice that she began to find herself being crowded out of her newfound sphere by her brother worker. Although this condition to a limited extent prevailed in this country, it was of far greater magnitude in England and continental Europe. As a result there has recently been formed in London a Women's Engineering Society. Information as to whether this society is a trade union or an engineering society, as we know such bodies in this country, is not available. However, what such a society will develop into only the future can show.

There are still hopes that the real coal profiteer will be apprehended and given his just deserts. The men who run the price of coal up beyond reason by successive sales of the same coal with large profits on each sale are, it has been announced, to be the subjects of the newest campaign of the Attorney General against coal profiteers. Those that pay the high prices are patiently waiting to see something happen other than the price of coal go higher.

CORRESPONDENCE

Roof Condensation

For three years we had trouble with roof condensation, as mentioned in the editorial in the Aug. 31 issue of *Power*. We overcame this trouble as follows: Our engine room is 26 x 44 ft. with concrete walls and corrugated iron roof. We have 100 ft. of 2-in. pipe on the cold side of the room. On cold nights and Sundays we turn steam in these so that the oil cups will feed freely in starting mornings. After running about an hour, when the engine room begins to get warm, we shut off the heat; on very cold days the heat remains on.

If the roof drips or if it rains, we open the windows to lower the temperature. One window in the peak of the wall, which is opened and closed by ropes, is all we find necessary to stop sweating. **PETER BURKARD.**

Gladstone, Mich.

To Prosecute Coal Profiteers

In the Aug. 31 issue of *Power*, page 354, is an item stating that the Attorney General instructs all District Attorneys to investigate and institute prosecution in cases where unreasonably high prices have been exacted in the sale of bituminous coal. In the editorial entitled "Who Gets It?" on page 400 of the Sept. 7 issue, it is stated that the Public Service Corporation of New Jersey is paying $14 a ton for coal, that Mayor Creamer of Lynn, Mass., says that the coal dealers would sell quantities of coal at $16 per ton, and that Admiral Benson, chairman of the Shipping Board, is quoted as saying that the board is paying from $18 to $20 per ton for bunker coal at Atlantic and Gulf ports.

What does the Attorney General assume to be an unreasonably high price? If $14, $16, or $18 to $20 a ton for coal is not a high price, what would be considered such? It is quite evident that the readers of *Power* would like to know if the Attorney General purposes to investigate the dealers who are charging such prices and what he intends to do when he finds that they are. As a matter of fact, the general public has lost faith in any statement regarding proposed investigation of high prices, because such statements have been issued for the last three or four years and nothing has come of them.

To the best of my knowledge, the reason that there has been a reduction in the price of any commodity has been mainly the fact that the banks have withdrawn their credit and the holders of various merchandise have been forced to put it on the market in order to clear themselves financially. This seems to have been the case largely in the matter of clothing and shoes, but it would appear that the coal operators are not depending so much upon the banks for capital, or if they are, the banks are being lenient with them. Furthermore, with coal selling at around $9 a ton at the mines, the operators could afford to pay a pretty high rate of interest to banks out of the excessive profits that they must be making over the cost of production.

No engineer believes that it costs $3 or $4 to produce a ton of coal at the mines, and if it does no one will believe that the operators are not charging a price that will put them under the heading of the Attorney General's letter; that is, that they are charging unreasonably high prices for bituminous coal.

There may not be a conspiracy between operators regarding the upholding of coal prices, but it looks as if such a situation existed and that if they were all put in a bag and shaken up one would be just about as guilty as another. Engineers who are using bituminous coal for fuel would like to see the Attorney General's letter produce results, but few, if any, have any hope that it will. **J. W. WILBUR.**

New York City.

Has the Public a Right to Know What It Costs to Mine Its Coal?

The editorial on page 399 of the Sept. 7 issue of *Power* under the title "Has the Public a Right to Know What It Costs to Mine Its Coal?" would be answered by an emphatic yes by the men who burn and pay for it. The latest quotation of bituminous coal at the mines is $8. The quotation showing the average price per ton realized at the mines as published in its editoral was, in May, $3.31. Therefore, in a period of four months, the price realized at the mine has advanced from $3.31 to between $8 and $9.

No sane man will attempt to make the statement that the increased cost of production is responsible for this rise in the price of coal at the mines.

Early in 1914, if the coal producer obtained $1.25 per ton for coal at the mines, he was getting a high price. By the experts who have so profusely given figures regarding the reason for the advance in the cost of practically everything, we are told that the production cost has increased 100 per cent. If this is true of the average commodity, it is doubtless true regarding the production of coal, but even then it does not give a justifiable reason why the price of coal should be between $8 and $9 at the mines as at present.

One reason that would doubtless be given for prevailing prices is that the producer can obtain such a price, which conditon is brought about by the scramble of all coal users to get in a winter's supply, and everybody is doing it at once. It is to be hoped that the bottom will fall out of the market some time, but there is no evidence that it will do so until a permanent restriction is placed upon the tremendous amount of coal that is to be exported, if newspaper reports are reliable.

Quotations show that steam coal at tidewater is bringing from $12 to $15 per ton. In a recent conversation a coal dealer in the vicinity of New York City stated that, while he dealt only on a small scale in bituminous coal, he knew of instances where $18 per ton was being paid.

It is to be hoped that the Federal Trade Commission will be able to enforce its demand that information regarding the cost of producing coal will be made public, but it is doubtful. Furthermore, when coal operators are receiving $8 or $9 a ton for the coal at the mines, it is to be expected that they will do everything in their power to prevent the public from knowing what it costs to mine a ton of coal. J. W. Edwards.

New York City.

Where Should the Beginner Start?

The discussion that has been carried on regarding the question as to where a beginner in a power plant should start, hinges largely upon the mental and physical qualifications of the candidate for the engineering job. It would be useless to start a man in an engine room with the idea of making a competent engineer out of him if he were the sort of person referred to by C. F. Dewey, on page 402 of the Sept. 7 issue, where he states that a man had been on the same job for twenty years and could not put in a gage glass. Truly, such an individual will make a sorry specimen of an engineer.

On the other hand, there are many mechanically inclined men who have stepped into power plants as engineers without having had any extended previous experience. Of course, this cannot be done now under the license laws that are in force in various cities and states, but it goes to show that the man who is determined to become an engineer will do so, regardless of where he starts.

Taking my own case, for instance. Something like twenty years ago my ambition was to become a stationary engineer. My only experience had been two weeks' service nights without pay with the engineer of a small electric-lighting station in order to get an idea of how a plant was operated. In those two weeks, sometimes coming in on the day shift, I learned how to wash boilers, how to fire after a fashion, and gained a little knowledge in the operation of a steam engine and alternating generator.

After the two weeks' course in engineering, application was made for the position of engineer in a small electric-light station, and the position was secured. Therefore, with, you might say, practically no previous experience, I became a full-fledged engineer, having charge of two 90-hp. boilers, one 200-hp. Corliss engine and three direct-current generators.

No difficulty was encountered in operating the plant, although there was plenty to do, as it was in a run-down condition. And although it was not operated as efficiently as it could have been under a competent engineer, the residents of the town maintained that the service was better than it had been for years and the kerosene lamps that used to adorn the shelves of the stores handy for instant use, gradually disappeared. Since that time some years' experience has been obtained in both the engine and boiler room, but the chances are, had I started in the boiler room, it would have taken several years before I would have had a chance to hang up my hat and coat in an engine room.

In a certain plant in Ohio the practice with the chief engineer is to take men who seem to possess certain qualifications and place them in the boiler room, many times starting as coal heavers, advancing to firemen, and if they show the proper qualifications they are sent into the engine room. As a matter of fact, eight or ten men have been advanced from the boiler room to higher positions, and as the company operates several power stations, the men are frequently taken from one power plant to another, each time going to a better position.

If this were the practice in the majority of power plants, the argument that a man should start in the boiler room, if he is to become an engineer, would hold good. But in the majority of cases, if a man proves himself to be a good fireman the chief engineer is likely to keep him at that work rather than to advance him and run a chance of getting another fireman who would not prove as good.

Most engineers will agree with Mr. Dewey regarding the practice of employing illiterate and ignorant foreigners as firemen. I remember some years ago going into a boiler plant and upon asking a question of the fireman found that he could not understand what I was saying. Not one of the five firemen employed in that plant could speak English. They were under a chief fireman who held a license and was American born. It would seem that a boiler room operated with such men would be considerably handicapped, especially as in case of an accident, foreigners usually become excited and lose their self-possession in case anything goes wrong.

It is safe to say that nine-tenths of the big engineers of today—that is, the chief engineers in medium and large-sized plants—started in the little two-by-four, so-called, years ago and that very few of them began their careers in the boiler room.

On shipboard, as I understand it, the boiler room is in charge of one of the lower-grade engineers, and it will be found in many of the larger plants that the chief fireman is a graduate from the engine room.

In my opinion the place for an engineer to start on his career is in a small plant where he will run the engine and also do his own firing. W. A. Reynolds.

Springfield, Mass.

Pit Holes in Feed Pipe

We are having trouble with small holes coming in the feed-water line between the heater and the boiler. In fact, we have had this trouble for a long time. The heater is of the closed type, and the temperature of the feed leaving it is around 190 deg. We have used black and galvanized pipe on this line, but within a few weeks after putting it in small holes will eat through the piping on the upper side of the horizontal run. No holes appear in the vertical lengths.

What causes the pipe to pit, and what can be done to remedy the trouble? I don't care for theories, but if any engineer has had the same trouble and can tell me how to overcome it, an act of humanity will have been done. The water used is highly pregnated with lime.

Ottumwa, Iowa. J. A. Wallace.

Side Slip of Crankshaft Caused Thump

Mr. Cultra's letter regarding trouble with split eccentrics, on page 475 of the Sept. 21 issue of *Power*, reminds me of a similar incident of an engine shaft slipping endwise with its resulting thump.

This was on a 125-hp. four-valve engine running at 98 r.p.m. and carrying a 12-ft. diameter flywheel. Every few revolutions there would be a dull thud, and its regularity indicated that something was out of order. What made it all the more puzzling was that the thud was out of time with every other movement of the engine.

Time after time the engine was examined, but the cause of the pound was not discovered until one day, while standing in front of the flywheel, I noticed that it made a sidewise movement, which was accompanied by the familiar thud.

This solved the mystery, and upon shutting down at noon a 4 x 4-in. timber was used as a lever against the rim of the flywheel to force the crankshaft toward the outboard bearing. Upon stopping it was found that there was a ¼-in. space between the eccentric and the nside of the pillow block, the eccentric acting as a collar to keep the shaft in place. The eccentric had gradually been forced away from the pillow block with the result that the shaft would run with the eccentric against the pillow block for a few revolutions and would then work away only to come back with a thud.

Setting the eccentric over against the bearing removed the cause of the thud, but as Mr. Cultra says, referring to his instance, had there been a shoulder turned on the shaft to fit against the end of the bearing, the eccentric would not have moved away from the bearing. A. C. WATERS.

Boston, Mass.

Indicator-Test Diagrams

The accompanying indicator diagrams were taken on a 16 and 32 x 36-in. Corliss, double-ported valves, cross-compound condensing engine, running 120 r.p.m. About half load was on the engine at the time, and several minutes elapsed between the taking of each diagram.

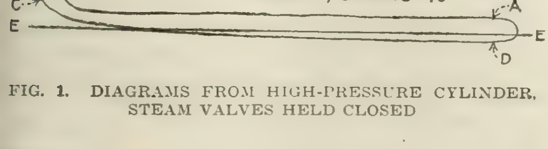


FIG. 1. DIAGRAMS FROM HIGH-PRESSURE CYLINDER, STEAM VALVES HELD CLOSED

As each diagram was taken, the steam valve on the end being indicated was kept closed by preventing the latch-block to engage, thus cutting off the admission of steam to the cylinder.

The idea of taking diagrams in this manner was to test the valves and piston for leakage. Referring to Fig. 1, *A* represents the instant the piston is at the extreme crank end of the cylinder with the exhaust valve open to the receiver and the full receiver pressure, about eleven pounds in this case, against the piston, retarding its movement toward the head end. *B* is the compression curve, *C* is the expansion curve, and *D* is the point at which the exhaust valve again opens. *E-E* is the atmospheric line. The letters on the diagram shown by Fig. 2 represent the same events. I consider the valves and piston tight. Any criticisms of these diagrams will be welcomed. GEORGE B. LONGSTREET.

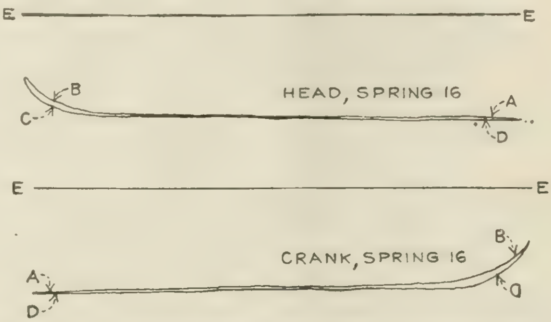


FIG. 2 DIAGRAMS FROM LOW-PRESSURE CYLINDER, STEAM VALVES HELD CLOSED

Medford Hillside, Mass.

Diesel Cylinder-Head Gaskets

In a small plant containing two 170-hp. Diesel engines the heads had cracked and had been welded. The welded portion, on cooling, became somewhat warped. These warped surfaces gave a great deal of trouble by leaking. It was impossible to tighten down on the regular copper gasket sufficiently to prevent this leak.

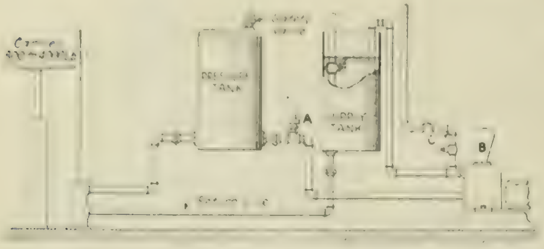
This was overcome by using No. 6 copper wire. The bare wire was cut with taper ends and was placed so that the ring pressed along the outside edge of the gasket groove. After the copper ring was placed, a small asbestos rope was placed alongside of the copper gasket, and the two were then lightly coated with red lead. After the head was set on the cylinder, the nuts were tightened down in the usual way. The copper wire can be drawn down a great deal and easily conforms to any unevenness of the joint. The asbestos rope and lead, being on the inside of the joint, will collect small carbon particles and thus will stop any small gas leak. This method has never failed to make a tight joint. When a new gasket has been placed it should be tightened up again after the engine has been in operation a short time. This should be done while the engine is still hot.

Some time ago, in another plant, a Diesel head gasket started blowing. The chief engineer shut the engine down and pulled the head. There was no extra gasket in stock, so the old one was cleaned and used again. As soon as the engine was started, the gasket started blowing again. Just as the engineer was about to pull the head again, the superintendent showed up and suggested an experiment. All the nuts were loosened except the two over the place where the gasket leaked. These two were sledged up as much as possible. The two adjoining nuts were then tightened; the remainder were tightened in rotation. The engine was started and ran without any leak showing. This is not the best of practice, but can be used in an emergency.

Brenham, Tex. W. A. DARTER.

Pound in Hydraulic Elevator System

The illustration depicts a hydraulic elevator system in operation at the plant where I am employed, and shows changes made to do away with pounding and groaning in the duplex pump. The pump had an air chamber and the safety valve was on top of the pressure tank. When lifting a heavy load on the elevator (located about 300 ft. away) through a 2-in. pipe the pump would pound at times so hard that it could be heard some distance from the engine room.



ELEVATOR SYSTEM AS NOW PIPED

We tried setting the valves of the pump according to the theory of lost motion, but this did not remedy the evil. We removed the safety valve from the pressure tank and placed it on the pump discharge line at *A*, thereby causing a more steady and constant working of the reducing or regulating valve on the steam end of the pump. Before this change was made, the safety valve would blow off frequently.

We next removed the air chamber *B* and drilled a hole in the intake pipe *C*, for a ⅜-in. pipe with a check valve in the line to regulate the amount of air taken in. The check valve is intended to keep the water from flowing out of the pipe if the elevator valves happen to be left in a partly open or closed position at the end of the day, so as to cause a blow back into the supply tank. This ⅜-in. air pipe has removed all the pound in the system, except at times when the valve must be regulated for the proper amount of air in the pressure tank. C. W. FIELDS.

Kent, Wash.

Pounding in a Semi-Diesel Engine

We have a 25-hp. Fairbanks Morse type Y semi-Diesel oil engine, also a 25-hp. kerosene engine. Each of these engines is belted to a 220-volt direct-current generator. On the peak load we carry about 210 amperes, which is above the engine ratings.

Our 25-hp. type Y engine runs very nicely when carrying up to 60 amperes. But from then on it begins to pound more or less. In fact, of late it is pounding more than usual. I am at a loss to fully understand the cause of the trouble. It must be either the fuel pump or the governor which is responsible.

As the load increases, the engine seems to smoke more than it should, and then at other times there will be but little smoke noticeable. About every three to four weeks the engine smokes terribly and the exhaust pot catches fire and burns out. These things then become normal for awhile. At present, though, the smoking is of everyday occurrence. I have felt that the fuel-injection pump might be throwing too much oil.

I have the mechanical oiler throwing more lubricating oil than usual; I have set the ratchet to feed a stream every 2½ seconds. This seems to allow the engine to carry a heavier load. I thought for a time that the excess lubricating oil caused the smoke.

What is the cause of the heavy smoke or the terrible pounding? Why does the engine die down then? When it dies down, all we do is to light the torch again and the engine starts running just as if nothing had happened. A person inexperienced with this engine would bet that every bearing was being knocked loose. I would welcome any information *Power* readers can offer.

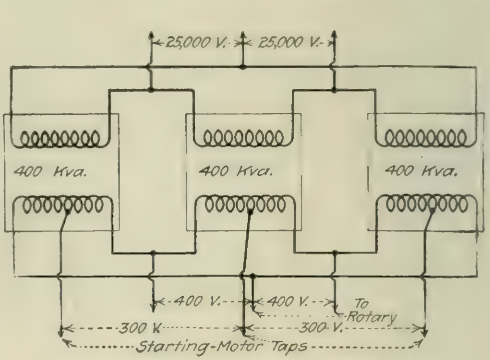
Winside, Neb. A. S. GABLER.

[*Power* will be glad to publish any communications from its readers offering a solution of Mr. Gabler's problem.—Editor.]

Open Circuit in Transformer

A substation supplying power to a particular district was thoroughly gone over in anticipation of a heavy load and was supposed to be in shape to handle loads up to 50 per cent over rated capacity. The rotary-converter transformers were cut out of service at midnight, and several electric fans were grouped about the bank to cool them down as much as possible before starting time in the morning.

The transformers were 3 single-phase 400-kva. units connected in closed delta, as in the figure, and stepped down from 25,000 volts to 400 volts, with percentage taps brought out to the rotary-converter starting motor. In the morning the transformers were cut into service and the rotaries started up. At the time of starting they were cold, but as the load increased they warmed up slightly. However, it was noticed that the temperature of one transformer was not increasing, while that of the other two was. This condition held throughout the day. The fans were removed from the cool transformer and turned on the other two to assist in cooling them.

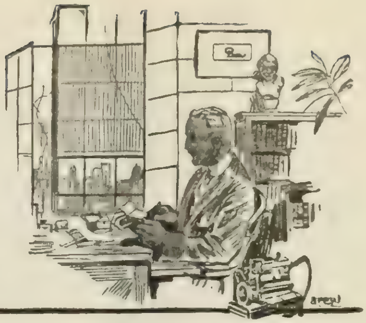


CONNECTIONS OF TRANSFORMER BANK

At night the cool transformer was cut out of service, and upon raising the core out of the case it was found that a connection between two sections of high-tension coils had burned in two, thus cutting the transformers out. In regard to the starting motor taps, the damaged transformer acted as an auto-transformer and the other two operated on open delta, thus giving three-phase current to start up with.

Pittsburgh, Pa. M. A. ANDERSON.

INQUIRIES OF GENERAL INTEREST



Repairing Piston Fire Cracks—I have a 100-hp. oil engine that has a fire crack in the piston head 8 in. long. Should I use cast or wrought brass to "sew" it? J. M. T.

It is necessary to use wrought brass since the cast brass will not admit of good riveting and will not stand up under the high temperature conditions.

Oil in Semi-Diesel Engine Exhaust—Why does my 50 horsepower semi-Diesel have a continual stream of oil dripping out of the exhaust, and how can this be remedied? E. S

Not knowing all the conditions, it is natural to assume that you are running your engine with the hot ball too cold or the fuel nozzle leaks oil into the engine late in the stroke. The remedy is apparent.

Feeding Boiler Compound—We are annoyed by clogging of valves of our boiler-feed pump from drawing soda-ash solution through the pump suction. How can this trouble be prevented? W. H. V.

A boiler compound or scale solvent should be introduced from a boiler-compound feeder discharging through a T in the feed line between the pump and boiler, and with special watchfulness to guard against stoppage of the feed line or impairment of operation of the stop and check valves or other fittings.

Casehardening Pins of Roller Expander—How can the pins of a roller expander be casehardened? F. A. K.

A quick process of casehardening small articles, like expander pins, is to plunge the part at bright-cherry heat into a box containing cyanide of potash crystals and then quench the piece at a dull-red heat. Cyanide is a deadly poison and should be handled accordingly. The operations of casehardening should be performed in the open air, the operator taking his position on the windward side of the cyanide, with care not to inhale or expose his eyes to any gases or vapors formed in carrying out the process.

Water Level Equalization Impractical—How can equalizer pipes be arranged to obtain uniformity of water level with a single-feed stop valve in a battery of high-pressure boilers? C. L.

Equalizer pipes of reasonable size cannot be depended upon for maintaining a uniformity of water level. This can be appreciated when it is considered that one inch difference of water level would result for a difference of only 1/27 lb. per square inch of pressure of steam generated, or from variation in loss of head of only 1 in. water-column pressure for overcoming the friction of flow in the equalizing connections.

Relative Efficiency of Injector—Is an injector as efficient as a reciprocating engine? H. K.

Considered as a pump, the mechanical efficiency of an injector is very low, amounting to only 1 to 2 per cent, whereas the mechanical efficiency of steam engines is from 50 per cent for small reciprocating engines to 97 per cent for the best pumping engines, depending on their design, construction and method of operation. When used for feeding water direct to a boiler, the injector has a thermal efficiency of 100 per cent less the trifling loss due to radiation, since all the heat not converted into work is carried into the boiler, whereas small direct-acting feed pumps, without utilization of the exhaust in a heater, give an efficiency of only about 50 per cent.

No Advantage Raising up Submerged Centrifugal—A centrifugal pump is operated submerged for raising water to a height of 75 ft. above the pump. Will the head pumped against and power required be reduced by raising the pump 8 feet? W. T.

The pump must operate against a pressure which is equal to the pressure due to the head above the pump, plus pipe friction, minus the pressure due to the head of the section water above the pump. This difference would be unchanged by raising or lowering the pump, excepting in the small difference of pipe friction due to variation in length of discharge pipe. Therefore, raising the pump and pumping at the same rate would require practically no less power for raising the water to the present elevation above the level of the suction water.

Designations of Pressure—What is the difference between absolute pressure, boiler pressure and gage pressure? J. B. S.

Absolute pressure is the total pressure above a perfect vacuum. Boiler pressure is the pressure resisted by the strength of the boiler, hence boiler pressure is absolute pressure less the exterior pressure of the atmosphere, or, as commonly expressed, is the pressure above atmosphere. The pressure of the atmosphere acts on the exterior of a gage tube or a diaphragm just as it acts on the shell of a boiler. Ordinary pressure and vacuum gages indicate 0 for the same pressure on both sides of tube or diaphragm, and the dial is laid off to indicate pressures above or below the pressure of the atmosphere, hence "gage pressure" means the same thing as "boiler pressure."

Crediting Value of Waste Heat Supplied to Boilers—Our boiler plant is completely equipped for oil burning, and some of the boilers are operated most of the time with heat obtained from waste gases of metallurgical furnaces; but at intervals it is necessary to operate the whole plant with fuel oil. How can the monthly service of waste gases be credited to the furnaces in terms of barrels of fuel oil saved? R. G.

To evaluate the service, it would be necessary to determine the total number of pounds of water evaporated per month by the boilers when supplied only with waste gases, reduce the evaporation to equivalent evaporation from and at 212 deg. F., and ascertain the equivalent evaporation from and at 212 deg. F. for the same boilers when operated as nearly as possible with the same average output, using oil as fuel. The evaporation per month using waste gases divided by the evaporation obtained per barrel of fuel oil will give the number of barrels of fuel oil to be credited.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

N.A.S.E. Annual Convention at Milwaukee

THE biggest and best ever was the verdict of those attending the thirty-eighth annual convention of the National Association of Stationary Engineers, held in Milwaukee Sept. 13-17. The attendance was large and enthusiastic, and the proceedings of the convention were conducted with businesslike dispatch on schedule time. Credit is due the local committee for attention to detail. The auditorium made an ideal place in which to display the great variety of power-plant products, there being 274 booths, and to hold the business sessions and the entertainment that had been provided.

DELEGATES AND THEIR GUESTS ATTENDING THE THIRTY-EIGHTH ANNUAL CONVEN

At the opening session Tuesday morning Charles F. Bindrich, chairman of the local committee, presided. There were the usual speeches of welcome and responses by officials of the association. President Calahan delivered an eloquent address upon taking the chair to open the convention officially. In his report the president called attention to the membership drive during the year, which had resulted in adding to the roster 1,500 members, and the formation of eight new local associations. The aim had been to place these new associations in localities where there would be a real chance for growth, so that they might prove to be prosperous and permanent organizations, adding to the support of the national body and giving a nucleus for continued growth in the future. Owing to the activities in the president's own state, New Jersey, his state had risen from sixth to second place in membership.

In his recommendations the president urged strong protest in regard to the discrimination against engineers in various government departments at Washington. It appears that a bill is now pending changing the title of engineer to "engineman," and prohibiting the promotion to the position of mechanical engineer or superintendent. The same restrictions would not be in force against electricians. The president objected to the appointment of a national educator, urged by the Educational Committee, as in his opinion there was enough talent in the organization to conduct the work successfully along the same lines as in the past. Later on the convention concurred with his opinion. He favored the appointment of a special committee to choose the convention city, requested authority for the incoming president to appoint a committee to carry on the membership-extension work, providing them with a fund of $3,000 to cover expenses, and was in accord with the agreement drawn up by the engineers and exhibitors to govern their working relations. This agreement was approved later by the convention.

Reports to the secretary from 231 associations showed that the membership totaled 20,721. Finances were reported to be in a flourishing condition. The income during the year of $44,488.44 was the largest on record. The License Committee had been active and had succeeded in establishing local license ordinances in Racine and Stevens Point, Wis., and Wilmington, Del. A comprehensive bill is now pending in Baltimore. To improve the efficiency in this work, it was recommended that a committee of five be elected, the term of office to be five years, with one member retiring at the close of each annual convention.

The Membership Extension Committee reviewed fully their work of the past year, outlined a plan of action for the coming year and recommended an appropriation of $3,000 to carry on the work.

Correspondence received by the Power Plant Cost Committee had convinced them that accountants pay little attention to cost details and their separation into unit charges. They are interested principally in the cost of heat, light and power as a whole, so that in their reports engineers should be guided accordingly. To promote greater interest in the keeping of accurate operating costs, the committee suggested prizes for the systems giving the best results, details to be given in articles appearing monthly in the *National Engineer.*

Among the referendum proposals appeared a resolution to change the name of the association by eliminating the word "stationary." Its use had created a false impression before the public. In any event the profession had become so diversified that this word did not designate properly. It was realized that legal difficulties would be encountered, so a committee was appointed to investigate thoroughly and report their findings to the 1921 convention.

Another matter for referendum was the increase of the mileage rate to delegates. The balance in the treasury after all expenses have been paid is to be divided among delegates pro rata, according to the number of miles traveled, but in no case to exceed ten cents per mile one way.

As is customary, the National Ladies' Auxiliary was received by the convention and was granted the usual donation of $100. It had been a banner year for the ladies as donations had totalled $4,374. The annual memorial service was impressive. On the roll were 186 members of the organization. Associations winning flags for appreciable gains in membership were more numerous than usual, 55 being entitled to the honor. The Life and Accident Department reported the payment of 59 claims amounting to $29,500, a reserve fund of $5,059.57 and a membership of 3,341, representing a gain of 23 members during the year.

As has been the practice of the past few years, reports were presented in abstract to give time in the convention for technical papers and welfare discussion. This year three papers were read. One entitled "The Progressive Engineer," by H. P. Wilder, traced the development in the field, the progress that had been made in the profession and enumerated the qualifications that a progressive engineer should have. In a paper on "Science and Engineering," Prof. B. G. Elliott urged the necessity of engineers becoming familiar with the fundamental laws on which engineering is based, as their tasks were daily applications of these laws. The speaker showed how simple these laws really were and suggested that the time had come for the association to adopt a stronger educational plan. Dabbling here and there in one subject or another did no good. Consistent courses followed through under the supervision of an educational director was the plan to be recommended.

"Capacity and Maintenance," by Charles A. Cahill, was the third paper. Because central stations generally worked equipment to the limit during the peak load to hold down investment and consequently overhead, he did not believe that such practice should be adopted generally by industrial establishments. The results were excessive maintenance costs and, with troubles continually piling up, a demoralized operating force. It was his opinion that the size of units should be proportioned to the capacity of the station, and that all equipment should be operated at the point of highest efficiency. Money should be appropriated yearly to keep the plant in strong operating condition. An engineer who has foresight to anticipate and correct beforehand is worth five times as much as one who can patch a thing up after it smashes through neglect. So-called improvements should be carefully weighed to make sure that they will bring adequate returns. Present high prices called for careful work in the power plant and an adequate system of records, and those who wish to attain the highest possible success will do well to devote more attention to human engineering.

Entertainment consisted of a smoker Tuesday evening moving pictures of Milwaukee industries on Wednesday evening, annual entertainment of exhibitors Thursday night, Friday night being given over to the closing feature, the grand ball. There were daily band concerts in the exhibition hall, and Wednesday afternoon was given over to the annual field day, at which horse racing and the ball game between engineers and exhibitors were the leading attractions. Inspection tours to the works of the Allis-Chalmers and Nordberg companies were arranged, and groups were daily given the privilege of inspecting the powdered coal plant at the Oneida Street Station. John Anderson and Mr. Kreisinger of the Bureau of Mines were in attendance to explain and comment upon the operation. Engineers to the number of 700 were taken through the plant, and all seemed to be favorably impressed.

THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS AT MILWAUKEE, WIS.

Officers for the ensuing year are: Alfred Johnson, president; R. W. Parry, vice president; Fred Raven, secretary; S. B. Forse, treasurer; Harold R. Hilton, national trustee; J. Albert Johnson, conductor; Frank S. Guth, doorkeeper. Dad Beckerleg conducted the installation services.

Rochester, N. Y., was chosen as the next convention city.

At the business meetings of the National Exhibitors' Association discussion turned largely to the new working agreement that was to guide their relations with the N. A. S. E. The following officers were elected: F. N Chapman, president; Frank Martin, vice president; A. W France, treasurer; Hudson Dickerman, W. L. Schaefer E. E. Jones, L. E. Hilton and G. E. Rowland, executive committee.

The newly elected officers of the Ladies Auxiliary are: National president, Mary E. Lamb, Pittsburgh, Pa.; vice president, Catherine Bastain, Chicago, Ill.; secretary, Lenore W. Farmer, Columbus, Ohio; treasurer, Mary T. Mahon, Chicago, Ill.; conductor, E. Florence Kimball, Boston, Mass.

Chemical Society Fuel Symposium

TWELVE papers were presented on September 9 before the American Chemical Society in the form of a fuel symposium. Four major topics were discussed by the various speakers: (1) Carbonization of Coal; (2) liquid-fuel problems, particularly gasoline; (3) the general problem of fuel conservation, and (4) the problem of sulphur in fuels. This session aroused a great deal of interest because of the widespread attention being given to fuel matters and urgency of fuel supply in industry at the present time.

LOW-TEMPERATURE CARBONIZATION

S. W. Parr presented a discussion of low-temperature carbonization by which he meant treatment of fuel at temperatures below 800 deg. C. He indicated that up to this temperature he considered essentially only primary products of distillation; secondary products of high-temperature decomposition do not enter materially until higher temperatures are reached. The usual method of rating coals as to cokability depending upon the ratio of oxygen content to hydrogen content is criticized by this author. He pointed out that conditions of treatment of the coal were of greater importance than this ratio, for if temperature is properly controlled, the interaction of the oxygen compounds with those compounds which afford the binder for the coke is prevented. He presented one example of a coal badly weathered which was still suitable for coke production by proper temperature control. He advanced the theory that those constituents which are soluble in phenol react upon heating with oxygen compounds to give compounds of variable composition and prevent coking. He emphasized particularly that the sulphur, nitrogen and oxygen compounds formed seemed to violate the laws of definite compounds, as the percentage composition of these compounds varied by small steps in a way inconsistent with our usual concept of definite composition.

Because of the low heat conductivity of the coke mass through which heat must have been transfered by ordinary systems of coking, this author has undertaken to use the exothermic heat of reaction during coal carbonization to furnish the bulk of the heat required for coking. He refers to the reactions thus as proceeding "autogenously." He expresses two of his conclusions in this particular as follows:

> It is possible to utilize the exothermic reactions inherent in high-oxygen coals in such a manner as to secure the autogenous transmission of heat to the center of an otherwise non-conducting mass and under conditions wherein the ultimate temperature attained at any point of the coal mass is not in excess of the prescribed limit.
>
> The time for autogenous heat transmission is governed by the speed of the exothermic reactions involved and is estimated to be approximately one-fourth of the time required for heat penetration as obtained under high-temperature conditions.

At the present time Dr. Parr has not proposed any definite industrial processes, but is working on a basis of a discontinuous operation with 35-lb. samples; that is, on a commercial laboratory scale.

CARBONIZATION OF LIGNITE

A paper entitled "Carbonization of Canadian Lignites," by Edward Stansfield, was presented by Mr. French, the engineer who has been associated with this investigation, covering the work done jointly by the Department of Mines and the Lignite Utilization Board of Canada. This report described the early small-scale experiments and the later larger-scale tests which have led up to the design and construction in Southern Saskatchewan of a plant which is expected to handle two hundred tons of raw lignite per day. The lignites used are available at about $1.75 per ton at the mine. A typical analysis of the material employed, on a moisture-free basis, is as follows: Water of constitution, 31.8 per cent; volatile, 28.9 per cent; fixed carbon, 34.1 per cent; ash, 5.2 per cent. The heating value is approximately 4,260 calories per gram. From this material the following results are reported.

	Percentage of Weight of Dry Coal	Per Cent of Original Heating Value
Water	11.7	
Gas	17.0	8.3
Crude tar	4.1	6.0
Residue (char)	66.7	78.1
Loss	0.5	7.6

These represent yields of about 3,150 cu.ft. of gas having a heating value of 385 B.t.u. cu.ft., 5.3 gal. of tar, 910 lb. of residue, and 10.2 lb. of ammonium sulphate per ton of dry lignite treated. The process is developed to a point where the tar is distilled and the pitch from this used as a binder for briquetting the char. The principal object of this work is the development of a solid fuel, therefore less effort has been made upon gas and byproduct recovery thus far. The commercial plant is nearing completion, and it is hoped that operations will begin within a few months.

As a contribution to the discussion of this report, E. P. Schoch, professor of the Department of Chemistry of the University of Texas, presented a discussion upon the utilization of Texas lignites. The effort in this work was to obtain a supply of city gas, and the tendency was, therefore, along different lines from those described in the Canadian work. Special attention was given to operation of the retorts under pressure. It was found that this gave a higher yield of gas but at the expense of a lower yield of tar. This result was probably caused by the slower elimination of the vapors from the retort causing a greater cracking and, therefore, larger gas yield from the otherwise liquid constituents.

The large percentage of carbon dioxide in the gas led to a special effort looking to the removal of this constituent. As a result liquid purification was adopted and very favorable results are reported. From 2,000 to 3,000 cu.ft. of gas per ton of raw lignite was thus obtained with a heating value in the gas approaching 600 B.t.u. per cubic foot. The yields of coke and tar were of the same order as those reported on the Canadian material.

The advantages claimed for the method of handling recommended were: Coke of a good heating value, gas immediately usable for city supply, maximum yield of tar, a cheap retort of large capacity operating under conditions that make for long life, and the production of coke easily handled in briquetting.

FUEL CONSERVATION

H. C. Porter discussed the general subject of present and future conservation of fuel supplies. Among the means of increasing our fuel resources he suggested the following: Increased use of boiler-plant accessories such as feed-water heaters and other efficiency devices; use of gas instead of coal in steel plants; electrification of railways; development of super-power electric stations; carbonization of coal at the mine; increased carbonization with recovery of byproducts; alternate carbonization and steaming of coke in a single machine for production of a mixture of coal gas and blue gas; use of oxygen to enrich water-gas blast (the oxygen to be made with power used at off-peak hours); a lower heating value per foot for city gas supply; elimination of beehive ovens and other well-recognized means of fuel economy.

BYPRODUCT COKING

F. W. Sperr, reviewing the byproduct coke situation, summarized the present status of work in this field. He emphasized particularly the trend toward byproduct gas manufacture and away from the production of water gas. The lesser labor requirement per ton of coal handled in byproduct ovens as compared with coal-gas plants handling the coal at smaller units is also a factor at present tending to increase byproduct oven operations. The relative economy of beehive and byproduct oven operations was emphasized, and the trend for many years past toward byproduct coke for blast furnace use was pointed out. It was urged that further study should be given to additional applications of coke so that more of our bituminous coal could be handled with byproduct recovery. Utilization of coke breeze by stokers was pointed out as one important contributing factor to the success of coking at the present time. Other factors mentioned were producer gas firing of ovens, use of silica refractories in place of fireclay materials, the extensive application of tar as a metallurgical fuel, etc. It was pointed out that recent byproduct ovens provided for steaming of coke in the oven, thus arranging that almost complete gasification of the solid fuel may be accomplished in what is practically a single operation.

Gasoline Losses

A. C. Fieldner and associates reported upon extensive tests of motor vehicles for efficiency in gasoline use. These tests make clear the very large losses of gasoline which result from improper carburetor adjustment and careless driving. These tests were those carried out in connection with the investigation of poisonous gases from automobile exhaust which must be cared for in the proposed vehicle tunnel under the Hudson River.

J. B. Garner urged the use of natural for the enrichment of manufactured gas supplies, stating that in his opinion natural-gas companies should no longer be permitted to sell natural gas as such, but should conserve it for the city supply to supplement the manufactured gas production for these purposes.

Commercial Realization of Low-Temperature Carbonization

Dr. Harry A. Curtis, chief chemist of the International Coal Products Corporation, reported on the carbocoal process which has been developed to the point of the installation of a plant having a daily capacity of 350 tons of product, using 500 tons of coal per day. The general process is described by him as follows:

Carbocoal, as it is called, is a bituminous coal which has been changed into a smokeless fuel resembling anthracite. It is prepared by crushing the soft coal and carbonizing it at a relatively low temperature of 900 deg. F. The coal is carried out in a horizontal retort about seven feet in diameter and twenty feet long, lined with carborundum. The coal is continually stirred and moved slowly through the retort by means of paddles mounted on two heavy steel shafts running lengthwise the retort. Each retort has a capacity of about a ton an hour, the Clinchfield Plant being equipped with twenty-four of these retorts. Carbonization of the coal in this manner yields about twice as much tar as is obtained from the ordinary coking process, but the semi-coke obtained is quite soft and friable. It can be used directly under the boiler of a power plant or put into a gas producer, but is not in good shape to market as a general fuel for domestic and industrial use. In the "Carbocoal Process" the soft semi-coke is ground, briquetted with pitch, and the briquets then carbonized for about six hours at 1,800 deg. F. The effect of this high-temperature carbonization is to render the briquets hard, dense and smokeless—quite unlike any other fuel on the market. A further substantial yield of byproducts is obtained during the second carbonization, so that the "Carbocoal Process" represents a very economical method of producing a smokeless fuel from bituminous coal. The high yield of oils obtained is also of great importance in view of the rapidly diminishing supplies of petroleum in the United States and the enormous growth of industries which use oil products such as gasoline, motor spirits, lubricating oils and fuel oil.

Sulphur in Fuels

The report by Alfred R. Powell discussed the factors which affect the sulphur content of coke and of gas produced by the carbonization of bituminous coals. The significance of the different sulphur compounds in the coal upon the distribution of the sulphur in the products is pointed out.

The report on a similar subject was presented by H. F. Yancey and Thomas Fraser, entitled "The Distribution of the Forms of Sulphur in the Coal Bed." The relations between the relative quantities of pyrite sulphur and organic sulphur were discussed. This work represents a report of a large number of mine samples, particularly those collected in southern Illinois and western Kentucky.

Applications Filed with Federal Power Commission

Additional applications have been filed for preliminary permits and licenses with the Federal Power Commission as follows (the serial number, the date, the name and address of the applicant, the kind of application, the type of project works, the stream, the state and proposed use, are shown):

Western New York Utilities Co., Inc., Medina, N. Y.; preliminary permit; diversion of an additional 500 s.f. for power development, Erie Canal, N. Y.; public utility. Montana Water Power and Electric Co., Spalding Building, Portland, Ore.; preliminary permit; power project; South Fork of Flathead River at the outlet of Flathead Lake, Montana; proposed use not stated. Millard F. Bowen, 117 Tennessee Ave., Washington, D.C.; license; reservoirs, conduits, locks and power houses; Lake Erie, Niagara River and watersheds between Lake Ontario and the Hudson River, New York; navigation and power for unstated uses. A. P. Connor, Five Cent Savings Bank Bldg., Springfield, Mass.; preliminary permit; power project; Connecticut River; Massachusetts and Connecticut; proposed use not stated. Big Bend Power Co., care F. C. Moon, Lynchburg, Va.; preliminary permit; power project; James River, Virginia; proposed use not stated. Moore's Creek Boulder Gold Dredging Co., care Clinton H. Hartson, Boise, Idaho; license; transmission line; Idaho; to transmit electric energy to the works of applicant for use in connection with its mining operations. Grand Rapids, village of Grand Rapids, Minn.; preliminary permit; power plant at Government dam on the Mississippi River, Minnesota; municipal. City of Dothan, Dothan, Ala.; preliminary permit; power project, Choctawbatchee River, Alabama; municipal. W. T. Larimore, Leo E. Mills and Charles E. Bailey, Hugo, Okla.; preliminary permit; power project, Little River, Okla.; proposed use not stated. Washington Development Corporation, L. C. Smith Building, Seattle Wash.; preliminary permit; power and irrigation project; Dunganess River and West Fork Creek, Olympia National Forest, Washington; power and irrigation. Reed Bingham, Pensacola, Fla.; preliminary permit; power projects, Perdido, Styx and Blackwater Rivers, Alabama and Florida; proposed use not stated. William F. Scheffel, Wenatchee, Wash.; preliminary permit; power irrigation project; Columbia River, Washington; power and irrigation.

Increase in Freight Rates on Coal

General increases in the rate of transportation of coal on the railroads have occurred due to the recent advance in transportation rates allowed the railroads by the Interstate Commerce Commission.

The new coal tariff filed with the Interstate Commerce by the Baltimore & Ohio R.R. is typical of the situation. The new rate on coal from the West Virginia fields, from the Cumberland region to Baltimore, inside the harbor is $2.53 per ton against the old rate of $1.95 per ton. The new rate outside the capes is $2.53 against the old rate of $1.73. From the Fairmont mine group in West Virginia, the new rate via the Baltimore & Ohio R.R. to Baltimore, inside the harbor, is $3.18 per ton as compared with the old rate of $2.20, or an increase over the Cumberland rate of 25 cents per ton. For delivery outside the Capes, the new rate is $2.78 against the old rate of $1.98, an increase over the Cumberland group rate of 80 cents per ton.

The new rate on coal moving via the Baltimore & Ohio R.R. from the Finleyville district of Pensylvania to Baltimore, within the harbor, was given at $3.33 per ton compared with the old rate of $2.95, or an increase of 15 cents over the Fairmont group rate. The new rate on coal moving from that district for delivery outside the capes is $2.93 against the old rate of $2.13 per ton, or an increase of 80 cents per ton over the Fairmont group rate.

The new tariffs formulated by the Pennsylvania R.R. are practically the same as those of other carriers serving the same fields. New rates on coal put into effect by the Pennsylvania R.R. on tariffs originating in West Virginia, Maryland and Pennsylvania, moving through New York, generally show a 96 cents increase per ton over the old rate.

Instructions to Employees at Pumping Station and Filter Plants*

BY DOW R. GWINN
President and Manager, Water Company, Terre Haute, Indiana

HUMAN nature is very much the same in Indiana and Illinois as it is in New York and Oregon. The tendency is to move along the line of least resistance—to do things the easiest way. There are cases where the easiest way and efficiency are not synonymous terms. In operating water plants the author has tried to find the best way of doing things and then to adopt them as standard methods, even if they are difficult, and hold to them until better ways have been found. After methods have been adopted, it is discouraging to find later on that they are not being observed by assistants. On inquiring why certain methods have been discontinued, the usual answer would be, "We don't do it that way any more," and further inquiry would not disclose why or when the method was discontinued.

The idea of printed instructions was then tried; it has worked very well. There is an advantage in having a particular time to do certain things, such as cleaning the heater, blowing down the boilers, taking indicator cards, making evaporation tests, etc.

The instructions are typewritten and are kept in loose-leaf binders. Change can be easily made, and additional sheets may be readily added. No method is so sacred that it cannot be changed by the manager. The employees are encouraged to suggest better methods, and when tried and found to be advantageous, they are substituted for old ones.

Each employee is supposed to read the instructions once a month; he may select his own time while on duty for the reading. A sheet of properly ruled paper is inclosed in the file on which are the list of employees and each employee records the date when he reads the instructions.

THE TERRE HAUTE WATER WORKS COMPANY
1920

Names	Jan	Feb	Mar	Apr	May	June	July	Aug.	Sept	Oct	Nov	Dec.

The Terre Haute plant takes its supply from the Wabash River and is a direct pumping plant, there being no standpipe or elevated reservoirs which could be used if pumps were not in operation. For pumping into the distribution system there is a 10,000,000-gal. vertical triple expansion and a 6,000,000-gal. vertical compound pumping engine, also smaller pumps. For delivering to the sedimentation basin there is a centrifugal pump operated by a compound high-speed engine connected with a rope drive. Steam is generated in water-tube and fire-tube boilers with hand firing. A vacuum pump for exhausting air from the suction of the principal pumps is a part of the equipment. There are 22 mechanical pressure filters and a sedimentation basin with sufficient capacity for approximately two to five hours subsidence, used when the turbidity exceeds, say, 60 in the Jackson Turbidometer, or about 55 per cent of the time. The turbidity of the river water ranges from 25 to 3,000. The pumps work against 70 lb. domestic pressure and 125 lb. fire pressure. The available pressure at fire hydrants in business or high-hazard districts is 100 to 110 lb. While the fire department is equipped with pumpers, they are seldom used, the pressure from the plant being usually sufficient. There are 100 miles of main, 62 per cent being 8 in. and larger diameters, and 1,155 public fire hydrants. There are 8,240 consumers; 97.7 per cent of all service pipes are metered, including private fire lines for automatic sprinklers.

At the plant there is a program clock which summons the attendants every half-hour to examine the water; this is just a visual examination of the raw and filtered water, and a record of the appearance of the water is made. This is necessary because of sudden changes in the turbidity of the raw river water.

A record of fire alarms is kept, showing the length of time extra pressure is maintained, increase in pumping rate, time of receiving alarm and strike out; also hydrants used and condition after fire.

Inspectors answer alarms received from high-hazard districts during day and second alarms at night. Engineers and firemen are on duty eight hours; that is, they are off duty sixteen hours per day for six days and the seventh day they are off twenty-four hours.

Monday is change day, when each man moves up one watch, the duties during the eight hours being performed by other employees. The changes are made at 7 a.m., 3 p.m. and 11 p.m.

Employees are given two weeks' vacation with pay. Baths are provided for the men, also books on engineering, a file of *Power* and other technical publications. The grounds on which the station is located were laid out by a landscape gardener and are very beautiful. A fine tennis court is provided. Long periods of service are the rule, one engineer having recently completed thirty years of continuous employment. The company arranges and provides for an annual picnic on the station grounds for employees.

Instructions such as the following have been found to be satisfactory for the Terre Haute plant; and while they would not be suitable in every particular to any other waterworks plant, they may be suggestive and valuable to other operators.

THE TERRE HAUTE WATER WORKS COMPANY PUMPING AND PURIFICATION DEPARTMENTS

These instructions are to be read monthly and the date of reading recorded in the proper column.

Suggestions for the improvement of the service are respectfully invited.

No man can know too much about his work.

Please bear in mind that you are guarding the water supply of your home city.

Be faithful in the discharge of your duty.

General Instructions—These general instructions are not intended to take away the power and obligation of the employee to meet his work with personal judgment and efficiency, but rather to assist by such rules and suggestions as seem necessary and helpful.

Bear in mind that it is up to us to maintain the standard; that it is our duty to furnish good water every minute and adequate fire service whenever it is called for; that the manager is depending upon his fellow workers to do their part and that he has confidence in them; that in emergencies it is not a question of spending a few dollars in order to get results, for the standard must be maintained regardless of cost.

Fire Alarms (Engineers)—The big general thing to remember is to "play safe." That is, to consider the location of the fire and its probable or possible magnitude and to promptly take any action that may seem necessary to furnishing an adequate supply of water, at proper pressure and maintain the quality of the water. To this end it is better to take much precaution, such as notifying the chief engineer and the assistant chief, calling out an extra fireman or station helper, having fire lighted in extra boilers, getting an extra engine ready, etc., rather than fail in any particular because of lack of having done these things.

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*Presented at the thirty-ninth annual convention of New England Water Works Association, Holyoke, Mass., Sept. 7-10, 1920.

In case of a serious fire or general alarm, notify chief engineer and assistant chief engineer; if the fire is at night, notify general foreman; get Holly engine warmed up and ready for action; consider the matter of whether there are enough boilers in use and whether extra help is needed in boiler room.

Engine No. 5 for Emergency—Engine No. 5 is the quick-acting emergency and peak-of-load engine. This engine should be put into service at once in case of any trouble with Allis or Holly. No. 5 can be put under full load, if necessary, in one minute; the best way to handle the engine for this quick action is as follows: Both steam valves should always be left hooked up, then first crack throttle slightly, proceed at once to open water-injection valve, unlatch one steam valve and go ahead. Each engineer should practice handling the engine until he can safely and surely get under full load in one minute as stated.

Call Bells at Allis—The call bells in lower boiler room and in filter room, with control at Allis engine are intended for use of the engineer when wanting help and not wishing to leave engine; they will sound continuously until stopped.

Call Bell at Observation Sink—This bell may be answered and observation noted by the engineer, filterman, or helper who happens to be nearest at signal. Do not, however, record any observation unless you actually take it. Do not indicate as O.K. unless water is clear. Smoky water is not satisfactory. For instance, if you record an observation at 3 o'clock and notice a blank for 2:30 do not go back and record 2:30 as an observation. Any signals that have been missed must be left blank; if the observation signal is not operating properly it should be reported by the engineers to the chief engineer. A signal answered within five minutes after its stated time may properly be recorded.

Report Trouble or Unusual Occurrence—Any particular trouble or unusual occurrence at the plant in the absence of the chief engineer should be reported as soon as practicable by telephone to Mr. Taylor or Mr. Ranbarger; also a written report of the matter should be left by the engineer on watch for the chief engineer, before going off duty.

Suspicious Behavior of Engine—Any of the engines developing any trouble or suspicious behavior should promptly be placed under control of the throttle or shut down as may seem necessary. If placed under the throttle the engineer should signal filterman or fireman for assistance.

Coppus Blowers and Low-Pressure Alarm—These are to be tested out for operation each week and recorded on weekly report sheet with date of test. As a general rule, they will be tested and recorded by the assistant chief, but if for any reason he does not do so the engineer making out weekly report on Friday night will test and record same, signing his name.

Inspecting Recording Gages, Etc.—The engineer on watch will, immediately after coming on, inspect water-pressure gage on Allis engine and general condition of all machinery in operation; a little later he will inspect recording steam gage and tachometer chart for proper operation and also for proper time setting and record observation on daily report sheet. Engineers will sign tachometer records in spaces made while on duty.

In addition to taking revolution counters at midnight for the daily pumpage, the engineer on watch will take the counter on No. 7 at 2 a.m. and at 4 o'clock each morning and record the average r.p.m. for the three-hour period on the daily report; also on the graphic chart posted on wall of engine room. Record manometer reading of liquid chlorine apparatus, as provided for on daily report sheet. Take temperature of No. 3 engine room daily, noon and midnight during winter months and record on weekly report.

Consider the Boiler Plant—The engineer on watch should always know exactly what boilers are in use; what, if any, are banked and held ready for emergency; whether or not any are out for cleaning; in short, have exact knowledge of the entire boiler plant. To this end it is a rule that each engineer, before taking his watch and before the preceding engineer has left, shall personally inspect conditions of both upper and lower batteries of boilers; and observe the conditions at every boiler, whether in use or out of use. If a boiler is banked, note the condition of the banked fire, the steam pressure, the height of water in gage glass, the coal supply in car, etc. If any of these are not right, have them corrected as soon as possible. If in the judgment of the engineer there are not enough boilers under steam to meet probable demands, he should report to the chief engineer or assistant chief, and if he cannot do this, he should have such changes made as seem necessary, or prudent. As a general rule, if the basin is in service and Stirling boiler is in use, one or more of the lower boilers should be under steam; in hot dry weather, with heavy pumpage, all the boilers not out for cleaning should be under steam.

Consider the Fireman—If any change in operation involves more steam use, such as putting additional engines in service, the fireman should receive ample and definite information in time to be prepared for such increase in steam consumption.

Fire-Alarm Reports, Etc.—A written report on the special blank is to be made of every fire alarm, showing time received, pressure, increased pump speed, etc. In addition, the office should be notified at 7 a.m. of all fire alarms received during the preceding night.

Record should be made daily on the weekly report by the engineer who receives the Gamewell alarm test at 12 noon. If test stroke does not come at 12 noon, the chief of the fire department should be notified at once.

During cold weather, when the automatic sprinkler pipes in exposed places are empty, the air pressure on same should be recorded twice daily on the weekly report.

Special for Chief Engineer

Sand Catchers—They are to be blown on the first day of each month and the conditions found are to be noted on daily and weekly report sheet.

Feed-Water Heater—The feed-water heater is to be cleaned about the 15th day of January, April, July and October, and the conditions found are to be noted on daily and weekly report sheets.

Cleaning Condensers No. 6 and No. 7—When the condensers are cleaned the time of cleaning and their conditions should be noted on the daily and weekly report sheets. When convenient the condenser should be tested for leakage

Indicator Cards—Indicator cards shall be taken about the fifth day of each month from engines No. 6 and No. 7. A set of cards should be sent to the office.

Coal—Coal cars shall be unloaded by day labor and a record of the cost kept.

River Soundings at Intake—Soundings in river bed along intake line and extending out to the opening in river should be taken each summer at low water and a profile made on basis of low-water mark.

Filter Manifolds—Two filter manifolds of each size shall be kept in stock.

Automatic Sprinklers—Thoroughly inspect automatic sprinklers at the station in November of each year and send written report to the office.

Boiler-Feed Pumps—These and the injector should be examined weekly and their condition reported.

Feed Water—Test feed water for soap hardness weekly and report same.

Evaporation Test of Boilers—Boilers to be tested monthly to determine evaporation per pound of coal; the Stirling and Battery No. 3 to be tested alternately.

Commercial stocks of bituminous coal in the United States on June 1, 1920, are estimated at 20,000,000 net tons. In the three months from March 1 to June 1, stocks decreased 4,000,000 tons, or 17 per cent. These estimates take into consideration coal in the hands of railroads, industrial consumers, public utilities and retail dealers. Information available concerning stocks of coal in the past is summarized in the following table:

TOTAL COMMERCIAL STOCKS OF BITUMINOUS COAL IN THE UNITED STATES OCT. 1, 1916 TO JUNE 1, 1920

(Net Tons)

Oct. 1, 1916	27,000,000	Jan. 1, 1919	57,900,000
Oct. 1, 1917	28,100,000	April 1, 1919	40,400,000
July 15, 1918	39,700,000	Mar. 1, 1920	24,000,000
Oct. 1, 1918	59,000,000	June 1, 1920	20,000,000
Day of the armistice,	63,000,000		

According to foreign trade figures of the United States Department of Commerce, exports of crude and refined oil for the fiscal year 1920 were nearly one-third as great as imports. Crude-oil imports amounted to 2,826,860,902 gal., of which Mexico sent over 2,825,000,000 gal. and Trinidad and Tobago more than 1,000,000 gal. Refined-oil imports totaled 81,888,904 gallons.

The Sixth National Chemical Exposition

The Sixth National Exposition of Chemical Industries opened its doors at the Grand Central Palace, Monday, Sept. 20, with the most interesting program and the biggest display of its kind ever seen.

Features of the exposition this year are the Fuel Economy and Materials Handling Symposium. These two divisions developed such progress that it was necessary to give each a separate section.

The official opening was held Monday evening. Dr. Charles H. Herty, chairman of the Advisory Committee, talked on the problems confronting the chemist and the progress made during the past five years. He was followed by Charles L. Reese and Sir George E. Foster, Canadian Minister of Trade and Finance.

On Tuesday afternoon the Fuel Economy Symposium was delivered. It included an address by the chairman, R. C. Beadle, managing editor of *Combustion*, and the following papers: "Burning Coal at 100 Per Cent B.t.u. Efficiency," W. O. Rankin; "Saving Fuel by Controlling Chimney Losses," F. F. Uehling; "Fluid Heat Transmission," Alexander B. McKechnie; "Producer Gas and the Modern Mechanical Producer," W. B. Chapman; "Refractory Cement—Life Insurance for a Furnace," F. W. Reisman; "Preventing Conduction and Radiation Heat Waste," S. L. Barnes, and "The Reason for the Fuel Saving in the Dressler Kiln," Conrad Dressler. In the evening motion pictures of interest to the chemical industry were shown.

Wednesday afternoon was devoted to the Industrial Management Symposium and the Materials Handling Symposium.

The Chemical Engineering Symposium was delivered on Thursday afternoon. In the evening a dinner of the American Institute of Chemical Engineers was held at the Technology Club. Friday was devoted to the ceramic symposium and in the evening motion pictures were shown.

The exposition closed on Saturday after a most successful week.

Thirty to Sixty Thousand Hp. Plants in the Mining Regions

Reasons for the establishment of a number of power plants of from 30,000 to 60,000 electric horsepower in the mining regions, rather than the building of larger plants at tidewater, are advanced by George S. Rice, the chief mining engineer of the Bureau of Mines. In discussing this matter, which is now being considered in connection with the Boston-Washington super-power plan, Mr. Rice said in part:

Power plants would not be located immediately at the mouth of a single mine, but rather at a point tributary to a group of mines, or where there is a large area of undeveloped coal in reserve. To carry the coal from the local mines to the near-by super-power station, there would need to be means of car transportation. Each super-power station, even if located in a coal district, should have coal-storage facilities adjacent, to contain at least a month's supply. Usually, however, it would be best to have coal hauled from the tipple and screening plant of the individual mine by open-top or bottom-dump railroad cars of standard type, and the cars hauled to the super-power station.

It may be pointed out that super-power stations located in the coal districts might have to be made smaller than super-power stations at tidewater points, on account of the limitations of condensing water in the former locations, so that there might be needed a larger number of smaller super-power stations, of 30,000 to 60,000 electric horsepower, but which would have a certain advantage in case of an accident or shutdown, from one cause or another, being of less importance than that of a super-power station of larger size.

Every consideration should be given to saving. One of the methods which would both effect a saving of such coal, and at the same time lessen the amount of water needed for a super-power station, would be through the further development of by-product coking plants, and the use of the gas from such plants in gas engines.

To locate super-power stations at tidewater will mean long railroad hauls over mountain grades, except on coal hauled from the anthracite fields, and distances by railroad of from 150 to 300 miles, and it means the hauling over railroads already crowded to capacity, and through congested terminals.

It seems evident from recent experience in securing fuel both in the East and the West, that it was not because of any shortage at the mine, but simply through lack of railroad capacity and any method that would lessen this difficulty should receive careful consideration.

DeLamater-Ericsson Memorial Tablets

At the annual convention of the American Society of Mechanical Engineers last December, a memorial meeting was held on the evening of Dec. 3 in commemoration of the eightieth anniversary of the arrival in the United States of Captain John Ericsson and his fifty years' association with Cornelius H. DeLamater in engineering work. In advance of the meeting it had been decided to erect memorial tablets to mark the sites of certain buildings which were closely identified with the work of DeLamater and Ericsson. It was proposed to erect four tablets as follows: One at the Phœnix Foundry at Laight and West Sts., New York City, where the first screw-propelled vessel in this country and the first steam fire engine were constructed and where many other original developments were made; one at Captain Ericsson's residence, 26 Beach St., where he designed the "Monitor" and made all his inventions during his later years; one at the DeLamater Iron Works at the foot of West Thirteenth St., where the engines of the monitors "Puritan" and "Dictator" were built, as well as the first submarine boat, the first torpedo boat, the first torpedo-boat destroyer, the first self-propelled torpedo, the first air compressors, the first ice machines, and many other industrial appliances now in general use; and one at the Continental Iron Works, Greenpoint, L. I., where the hulls of the "Monitor" and other warships were built.

Those wishing to contribute to the tablet fund are requested to communicate with the DeLamater-Ericsson Tablet Committee, H. F. J. Porter, chairman, Room 1100, Engineering Societies Building, 29 W. 39th St., New York City.

ALFRED JOHNSON
Recently Elected President, N. A. S. E.

Obituary

A. C. Buzby, president of the Keystone Lubricating Co., of Philadelphia, died suddenly on Tuesday, September 21. An extended obituary will appear in the Oct. 5, 1920 issue of *Power*.

William H. Tasker—On Aug. 17 funeral services for William H. Tasker, aged 71, for more than twenty years chief engineer at Symphony Hall, Back Bay, Boston, were conducted at his home, 11 Cedar Road, Medford Center, by Rev. A. Judson Hughes, pastor of the First Baptist Church of Everett. Delegations from Medford Lodge of Elks, the I. O. O. F. and the National Association of Stationary Engineers and of associates at Symphony Hall were in attendance. Mr. Tasker was a steam and electrical engineer well known throughout New England. The body was cremated and the ashes were buried in Pine Hill Cemetery, Dover, N. H., where Mr. Tasker was born and resided as a young man. He is survived by a widow, three sons and two brothers.

William M. Barr died recently after a long illness. He was born in 1842, in Muncy, Pa. He received the degree of mechanical engineering, to which profession he devoted his life. He served in the Navy throughout the Spanish and Civil Wars. He was well known in the world of technical literature for his works on "Pumping Machinery," "Boilers and Furnaces," "Combustion of Coal," etc. His chief work is "Barr's Industrial Engineering," a handbook of useful information for managers, engineers, superintendents, designers, draftsmen and others engaged in constructive work, Part I of which was recently issued. Part II is in preparation for early publication. Mr. Barr was a member of the American Society of Naval Engineers and the American Society of Mechanical Engineers.

Personals

A. A. Potter, Dean of Engineering at Kansas State Agricultural College since 1913, has assumed the same position at Purdue University.

A. W. Chesterton of the A. W. Chesterton Co., Boston, Mass., has lately returned from a business trip to Europe. One of the incidents of the visit was an aëroplane trip from London to Paris with his son as pilot.

O. L. Merket, who has been associated for the last 15 years with Westinghouse Church Kerr & Co., New York, has resigned and is now connected with the American Can Co. in the capacity of assistant chief engineer, with headquarters in New York City.

O. L. McIntyre has been transferred from the home office of the Fuller Engineering Co., Allentown, Pa., to Milwaukee, Wis., to superintend the erection of a 1,000-ton per day pulverized-coal installation at the Lakeside power plant of the Milwaukee Electric Railway and Light Co., for which the Fuller Engineering Co. has the contract.

Society Affairs

The American Electro-Chemical Society will hold its annual meeting in Cleveland, Ohio, Oct. 1 and 2.

The Technical National Section of the Prime Movers Committee will meet in Philadelphia on Oct. 18.

The Underground Systems Committee, Technical National Section, will meet in Pittsburgh, Nov. 11.

The National Association of Electrical Inspectors will hold their annual meeting in Philadelphia, Oct. 12-13.

Association of Railway Electrical Engineers will hold its annual meeting in Chicago from Oct. 28 to 30 inclusive.

The American Electric Railway Association will hold its annual convention at Atlantic City, N. J., Oct. 11 to 15 inclusive.

The Electric Power Club will hold its fall meeting at Hot Springs, Va., Nov. 15-18. Headquarters will be at the Homestead Hotel.

The Empire State Gas and Electric Association will hold its annual convention at Utica, New York, Oct. 7 and 8. Headquarters will be at the Hotel Utica.

The American Association of Engineers will hold its next regular meeting of the North Carolina State Assembly of A. A. E. (which is built around the North Carolina Society of Civil Engineers) in Raleigh next January.

The Inductive Interference Committee, Technical National Section, will hold a meeting in Salt Lake City, Utah, Nov. 15. The Technical National Section of the Prime Movers Committee will meet at the same time and place.

The Standardization Conference which is to be held at the Congress Hotel, Chicago, Ill., Oct. 9, has on its program a number of interesting papers. Among the problems which will come up for discussion is the present status of standardization of shafting sizes and the report of the Standardization Committee to the National Association.

The Engineering Society of Buffalo held a special meeting Sept. 21 at the University Club. The organization and aims of the Federated American Engineering Societies, to which the Buffalo society had been invited to become a member, were discussed. The meeting was addressed by Dexter S. Kimball and Richard L. Humphrey. The officers of the society for the year 1920-1921 are: W. B. Powell, president; C. G. Derick, vice-president; W. L. Spaulding, secretary; W. M. Dollar, treasurer. Directors representing affiliated sections are David Childs (A.C.S.), W. A. Kidd (A.I.A.), W. J. Gamble, Jr. (A.S.M.E.), David Bell (A.S.T.S.), E. T. Larkin (S.A.E.) and A. H. Hooper (A.E.S.).

The Federal Department of the American Association of Engineers has announced the appointment of the following engineers as members of the Federal Department Council: Morris Bien, assistant director of the Reclamation Service, Washington; N. S. Thompson, chief of the electro-mechanical division, supervising architect's office, Washington; H. E. Hallborg, radio engineer, Norfolk Navy Yard, Norfolk, Va.; William B. Harrison, of the United States Engineers' office, Washington; W. C. Dean, chief of the electrical division, Bureau of Construction and Repair, Washington; W. A. E. Doying, inspecting engineer of the Panama Canal, Washington; W. C. Lemen, of the United States Engineers' office, New York; J. T. Maguire, project manager, Bureau of Yards and Docks, Washington.

Miscellaneous News

Production of the Electrical Manufacturing Industry during 1919 was about $900,000,000, of which over $90,000,000, or 10 per cent, was exported. This is an increase of 50 per cent in exports since 1918, when we exported only $60,000,000 worth of electrical products.

The Alabama Power Co., Birmingham, is arranging an extensive construction program to include the erection of a number of power plants and extensions to existing generating stations. A hydro-electric plant will be built at Judkins Riffle on the Coosa River, at a cost of $10,000,000.

Business Items

The Industrial Heating & Engineering Co. announces the removal of the business to 385 Windsor St., East Akron, Ohio.

The Jeffrey Manufacturing Co., Columbus, Ohio, has opened a new branch office in Buffalo, N. Y., in the Marine Trust Building. H. W. Scott, formrly in charge of the home office, will manage the new branch.

Trade Catalogs

Consolidated Wire and Machinery Corporation, of Chicago, dealers in used electrical equipment is sending out a stock sheet of the loose-leaf variety assembled within a 4 x $6\frac{3}{4}$-in. paper binder. Full data and the price of the equipment, including generators, motors, transformers, regulators, remote control devices, etc., are given, and monthly lists follow for insertion to keep the stock record up to date.

Warren Webster & Company, of Camden, New Jersey, has just issued a new bound volume containing a number of catalog bulletins of feed-water heaters, oil separators, steam separators and other apparatus handled by the company. Each article is described in a most complete manner and is clearly illustrated by photographs and line drawings. Installations of feed-water heaters are shown and described. A description of construction and operation is also given. This booklet should prove instructive and interesting to power-plant engineers. A copy can be obtained on request.

New Construction

PROPOSED WORK

N. H., Manchester—I. W. Dickey, R. F. D. No. 5, is in the market for a 15 hp. gasolene engine.

Mass., Boston—Coolidge & Shattuck, Archts., 122 Ames Bldg., will soon receive bids for a 12 story office building including a steam heating system on Beacon and Somerset Sts. About $500,000. Owner's name withheld.

Mass., East Boston (Boston P. O.)—The City Schoolhouse Dept. is having plans prepared for a 3 story school including a steam heating system in the Samuel Adams Dist. About $250,000. C. G. Loring, 7 Water St., Boston, Archt.

Mass., Peabody—The School Comn. will receive bids until October 1 for a 2 story high school including a steam heating system on Central St. About $500,000. F. I. Cooper Corp., 33 Cornhill St., Boston, Archt.

R I., Newport—The Bd. Educ. will soon receive bids for a 3 story, 110 x 150 ft. high school including a steam heating system on Bway. About $600,000. B. H. Seabury, 21 Besse Pl., Springfield, Mass., Archt.

Conn., New Britain—The Bd. Educ. will soon award the contract for a 2 story, 60 x 240 ft. school including a steam heating system on Tremont St. About $350,000. Deebert K. Perry, 27 West Main St., Archt.

Conn., West Hartford—The Bd. Educ. rejected all bids for a 2 story, 200 x 210 ft. high school including a steam heating system on South Main St. About $500,000. W. T. Marchant, 36 Pearl St., Hartford, Archt. Work will be readvertised. Noted August 3.

N. Y., Buffalo—The Lambert Press, 813 Seneca St., is in the market for a generator and electrical welding equipment and tools.

N. Y., Jamestown—I. S. Burns, Secy. of the Bd. of Park and City Planning Comrs., is preparing plans for repairing the heating and lighting system at the Fenton Homestead here. About $25,000.

N. Y., Marcy—The State Hospital Comn., Capitol, Albany, will receive bids until October 6 for the construction of tunnels and conduits and heating work for service connections, etc., at the Utica State Hospital, here.

N. Y., New York—Carlson & Wiseman, Archts. and Engrs., 226 Henry St., Brooklyn, are preparing plans for a 2 story theatre including a steam heating system on Bway. and Hamilton Pl. About $500,000. Owner's name withheld.

Pa., Allentown—Malcolm W. Gross, Mayor, Central Fire and Police Station, will receive bids until October 11 for furnishing and installing one 750 hp. steam turbine, with reduction gears, one 12,000,000 gal. centrifugal pumping unit, one 500 hp. a.c. motor and one 3 stage, 7,000,000 gal. centrifugal pump, etc., at the pumping station.

Pa., Harrisburg—Henry W. Gough, Dauphin Co. Controller, will receive bids until October 1 for the installation of an atmospheric steam heating system in the Courthouse.

Va., Richmond—W. S. Fulcold, 506 East Broad St., is in the market for an air compressor.

Va., Richmond—F. F. Hough, c/o Realty Finance Co., 108 North 8th St., is in the market for 1 electric motor, 1 gasoline engine (new or used).

Fla., Jacksonville—The United States Engineer will receive bids until October 15 for constructing and installing 4 Scotch marine boilers, oil bunkers, etc.

La., New Orleans—The McComb Ice Factory, McComb, Miss., is in the market for two 150 hp. horizontal tubular boilers (used preferred). N. A. Kramer, Co-partner.

Ind., Indianapolis—The Bd. of School Commrs., Meriden and Ohio Sts., will receive bids until October 1 for a 2 or 3 story, 250 x 400 ft. shop building for school on East Michigan St. Plans include the installation of a power house, boilers, stokers, coal ash handling equipment, etc. About $225,000. Snider & Rotz, 703 Merchants Bank Bldg., Engrs. D. A. Bohlen & Son, Majestic Bldg., Archts.

O., Bryan—The Central Light & Power Co. plans to build a power plant.

O., Cleveland—The Bd. Educ. will receive bids until October 11 for a 1 story sewage treatment and water pumping plant. About $50,000. L. H. Geiss, Clk. C. W. Bates, Natl. Bank Bldg., Wheeling, West Va., Archt.

O., Cleveland—The Brotherhood of Locomotive Engineers, c/o Warren S. Stone, Engineers' Bldg., plans to build a 20 story bank and office building including a steam heating system on St. Claire Ave. and Ontario St. About $5,000,000. Knox & Elliott, 1248 Rockefeller Bldg., Archts.

O., Toledo—The Maumee Tire & Rubber Co., 705 Madison Ave., is having plans prepared for a 3 story, 100 x 300 ft. rubber tire factory on Lackey Rd. Boilers will be installed in same. About $300,000. Osborn Eng. Co., 2848 Prospect Ave., Cleveland, Archt. and Engr.

Mich., Lansing—Walter E. Boose is having plans prepared for an 8 story, 190 x 230 ft. hotel including a steam heating boiler and equipment. T. E. White, City Natl. Bank Bldg., Archt.

Mich., Muskegon—H. H. Turner, Archt., 923 Michigan Trust Bldg., Grand Rapids, will receive bids until October 1 for a 3 story high school including a steam heating system on Denmark Ave., for the Bd. Educ. About $250,000.

Ill., Noble—The Bd. Educ. will soon award the contract for a high school, including a steam heating and ventilation system.

Wis., Fond du Lac—The Bd. Educ. will soon award the contract for a 3 story, 66 x 261 ft. senior and junior high school including a steam heating system, motors, etc. About $500,000. A. M. Hunter, Secy. Childs & Smith, East Van Buren St., Chicago, Ill., Archts.

Wis., Fond du Lac—The Fountain City Ice Cream Co., 218 South Main St., is having plans prepared for a 2 story, 60 x 180 ft. dairy plant on Division St. A refrigeration system will be installed in same. About $80,000. B. E. Mehner, Archt.

Wis., Hartford—The city plans to build a 60 x 155 ft. power house on Main St. Estimated cost, $50,000. W. Radke, City Clk. A. H. Martin, Engr.

Wis., Neillsville—Herman North is having plans prepared for a 3 story, 70 x 170 ft. hotel including a steam heating system on Main St.

Wish., Sheboygan—The Northern Furniture Co., South Water St. and New Jersey Ave., is having preliminary plans prepared for a 4 story, 60 x 240 ft. office building and power house on South Water St. About $200,000. W. C. Weeks, 730 Ontario Ave., Archt. and Engr.

Ia., Crystal Lake—F. A. Gabrielson, Secy., will soon award the contract for the heating, plumbing and electrical work in school for the Consolidated Independent School Dist.

Ia., Mason City—The Mason City Hotel Co., c/o C. H. McNider, plans to build an 8 story, 142 x 167 ft. hotel including a steam heating system on South Federal St. About $1,000,000. Proudfoot, Bird & Rawson, 810 Hubbell Bldg., Des Moines, Archts.

Minn., Madelia—The city plans to install pumping equipment in connection with the proposed waterworks system. About $12,000. John W. Shaffer, 501 New York Life Bldg., Minneapolis, Engr.

Minn., Minneapolis—The Hennepin Minneapolis Knights of Columbus No. 435, 428 South 8th St., had preliminary plans prepared for a 3 story club house including a steam heating system. About $500,000. E. J. Loring, Grand Knight.

Kan., Osawatomie—The city is having plans prepared for the installation of an addition to the present power plant and a dam to impound 60,000 gals. About $85,000. Black & Veatch, Mutual Bldg., Kansas City, Engrs.

Kan., Topeka—The city plans an election November 3 to vote on $460,000 bonds to build a filtration plant and pumping station. Black & Veatch, Mutual Bldg., Kansas City, Mo., Engrs.

S. D., Aberdeen—The Y. M. C. A. plans to build a 3 story Y. M. C. A. building including a steam heating system. About $225,000. R. C. Bell, Secy.

N. D., Ashley—John Hildenbrand, Aud. of McIntosh Co., will receive bids until October 19 for the installation of electric light equipment including a 20 hp. oil or gasolene engine, 1 fuel tank, one 12½ kw. generator, switchboard, etc., in the Court House.

Mo., Liberty—The town is having plans prepared for a pumping plant. C. E. Jacoly, 528 Shubert Bldg., Kansas City, Engr.

Okla., Spiro—The city plans an election November 4 to vote on $40,000 for an addition to pumping plant. H. G. Olmsted & Co., Oklahoma City, Engr.

Tex., Dallas—A. H. Woods Enterprises, 236 West 42nd St., New York City, plans to build a theatre including a steam heating system on Griffin St. About $500,000. W. Wellman, Supt.

Tex., Wichita Falls—The State Bd. of Control, Austin, will receive bids until October 4 for the installation of a heating and plumbing system, refrigeration plant, etc., in the Northwest Texas Insane Asylum, here.

Cal., Cantara (Shasta Springs P. O.)—The Sacramento Klamath Water, Land & Power Co., Salem, Ore., through Victor De Marais and Charles E. Watson of Sacramento has applied to the State Engr. for permission to divert 1,000 sec. ft. of water from the Klamath River for the purpose of irrigating 250,000 acres of land and developing 150,000 hp. Plans include a dam, headgate and power plant here. About $15,000,000.

N. B., St. John—The New Brunswick Electric Power Comn. will soon award the contract for earth dams across the East branch of the Musquash River, in connection with the development of the power projects at Shogomoc and Musquash. About $150,000. Reid McManus, Canada Bldg., Secy. C. O. Foss, Engr. Noted Sept. 21.

Ont., Windsor—Colthurst, Trace & Nickols, Archts., 16 Sandwich St., West, will receive bids about January 1 for a 2 story, 120 x 400 ft. cold storage plant. About $600,000. Owner's name withheld.

CONTRACTS AWARDED

Conn., Montville—Robert Gair, 50 Washington St., Brooklyn, New York City, has awarded the contract for a 2 story, 200 x 500 ft. manufacturing building and a 1 story, 50 x 50 ft. power plant, to Barney Ahlers, 110 West 40th St., New York City. Incorrectly noted in August 31 issue.

R. I., Providence—The Providence Biltmore Hotel Co., 217 Hospital St. Trust Bldg., has awarded the contract for a 19 story hotel including a steam heating system on Dorrance, Eddy and Washington Sts., to Thompson Starrett Co., 49 Wall St., New York City. About $300,000.

N. J., Jersey City—The Hespe Realty Co., Central Ave., will build a theatre on Central Ave. Estimated cost, $250,000. Work will be done by day labor.

N. J., West Orange—The Edison Electric Co. has awarded the contract for a boiler house, to the Amer. Concrete Steel Co., 27 Clinton St., at $100,000.

Pa., Philadelphia—The Orinoka Mills, Ruth St., has awarded the contract for a 1 story, 50 x 117 ft. boiler and power house on Sterner and Jasper Sts., to the Wilson Ruff Co., Franklin Trust Bldg., at $100,000.

Pa. Tabor (Philadelphia P. O.)—The Fox Motor Car Co., Broad and Huntington Sts., has awarded the contract for a 3 story, 60 x 400 ft. automobile plant including a steam heating system on Grange Ave. along the Reading R.R., to J. S. Rogers, 970 Drexel Bldg., at $500,000.

O., Cincinnati—S. and L. Shubert, Inc., 225 West 44th St., New York City, has awarded the contract for a theatre including a steam heating system to Ed. Margolies, 19 East 33rd St., New York City, at $500,000.

Ill., Rockford—The town has awarded the contract for the installation of a pumping station, to Ross P. Beckstrom & Co., at $88,121.

Wis., Sheboygan—The Tomah Rubber Co., 176 16th St., Milwaukee, has awarded the contract for remodeling old plant and constructing two 70 x 100 ft. units on Lymans Ave., here, to H. Loesing, 914 Superior Ave., at $35,000. A steam heating system and electric power will be installed in same.

Ia., Cherokee—The State Bd. of Control, Des Moines, has awarded the contract for a pump house, pump pit, and reservoir, to Rhodes & Christianson, Guthrie. Noted July 13.

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89 to 101

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POWER

Volume 52 | New York, October 5, 1920 | Number 14

To Celebrate Dad's Raise at the Power-House

Automatic Oil-Burning Plant in California Sugar Refinery

Particulars of the Equipment and Details of Performance of the Most Up-to-date Oil-Burning Steam-Power Plant—Steam Coils to Smother Fire—Boiler Room Has Complete Gage and Control Board

By CLAUDE C. BROWN
Power Engineer, California and Hawaiian Sugar Refining Company

THE California & Hawaiian Sugar Refining Co., whose 2,000-ton capacity cane-sugar refinery is located at Crockett, Cal., has the distinction of possessing one of the most modern and up-to-date automatically controlled oil-burning boiler plants on the Pacific Coast. The new boiler room is shown in Fig. 1 and the turbine room in Fig. 2.

This plant, which was installed by Charles C. Moore & Co., engineers, San Francisco, Cal., consists of ten 600-hp. water-tube boilers equipped with economizers, together with all the automatic control apparatus necessary for the economical and efficient burning of oil.

The boiler plant is composed of the "New House," which contains the ten 600-hp. boilers, and the "Old House," which contains four 275-hp. water-tube boilers, four 250-hp. water-tube and fourteen 175-hp. return-tubular boilers.

Two separate steam-pressure systems are maintained at present; in the "New House" steam is generated at 150 lb. for operating three 1,500-kw. non-condensing horizontal turbo-generators. The surplus steam from this high-pressure header is stepped down through an automatically regulated butterfly valve, and delivered through a crossover connection, Fig. 3, fully guarded with safety valves, to the 100-lb. header of the old house. The steam from this header, after being reduced to 55 lb. pressure, is used almost entirely for the concentration of sugar solutions to the crystalline stage, in 14-ft. diameter vacuum pans.

The turbines are non-condensing and exhaust into an exhaust steam system, the pressure of which is maintained at about 10 lb. The steam from this exhaust system is also used for the concentration of sugar solutions to the crystalline stage. In addition it is used for the heating of various liquors, syrups, etc., and supplies the necessary heat to operate a quintuple evaporator of approximately 15,000 sq.ft. of heating surface. It also heats over one million gallons of water daily for refinery use.

The pressure on the exhaust-steam system is maintained fairly uniform at 10 lb. per sq.in. by one of two 6-in. reducing valves which operate between the 150-lb. live-steam header and the 10-lb. exhaust-steam header. This valve opens when the exhaust pressure drops to 5 lb. and closes when this pressure reaches 10 lb. If the exhaust pressure goes up to 15 lb., a multiport safety exhaust valve permits the excess exhaust steam to blow to the atmosphere.

The fuel oil used in this plant is a California product of about 17 deg. Bé. gravity, and contains approximately

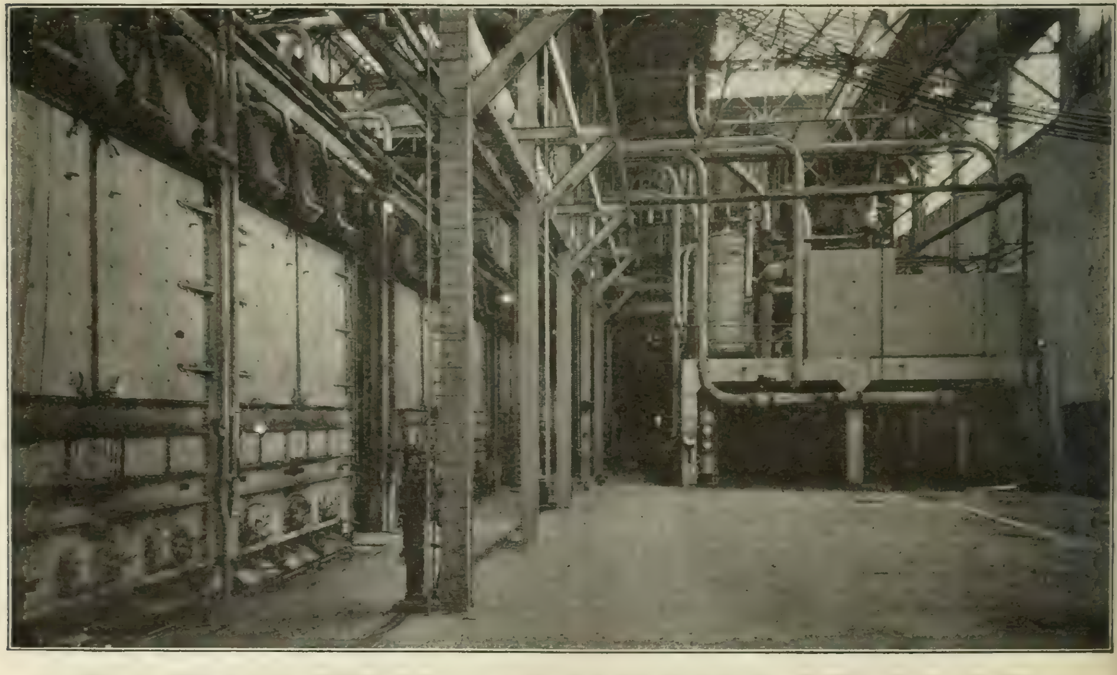


FIG. 1. BOILER ROOM, SHOWING GENERAL CONSTRUCTION, BOILERS AND FEED-WATER HEATER

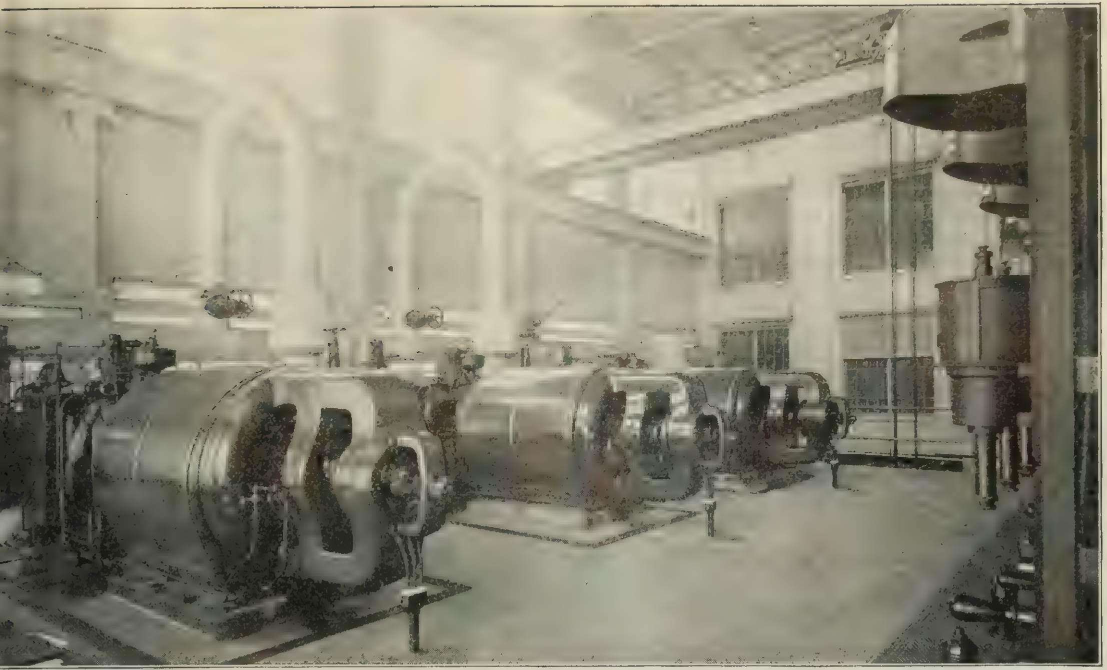


FIG. 2. VIEW OF THE TURBINE ROOM, CALIFORNIA & HAWAIIAN SUGAR REFINING CO.

8,750 B.t.u. per lb. It is brought to the plant in barges nd pumped from the barges into two steel storage anks of 25,500 bbl. and 3,780 bbl. capacity respectively. 'rom these tanks it is pumped to four auxiliary underround concrete storage tanks adjacent to the boiler ouse. Two of these are used for furnishing fuel oil to he plant, while the others are being filled for stand-by torage. All tanks are equipped with steam smotherng coils for use in case of fire.

The method of measuring the amount of oil drawn nd consumed is accurate. Each tank is carefully calirated for each quarter of an inch in depth and these gures are entered on a blueprinted table. At the nd of each eight-hour shift, and also whenever the anks in use are changed, careful soundings of the oil epth are taken by means of marked steel rods. These ods are counterbalanced by means of weights suspended n chains which pass over pulleys, so that their use equires little effort on the part of the operator.

Accurate temperature readings are taken at two-hour ntervals by means of angle thermometers, and in addiion to this a continuous recording thermometer is intalled on the oil intake to the boiler-room oil pumps. ‹t the end of each shift the average temperature of the il is obtained and all readings corrected to a 60 deg. F. asis.

From the auxiliary tanks the oil is drawn through trainers to two duplex horizontal steam pumps, size x 8 x 10 in., of 80 gal. per min. capacity each; from here it is delivered to two special coil oil heaters each aving an internal heating surface of 600 sq.ft.

Each heater consists of twelve sections, each section ontaining a coil of 1-in. extra-strong wrought-iron ipe, from which the oil circulates from a 4-in. inlet nd a 4-in. outlet header. Each coil is designed for pressure of 150 lb. per sq.in.

Within the section castings and around the coils steam is circulated at exhaust pressure, 5 to 15 lb. The amount of steam admitted to these heaters is varied to maintain the outlet oil at a temperature of 180 deg. F., this temperature having been found to give the best results for combustion purposes.

From one of these heaters the oil is led directly to an oil header above the 22 boilers in the Old House, and thence through drop lines to the oil burners of each boiler. From the other heater the oil is led through an automatically controlled butterfly valve, and from thence to the oil headers over the ten boilers in the New House.

The pressure of the oil at the burners is automatically controlled by a regulating system described in detail later. This pressure is varied between 10 and 30 lb., according to the steam demands.

The oil burners used on all boilers are an outside-mixing, steam-atomizing type. They are "rear shot"; that is, they extend the full length of the furnace, underneath the furnace floor, and rise into a small housing at the bridge wall; the burner head faces forward toward the boiler front, and the flame travels from the bridge wall forward. At the inlet to each burner is a small removable strainer that catches any grit and dirt that comes through the heaters.

In the refining of sugar much heating and boiling is done by means of steam coils immersed in the product to be boiled or heated. The return drips from these coils are led back to the boiler room by gravity and into one of two open feed-water heaters, each of a capacity of 250,000 lb. of water per hour. These return drips constitute about one-half of the feed water evaporated. The remaining half is made up of treated river water, which is admitted to the heater at the steam-inlet end. From the heaters, which are placed on a raised concrete platform, the feed water drops straight down to one of two turbine feed pumps on the boiler-room floor underneath the heater platform.

The makeup water, which comes from the Sacramento River, is pumped to a softener, located outside the boiler room and over the auxiliary oil tanks.

This softener is a cold-process type apparatus, having a capacity of 27,000 gal. per. hr. and a storage capacity of 17,000 gal. of treated water. It consists of a redwood tank, 30 ft. 9 in. in diameter by 19 ft. 4 in. high, into one side of which is led the water, together with its lime and soda treatment, where it is stirred or agitated. From here it passes down under a dividing partition and comes up through an excelsior filter bed to the outlet on the other side. From this point the treated water drops by gravity to a cistern underneath the boiler house. From the cistern it is picked up by one of two motor-driven centrifugal service pumps each capable of pumping 1,000 gal. per min. against a head of 55 ft., and delivered to the feed-water heaters through float-operated valves that maintain a depth of three feet in the heaters.

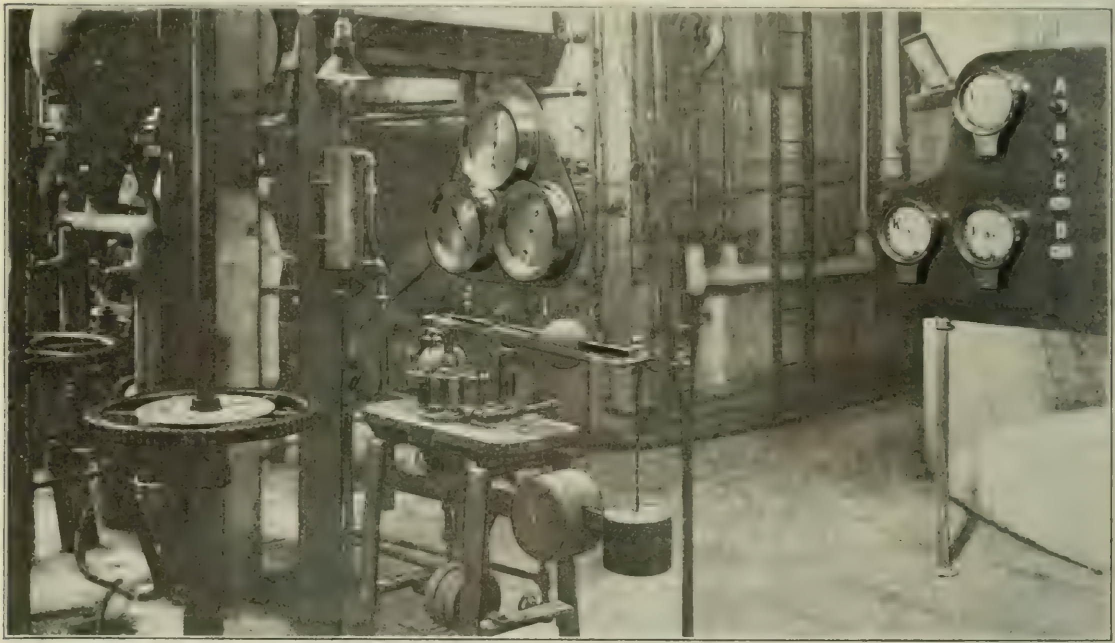


FIG. 3 CROSSOVER REGULATOR, SHOWING HYDRAULIC CYLINDER WHICH OPERATES THE BUTTERFLY VALVE

To prevent the possibility of the turbine-driven feed pumps running away after draining the heater dry, with the power off the motor-driven centrifugal service pumps, there is installed an emergency duplex steam pump, size $7\frac{1}{2}$ x $8\frac{1}{2}$ x 10 in., with a capacity of 500 gal. per min. Should the water level in the heaters fall to 24 in. from the bottom, a float-actuated valve opens, releases the pressure on the discharge side of this pump, which in turn operates a governor, thereby admitting steam and delivering 500 gal. per min. from the cistern to the heaters.

From the bottom of the heaters a manifold delivers the water to one of two turbine feed pumps which feed the boilers of the New House, and three reciprocating horizontal pumps that feed the Old House. The turbine-driven feed pumps are of the turbine type, of 1,000 g.p.m. capacity, against 462 ft. head, at 1,800 r.p.m. Each is driven by a horizontal, single-stage turbine, 1,800 r.p.m., with a throttle pressure of 140 lb. and an exhaust pressure of 15 lb.

The feed water, which is at an average temperature of 170 deg. F., is then pumped through a 10 x 4-in. venturi meter having a capacity of from 55,600 to 722,000 lb. of water per hour, and its rate and amount are recorded. From thence it goes, at approximately 190 lb. to five economizers, each consisting of 32 sections of 10 tubes each, the tubes being $4\frac{5}{8}$ in. in external diameter by 12 ft. long. The capacity of each economizer is 19,840 lb. of water, and each has a heating surface of 4,080 sq.ft.

From the economizers the feed water passes to headers that are located over the tops of the boilers, and the feed to each boiler is taken care of automatically by a regulator.

The New House consists of ten 600-hp. Babcock & Wilcox vertical header boilers, each equipped with a patented oil-burning furnace consisting of a checker brick floor with ashpits divided into three equal aisles, one aisle under each of the three burners.

Each boiler is steel incased, the steel casing covering 4 in. of 85 per cent asbestos magnesia insulation. The boilers are set in batteries of two each, the front center column being eliminated, the weight being taken at this point by an extra-heavy cross-beam which extends clear across the fronts of the two boilers. The boiler fronts are held in place by means of four stay rods which extend from the front false column, through the center wall, to the rear center column. These rods are $1\frac{1}{8}$ in. diameter and each is inclosed in a 2-in. pipe. Each boiler consists of three 42-in. drums, 20 ft.

5½ in. long and 21 sections of tubes, 14 tubes high, each tube being 4 in. in diameter by 18 ft. long. The stop valves are 8-in. automatic type, and all joints in risers and pipe lines are of the Van Stone type. On each boiler is a complete installation of soot blowers and a differential draft gage. In the main riser from each boiler there are ½-in. taps and valves that are used for the purpose of making moisture determinations with the calorimeter.

On one boiler there has been installed a steam-flow meter, recording draft gage and recording flue-gas thermometer. In addition there are three CO$_2$ machines each fitted with recorders and indicators.

Each of the five machines takes care of two boilers. Fig. 4 shows the boiler-house gage board.

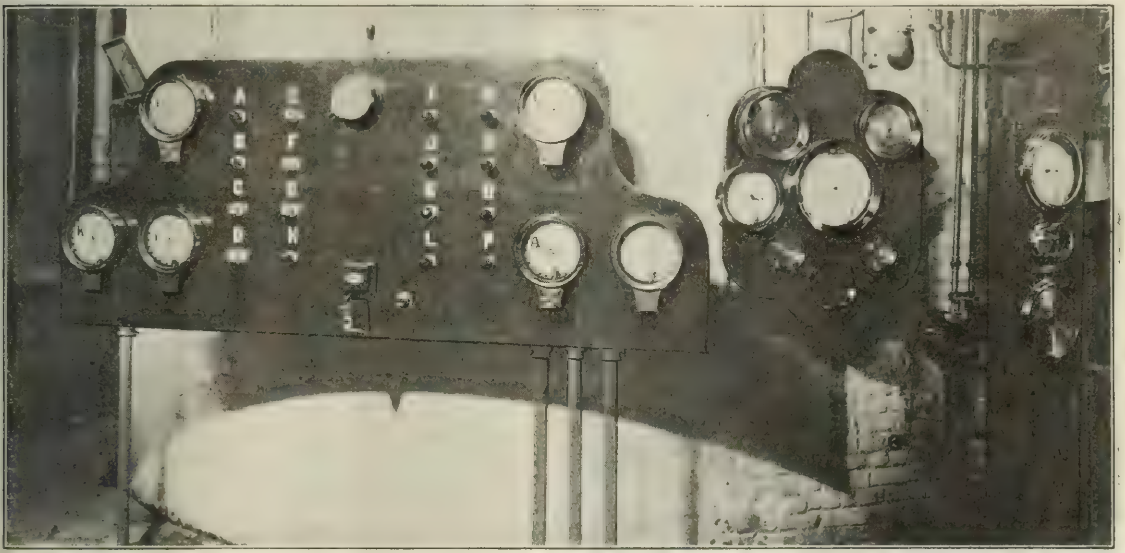


FIG. 4 THE BOILER-HOUSE GAGE BOARD

An automatic regulator controls the fuel-oil pressure, the steam-to-burner pressure and the damper opening, varying each in accordance with the load demand. This regulating system consists of: Oil-to-burner pressure regulator, Fig. 5; steam-to-burner pressure regulator, Fig. 6; damper regulator; water pump and necessary motors; hydraulic cylinder, tank, piping drains, etc.

The principle upon which this regulating system works is the varying of the oil pressure inversely with the steam pressure on the main header, and in turn the varying of the reduced steam pressure to burners and damper opening more nearly directly with the oil pressure.

A description of the operation of this automatically operated boiler plant follows:

In so-called hand-fired plants it is generally the custom to maintain a constant oil pressure at the fuel-oil pump and to regulate the generation of steam in individual boilers by throttling the burner valve of each boiler, thus increasing or decreasing the size of the fires under each boiler in accordance with the judgment of the operator. When the fact is taken into consideration that almost always the amount of atomizing steam, which is generally at full boiler pressure, is left unchanged and remains a maximum for all loads, and also that as a rule the dampers are left wide open, it can be readily appreciated that an efficient, uniform rate of firing by hand methods is well-nigh unattainable, if not impossible.

The automatic regulating system in this plant controls the supply of oil to all burners, the supply of atomizing steam (which is reduced from boiler pressure) for ten boilers, and one damper regulator controls the damper opening on six and another on the remaining four boilers, all from a single central point. All burners are operated with burner valves wide open, the size of fire being automatically controlled by the regulation of oil pressure. This applies also to the atomizing steam valves. All the dampers of the six boilers which are controlled by one of the damper regulators are connected to a common rocker shaft and move simultaneously. Similarly, those of the four boilers act likewise and are controlled by the other damper regulator.

Any variation in steam pressure of the main header due to a variation in the load demand is the primary means of control of a steam governor which varies the oil pressure in the oil headers. When the main steam pressure drops, owing to increased demand for steam, the regulator increases the oil pressure in the oil headers, which in turn increases the size of the fires and consequently the rate of evaporation. An increase in steam pressure in the main header works just opposite and tends to reduce the oil pressure. In this way a state of equilibrium is reached for any given steam-demand rate.

In the steam-to-burner regulator the actuating elements are opposing steam and oil diaphragms with areas and leverages conforming to a ratio of approximately 4 to 1 between atomizing steam and oil pressure. Any increase in oil pressure causes an increase in the pressure of atomizing steam in accordance with this ratio. This is accomplished by means of the action of a butterfly valve in the steam-to-burner main, which is actuated by the water motor of the regulator. Thus the steam-to-burner pressure is regulated by the oil pressure.

In the damper controller also the oil pressure is the controlling factor. A diaphragm is actuated by the pressure of the oil in the fuel-oil header, and the movement of the diaphragm is opposed by a lever connected to a coil spring, which is adjustable along the lever for the purpose of obtaining the required range of motion of the dampers for a given range of oil pressure. A double-ported valve connected to the controller admits water from the pressure-supply system, either to the top or to the bottom of a hydraulic cylinder which actuates the aforementioned rocker shaft, to which the dampers of all the six boilers in one case and four in the other are connected.

The action of these regulators is entirely automatic. To cut out any of them, it is necessary only to close the valve between the oil header and the oil-to-burner regulator, bypass the steam-to-burner regulator or cut off the pressure-supply water to the damper-controller hydraulic cylinder, opening both drain valves, which will allow the dampers to be thrown wide open by their counterweights and regulated by hand.

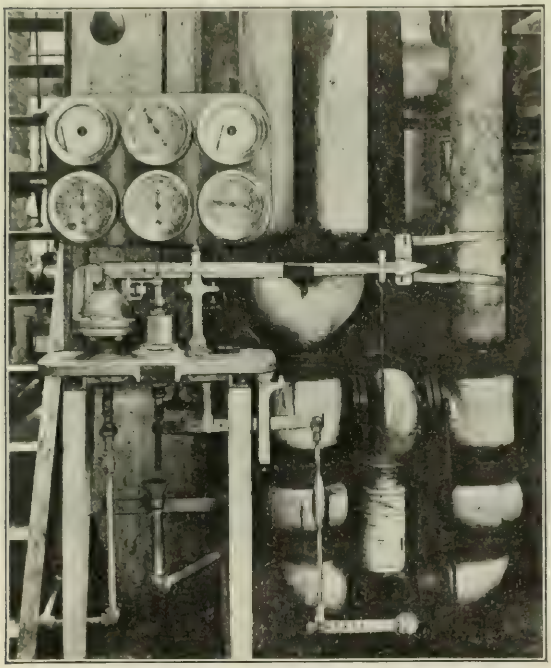


FIG. 5. FUEL-OIL REGULATOR

When the automatic control has been once set, little trouble is experienced with it. The accompanying log sheet, Fig. 7, for May 12, 1920, will show the results obtained with the automatic control system.

After all boilers have been put on and the fires started, it is the practice at this plant to equalize all the fires and make refined settings of both steam-to-burner and damper controllers. When the respective dampers are set, the fires are equalized by slightly opening or closing all the burner valves, thus setting the valves so that they pass just enough oil for complete combustion, which is indicated by a slight smoky haze as seen through the side peepholes of the boiler. Similarly, the steam-to-burner supply is adjusted by slightly opening or closing all the supply valves on the burners. On sudden changes of load of large proportions the regulators all promptly act together. There is, however, one point to be noticed in connection with this automatic control; namely, that after a certain set of conditions become established for a given load, such as rate of flow of chimney gases, temperature of gases, draft, etc., the regulator will respond to changes in load more quickly than the chimney. The result is

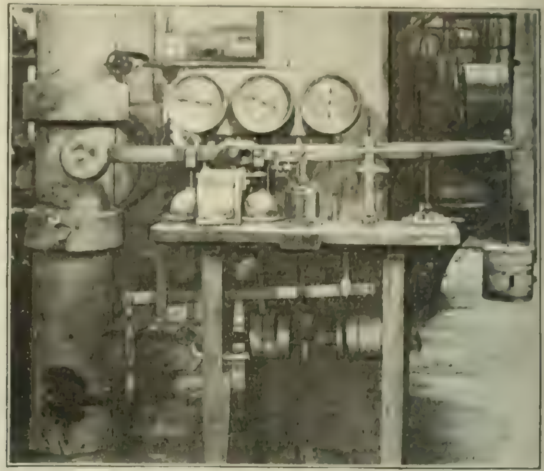
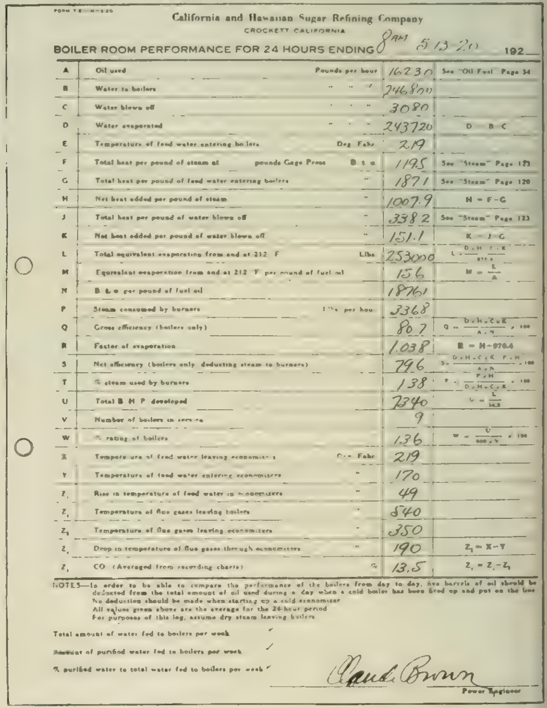


FIG. 6. THE STEAM-TO-THE-BURNER REGULATOR



FORM [illegible]

California and Hawaiian Sugar Refining Company

CROCKETT CALIFORNIA

BOILER ROOM PERFORMANCE FOR 24 HOURS ENDING 8 AM 5 13 20 192__

A	Oil used	Pounds per hour	16230	See "Oil Fuel" Page 34
B	Water to boilers	" "	246800	
C	Water blown off	" "	3080	
D	Water evaporated	" "	243720	D = B − C
E	Temperature of feed water entering boilers	Deg. Fahr.	219	
F	Total heat per pound of steam at pounds Gage Press.	B.t.u.	1195	See "Steam" Page 123
G	Total heat per pound of feed water entering boilers	"	1871	See "Steam" Page 120
H	Net heat added per pound of steam	"	1007.9	H = F − G
J	Total heat per pound of water blown off	"	338.2	See "Steam" Page 123
K	Net heat added per pound of water blown off	"	151.1	K = J − G
L	Total equivalent evaporation from and at 212° F.	Lbs.	253000	$L = \frac{D \times H + C \times K}{970.4}$
M	Equivalent evaporation from and at 212° F. per pound of fuel oil		15.6	$M = \frac{L}{A}$
N	B.t.u. per pound of fuel oil		18761	
P	Steam consumed by burners	Lbs. per hour	3368	
Q	Gross efficiency (boilers only)		80.7	$Q = \frac{D \times H + C \times K}{A \times N} \times 100$
R	Factor of evaporation		1.038	R = H ÷ 970.4
S	Net efficiency (boilers only, deducting steam to burners)		79.6	$S = \frac{D \times H + C \times K - P \times H}{A \times N} \times 100$
T	% steam used by burners		1.38	$T = \frac{P \times H}{D \times H + C \times K} \times 100$
U	Total B. H. P. developed		7340	$U = \frac{L}{34.5}$
V	Number of boilers in service		9	
W	% rating of boilers		136	$W = \frac{U}{600 \times V} \times 100$
X	Temperature of feed water leaving economizers	Deg. Fahr.	219	
Y	Temperature of feed water entering economizers	"	170	
Z_1	Rise in temperature of feed water in economizers	"	49	
Z_2	Temperature of flue gases leaving boilers	"	540	
Z_3	Temperature of flue gases leaving economizers	"	350	
Z_4	Drop in temperature of flue gases through economizers	"	190	$Z_1 = X - Y$
Z_5	CO₂ (Averaged from recording charts)	%	13.5	$Z_4 = Z_2 - Z_3$

NOTES—In order to be able to compare the performance of the boilers from day to day, five barrels of oil should be deducted from the total amount of oil used during a day when a cold boiler has been fired up and put on the line. No deduction should be made when starting up a cold economizer.
All values given above are the average for the 24-hour period.
For purposes of this log, assume dry steam leaving boilers.

Total amount of water fed to boilers per week ✓

Amount of purified water fed to boilers per week ✓

% purified water to total water fed to boilers per week ✓

Claud. Brown
Power Engineer

FIG. 7. THE BOILER-HOUSE PERFORMANCE SHEET

that momentary smoking is caused, the condition enduring for a brief period, which is known as the "lag."

While this system results in a large saving in manual labor, it does not dispense with any large number of iremen. We have at this plant a total of 32 boilers. The boiler-room crew consists of one fireman and two vater tenders per shift and the repair gang of nine nen, all under the supervision of a boiler-house foreman. The saving as obtained with the various aforementioned devices comes in the increased economy as btained with automatic regulation over hand regula-ion. With the automatic regulation the personal element is eliminated, and as long as the apparatus is kept n good order, more dependable economical and efficient peration is sure to result.

George M. Rolph is general manager, A. M. Dupern, plant manager, and L. L. Edmunds, chief engineer, for the California & Hawaiian Refining Co.

Some of the equipment in the power plant of the California & Hawaiian Sugar Refining Co.:

Consulting Engineers, Charles C. Moore Co.
Ten 600-hp. Babcock & Wilcox water-tube boilers, four 275-hp Stirling boilers, fourteen 175-hp. return-tubular boilers.
One 1,500-kw. Curtis non-condensing turbine.
Automatic oil burning system, C. C. Moore Co., San Franciso.
Oil-burning furnaces, Peabody, "rear shot."
Fuel oil, 17 deg. Bé; 18,750 B.t.u. per lb.; Standard Oil Co.
Fuel-oil burners, Leahy, type D1.
Oil heaters, National Pipe Bending Co.
Feed-water regulators, Copes.
Feed-water heaters, open, Cochrane.
Water softener, cold process, Booth, type F-14.
Thermometers, Tycos.
Economizers, Green.
Soot Blowers, Diamond
CO_2 recorders, Uehling.

Ammonia-Compressor Troubles

BY J. C. MORAN

ONE of the two small vertical single-acting compressors in a cold-storage plant began to develop a slight knock one day, and this gradually got vorse until about a week later it became so bad that t had to be attended to. The engineers hunted all over he machine for the cause of the trouble for several lays without being able to discover it. When they were n the compressor deck it seemed that it was somevhere in the cylinder on one side, and when they were lown below it appeared to be in the connecting rod or rank.

After taking up on the wedges and bearings all round until everything ran hot most of the time, one f the oilers suggested that it might be caused by too ittle clearance in the cylinder, and being unable to hink of anything better to do and not wanting to shut he machine down for any length of time for close nspection, they decided to screw the piston rod into the rosshead a little more and thus increase the clearance. The rod was screwed in about $\frac{1}{16}$ inch for trial and the nock disappeared entirely. A few days later, however, t appeared again and was just as bad as ever. The od was screwed in some more and again the racket topped. This lasted only a day, when the knock came ack again.

VALVE-SEAT CAPSCREW CAUSED TROUBLE

By this time the engineers realized that there must e something wrong inside the compressor. There was ut one thing to do, and that was to shut down and pen up the machine and examine the inside. When he cylinder head and the false head were removed and he piston and suction valve exposed, it was seen that ne of the screws that hold the suction-valve cage in he piston had backed out and was striking the false ead at the end of the stroke. The construction of the iston and the screw which caused the trouble is shown t *A* in Fig. 1. The screw was badly battered and the hreads of both the hole and screw damaged so badly hat it was impossible to put in a new one. The hole vas reamed and tapped for a larger screw and a new crew inserted. After this had been done, no further rouble was experienced. As a precaution against fu-ure trouble of this nature the heads were removed once very two months and the suction valves and cages nspected for loose screws as well as other troubles hat might have started.

One engineer having had trouble of this kind twice in succession during a hot spell one summer, stopped it by drilling a small hole about half an inch deep partly in the screw head and partly in the body of the valve cage. The hole was filled with babbitt. This served as a dowel pin and securely locked the screw in place. When he wanted to take the screw out all he had to do was to run the drill down into the hole, removing most of the babbitt; then the screw came out as easily as before.

PIECE OF PIPE CAUGHT UNDER VALVE

One night one of the engineers in the plant first mentioned heard a hard thump on one of the machines, and from then on there was a steady but light pound as it passed the center at the top. It was reported to the chief the next morning, and he decided that it must be caused by the piston rod backing out of the crosshead as he found that the locknut on the crosshead was loose. After the piston was screwed in a couple of turns, the knock disappeared and no more was heard of it.

Another trouble appeared, however. The machine did not run steadily, but made a jump at every revolution and, so it seemed, on the compression stroke of the cylinder on which the knock had existed before. At first the trouble was believed to be in the governor, but this was tinkered with for a couple of weeks without any sign of improvement.

At the same time the cylinder on this side ran very hot and it was also noticed that the suction-pressure and discharge-pressure gages on the machine jumped considerably. Furthermore, they had to run the compressor quite a little faster for about the same amount of work, so they finally came to the conclusion that they had better look inside.

When the head and false head were removed they could see nothing wrong and were just about to replace the heads when one of the men happened to put his hand on the suction valve. To his surprise it stopped solid while it was still $\frac{1}{16}$ in. open. This led to further investigation, and it was finally discovered that there was a short piece of $\frac{1}{4}$-in. pipe caught under the valve, as indicated by *B*, Fig. 1. It had been crushed flat. No one knows to this day where that piece of pipe came from or how it came to work its way into the cylinder. It was just another of those cases where the unexpected happens and in the most unheard of places.

By inspection of Fig. 1 it will be noticed that the spring C tends to hold the valve open instead of closed; in fact, when the machine is opened up, it will generally be found that the valve remains partly open. This is as it should be, the purpose of the spring being to practically balance the valve so that it will close more easily at the end of the suction stroke and open more lively at the beginning of the suction stroke. One man, in charge of his first plant, decided that this was all wrong and proceeded to fix it up to suit himself. First he cut off a few sections of the spring, which made it considerably shorter. He then drilled holes in the valve and also in the recess for the spring in the valve cage and rigged up some hooks so that when the whole rig was in place the spring tended to pull the valve shut with considerable force.

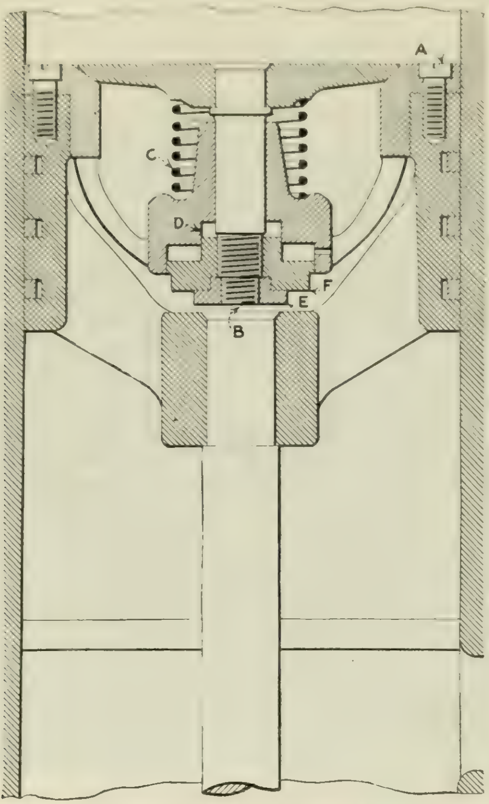


FIG. 1. DEFECTIVE VALVE-SEAT CAPSCREW

The change did not seem to make much difference excepting that at times the valves had a tendency to slam at the end of the suction stroke. They also had to run the machine quite a bit faster because the restriction of the valve area by the tight spring holding the valve partly shut most of the time kept the cylinder from filling properly. One day there was solid thump in one cylinder and, while it slacked off a little, it did not stop. It continued so long that the engineers decided that they had better look into it, so it was pumped out and the heads removed.

It was then found that one of the hooks which had been inserted to hold the spring of the suction valve had come loose and got caught between the valve and seat, holding the valve open all the time, and as the clearance was pretty close there was nothing for it to do but bump up against the safety head at every revolution. The valve was so badly battered that a new one had to be ordered from the factory. One of the company's erecting engineers also came along to help put it in when it was delivered. When he found out what the engineer had done to the springs, he said a few things that would not look well in print. After explaining to the chief what the spring was for and how it worked, he ordered a new set of springs and put them in the way they were originally intended. When they started up the machine again, they were able to handle the load at considerably lower speed and it also ran quite a bit cooler.

Broken Valve Cage Puzzles Experts

In another plant one of the two machines of the same make suddenly began acting irregularly. On the crank-end stroke of the steam cylinder it would take a sudden jump and then slow down with a jerk as it neared the center, while the governor jumped up and down like a jack-in-the-box. All the governor experts in the neighborhood tried their hand at it without improving matters in the least, and finally a man from the factory was sent for.

He went over the machine from one end to the other, tinkered with the governor, reset the steam valves two different times, opened up the compressors and found everything in good order and finally gave up and went back to the factory.

In a few days another man was sent out and brought along an indicator. First, he indicated the steam cylinder. This was in pretty good shape and after a few small adjustments he next indicated the ammonia compressors.

After sizing up the action of the machine, he first tackled the one he suspected might be the cause of the trouble. The first card looked somewhat surprising and he tried another with the same result. According to the indicator this compressor was getting practically no gas, as there was a high vacuum in the cylinder during the entire suction stroke and on the compression stroke the pressure barely reached discharge pressure at the end of the stroke. Apparently the compressor was doing little or no work.

From all indications there was some restriction in the suction connections or the suction valve to this compressor. The head and the false head were removed, and the machine was turned over very slowly. Then a flange was removed in the suction connection to this cylinder in order to provide an easily watched source of supply.

The suction valve appeared to be stuck, as it barely moved at each suction stroke of the compressor. Generally, these valves jump wide open at the instant the piston reverses its travel and starts downward. The suction-valve cage was then removed by unscrewing all the screws *A*, Fig. 1, which hold it in position, and when it was removed from the machine the valve was found to be practically stuck shut. There was a slight movement, just about enough to lift the valve off the seat.

After fussing with it for an hour or more, trying to work it loose, the expert finally decided to take it apart and the jam nut *E* and the large nut *F* were removed. When the large nut was slipped off, a small piece of the valve cage dropped out. This was found to have been cracked out of the guide at *D*, the broken part ımming into the space between the large nut and the uide. A new valve cage was ordered, and when this as installed all the trouble was over.

A 200-ton Ball compressor had been overhauled and ut in service again a short time when it developed a narp knock at irregular intervals. At times it was ery light, and then again it sounded as if someone were ounding the cylinder as hard as he could with a heavy ammer.

At first it was thought that the trouble was in the alves, due to broken springs, which produce a some- hat similar racket, but this was found not to be the ase. The piston was removed and every part was in- pected for improper adjustment without finding any- hing wrong—everything was apparently in perfect rder.

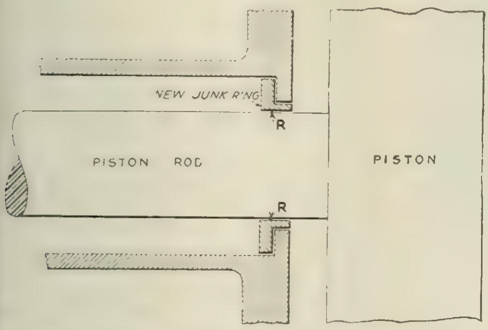


FIG. 2 REPAIR OF WORN STUFFING BOX

One of the oilers was a somewhat observing sort of fellow, and he noticed that adjusting the stuffing box little at a time had an effect on the racket. One day when it started again he began the same process and retty soon the knock stopped altogether. After the tuffing box was loosened up again it was not long be ore the knock was as bad as ever.

Junk Ring in Stuffing Box Was the Cause of the Trouble

After thinking the matter over and trying it for imself, the engineer in charge came to the conclusion hat the trouble was due to a junk ring that had been ut in the bottom of the stuffing box to make up for he amount that the rod had been turned down during he overhauling. It must be remembered that the hole hrough the bottom of the stuffing box is just a snug it on the rod when the rod is full size, and if the rod s turned down after it is worn, some provision must e made to make the bottom of the stuffing box a tight it on the rod, otherwise the packing will all work out etween the rod and the neck of the stuffing box. In most cases this is done by slipping a ring, generally ermed a junk ring, into the bottom of the box, which s a snug fit on the rod. This is only a makeshift affair, ut it generally serves the purpose, although it will requently wear rapidly, as it did in this case, and then ome other scheme must be worked out.

Fig. 2 shows how the engineer solved the problem. The neck of the stuffing box was bored out so that it was about half an inch larger in diameter than the full ize of the rod. A ring was made of the cross-section hown, with the hole through it a snug fit on the rod nd the ouside diameter of the projecting part a tight fit in the enlarged hole in the neck of the stuffing box. Whenever the rod was turned down, it was a simple matter to drive the old neck ring out and turn up another to fit the changed diameter of the rod. As the ring was a tight fit in the neck of the stuffing box, there was no possibility of its moving or knocking; it also reduced trouble with heating of the stuffing box and rod, occasioned by the changing pressure on the packing when the ring was shifting back and forth.

An Easy Check on Plant Economy

By E. H. Tenney

In St. Louis the Union Electric Light and Power Co. operates twenty-eight isolated plants, generating current to the limit of the heating requirements in those plants having generating equipment. As a guide to the operator on fuel requirements and as a check on the economy obtained, a chart on the order shown herewith is prepared for each building. To make up such a chart, a careful analysis is made of each building and its respective power plant. The type of construction, the proportion of glass area, the exposure, the amount of radiation, etc., are considered in computing the heat loss for the building. From such data the steam requirements for temperatures ranging from 10 deg. below zero to 70 deg. above are obtained. A careful inspection of the plant equipment and its physical condition determines the economy of operation and the evaporation to be expected from a certain quality of coal. The final analysis is thus brought down to pounds of coal per shift, and by plotting these data against outside temperature the chart is produced.

As an example, suppose the temperature during the night shift averages 20 deg., the coal requirements for the 12 hours will be 12,800 lb. If the temperature during the day averages 25 deg., the coal consumption should be 18,500 lb. A chart of this character is posted in the boiler room as a guide to the firemen, and of course charts for all buildings are retained in the supervising office to provide an easy check on plant records for determining whether the respective plant is operating at the economy expected or whether it requires the attention that would be needed if the coal consumption exceeded the chart figure.

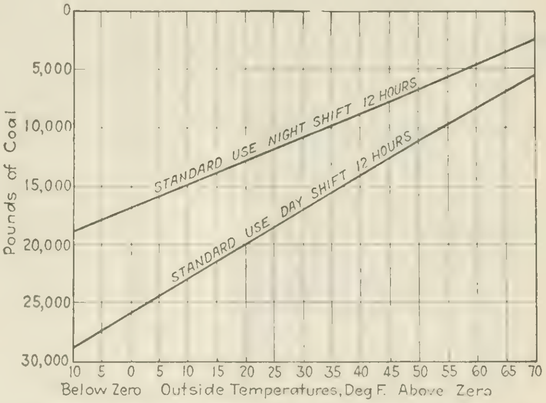


CHART OF COAL REQUIRED FOR TEMPERATURE CONDITIONS

Circuit Breakers—Principle of Operation

The Principle of Operation of a Modern Type of Circuit Breaker—Shunt-Trip Attachments, Underload Releases, Undervoltage Releases and Overvoltage Releases

BY VICTOR H. TODD

THERE are a number of abnormal conditions that may occur in an electric circuit and against which protective measures must be taken to prevent damage to the various units such as motors, transformers, lines and generators. The most frequently occurring abnormal condition is an excessive flow of current, which may be due to overloading motors, or to short-circuits in the receiving, transmitting or transforming apparatus. Other abnormal conditions that may occur are undercurrent, under voltage or overvoltage, in a constant-potential circuit. The last-named might be caused by an increase in prime-mover speed, or short-circuit in field resistor, and result in a burning out of lamps or motors. For protection against these conditions and also for protection against excess current (overload) when it is of such frequent occurrence that the renewal cost of fuses is prohibitive, an automatic switch, called a circuit breaker, is commonly employed. Circuit breakers are usually arranged to open on the occurrence of excess current, but may be provided with attachments or releases which actuate the breaker on the occurrence of undercurrent, overvoltage and undervoltage. For such conditions as reverse current, reverse power, reversed phases, excesses in temperature or frequency, or obtaining specific time delay between the instant of excess current and opening of the breaker, and to obtain accuracy in the measurement of the excess current or voltage and undervoltage and current, it is usual to control the opening of the breaker by protective relays. Circuit breakers may open the circuit in air, as in Fig. 1, or under oil. The first are commonly called "carbon-break circuit breakers" because the final break is between carbon contacts, and the second kind are often called "automatic oil switches" or "oil circuit breakers." Breakers may be semi-automatic, full automatic or electrically operated. A semi-automatic circuit breaker is one that opens automatically on the occurrence of an abnormal condition, but must be closed by hand, and if the handle is held in a closed position, the breaker is inoperative. In the full automatic breaker the handle is said to be "trip-free"; that is, if the breaker has opened owing to an abnormal condition, and attempt is made to reclose it by hand, then if the abnormal condition still exists, the breaker will open even though the handle be held in the closed position. An electrically operated breaker is one that is both closed and opened electrically. The opening is usually due to an abnormal condition, but the breaker may be either opened or closed from some remote source; for instance, a remote-control panel board or a protective relay.

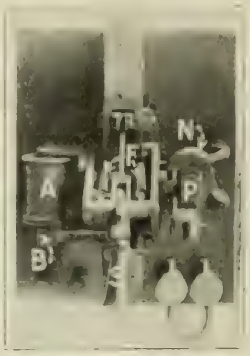
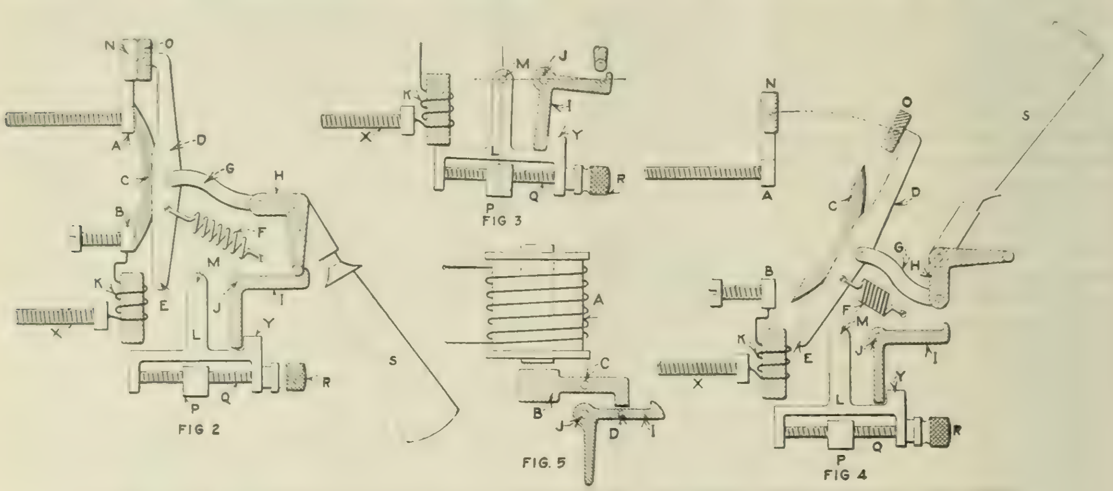


FIG. 1 CIRCUIT-BREAKER WITH SHUNT-TRIP AND UNDERLOAD RELEASE



FIGS. 2 TO 5. SCHEMATIC DIAGRAMS SHOWING PARTS OF CARBON-BREAK CIRCUIT BREAKER

Circuit breakers are usually arranged so that when they are closed, considerable energy is stored in strong springs and the parts held in a closed position by a small trigger or tripping lever. When the predetermined conditions occur for which the breaker is set, this trigger is tripped, thereby releasing the springs, which causes the contacts to open in a small fraction of a second. This may be readily seen from the schematic diagram of parts of a typical carbon-contact circuit breaker, Fig. 2, which shows the breaker in its normally closed position. *A* and *B* are the main contacts (usually heavy copper blocks), which are spanned by the laminated copper brush *C*. This is loosely attached to the moving arm *D* in such a manner

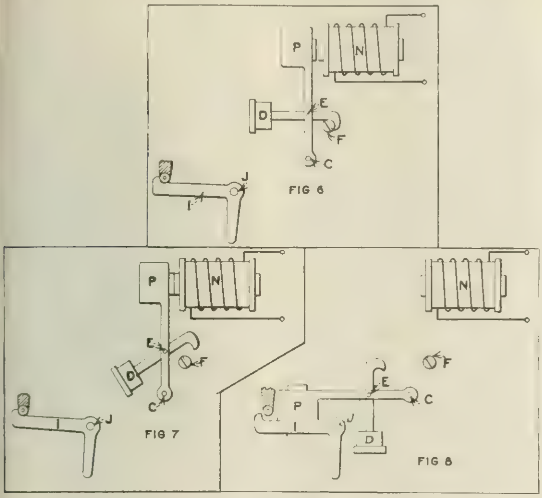


FIG 6

FIG 7

FIG 8

FIGS. 6 TO 8. SCHEMATIC DIAGRAMS SHOWING OPERATION OF UNDERLOAD ATTACHMENT

that it is self-aligning, and when the breaker is being closed, contact *C* is forced against *A* and *B* with considerable pressure, resulting in a "wiping" action, which makes a good electrical connection. The moving arm *D* is pivoted at *E* and the springs *F* are under tension, tending to pull the contact open. This is prevented by the toggle joint *G* and *H* which is held in position by the trigger *I*, pivoted at *J*. Connected between the lower stud *X* on the breaker, and the lower main contact *B* is a coil *K*, which carries the main current; and under its influence is an iron armature *L*, pivoted at *M*. When the current in coil *K* becomes great enough, the armature *L* is attracted to its core; this causes the projection *Y* on the armature to strike the tripping lever *I* a sharp blow, thereby releasing the toggle joint and allowing the springs to open the contacts quickly. In Fig. 3 is shown the breaker's trip mechanism just at the instant of tripping, and Fig. 4 shows the breaker fully open. In order to reset the breaker, handle *S* must be pulled down, thereby straightening the toggle joint and giving the necessary power to force the contacts closed. If the main contacts, *A*, *B*, and *C*, were to open the circuit directly, the resultant arcing would soon cause them to become so pitted that they could no longer make contact. Therefore, the circuit is finally broken by two auxiliary carbon contacts at *N* and *O;* when the main contacts open, the current is shunted through these contacts, but they are separated so quickly that no arc or excessive burning results, the oxide of course passing off as a gas.

In order to allow a variation in the tripping current required, the armature *L* is provided with a threaded weight *P*, which is mounted on a screw *Q*, so that the former's position may be varied by turning the nut *R*. When the weight is near the electromagnet *K*, its full weight tends to keep the armature away from the magnet, thus requiring the maximum current to cause tripping; when it is near the nut *R*, its weight tends to assist the attraction of *K*, thereby requiring a minimum of current.

Provision is usually made to open the breaker by hand. The type of breaker shown in Fig. 2. can be opened by raising the handle *S*, which results in tripping. Many operators prefer to touch the trip lever *I* or the nut *R* to open the breaker, but this should be done with care, since this part is "alive" and there may be danger of a severe shock. Many breakers provide for opening in this manner by using a well-insulated nut at *R*, thus preventing danger of accidental shock.

It will be readily seen that anything that trips the lever *I* will cause the breaker to open. The shunt trip is a device for tripping the breaker from some remote source, either manually or automatically. In Fig. 5 is shown the trip lever *I*, pivoted at *J*, with the other parts shown in Fig. 2 omitted for clearness. The electromagnet *A* is wound with many turns of fine insulated copper wire and is mounted on the side of the breaker, as shown at *A* in Fig. 1. When this electromagnet is energized, it attracts the iron armature *B*, pivoted at *C*, and causes it to strike a stud *D* on the tripping lever *I* and trips the breaker, as described in

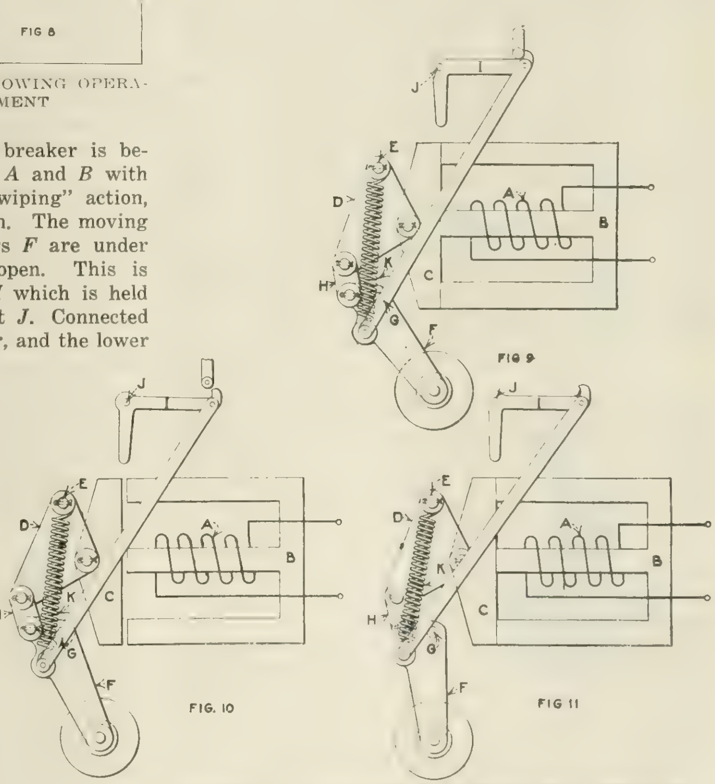


FIG 9

FIG. 10

FIG 11

FIGS. 9 TO 11. SCHEMATIC DIAGRAMS OF ALTERNATING CURRENT UNDERVOLTAGE RELEASE the foregoing. The shunt-trip attachment is the device usually employed when protective relays are used; upon the occurrence of conditions for which it is set, the relay closes the circuit to the shunt-trip coil, thereby opening the breaker.

There are cases not important enough to warrant the use of accurate relays, where a circuit must be protected from damage due to reverse current or underload. For instance, if for any reason the voltage of the charging source of a storage battery decreases below that of the battery, the latter may attempt to assume the load, or to motorize the generator. However, the instant the current drops to zero, as it must do before reversing, the breaker may be tripped by an underload attachment.

The principle of operation of a breaker with an underload attachment is shown in Fig. 6. The tripping lever is represented by *J* and *I* as before, and the device is shown ready to apply current. An electromagnet *N* carrying the main current is mounted on the side of the breaker, as shown in Fig. 1. The heavy iron armature *P*, pivoted at *C*, has on its side a small lever *D* which is pivoted at *E* and is manually hooked over the stud *F*, Fig. 6, thereby holding the armature a slight distance from the electromagnet. When the electromagnet is energized, it attracts the armature *P* to the position, Fig. 7, thereby releasing the catch-lever *D*. Now should the current fail, the armature *P* is no longer attracted and from its own weight falls down to the position shown in Fig. 8, striking the trip lever a sharp blow and tripping the breaker. Care must be taken that the device sets itself when current is applied; that is, the iron weight must be attracted and the lever *D* released, otherwise the device will not operate on the cessation of current.

The foregoing device, when wound with many turns of fine wire, may be used as a direct-current undervoltage release, operating when the voltage drops to a predetermined amount. On alternating current the electromagnet must have a closed magnet circuit, therefore the armature must be in the same position (closed air gap) in both operating and tripped position. This is accomplished by a toggle-joint arrangement as shown in Fig. 9. *I* and *J* represent the trip lever as before. The coil *A* is wound on a laminated iron core *B*, which with the armature *C* forms a closed magnetic circuit. Attached to the back of the armature is a triangular piece *D*, pivoted at *E*, which is connected to the setting lever *F*, pivoted at *G*, by the link *H*, which forms a toggle joint. The spring *K* tends to rotate *F* in a clockwise direction, and this by attempting to straighten the toggle, would tend to give *D* a clockwise rotation also and pull the armature away from the electromagnet. This is prevented by the energizing of *A*.

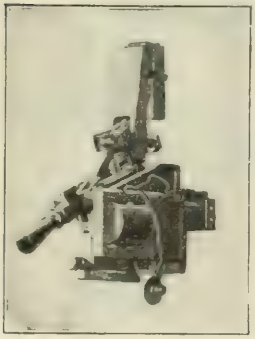


FIG. 12. CIRCUIT BREAKER WITH A.-C. UNDERVOLTAGE RELEASE

As soon as the voltage drops to a predetermined amount, the armature is pulled away, allowing the springs *K* to move the lever *F*, thereby tripping the lever *I* and causing the breaker to open. This position is shown in Fig. 10. But the spring pulls the lever *F* farther than the tripping position, and this causes the link *H* and piece *D* to force the armature *C* back against the electromagnet, Fig. 11, thereby again completing the magnetic circuit and preventing the coil *A* from burning out should the voltage come on again before the device was reset. Resetting is accomplished simply by moving lever *F* to the position in Fig. 9. A breaker with this form of release is shown in Fig. 12. For an overvoltage release a device somewhat similar to the shunt-trip attachment is used, but is usually designed with the heavier magnetic circuit to allow a smaller energy loss. An overvoltage release is shown on the breaker in Fig. 13. The solenoid *S* is wound on a heavy iron casting and has in its center an iron plunger. When the voltage increases to a certain amount, the plunger P is drawn upward, striking the pivoted lever *L*, which in turn strikes the projection on the trip lever and trips the breaker.

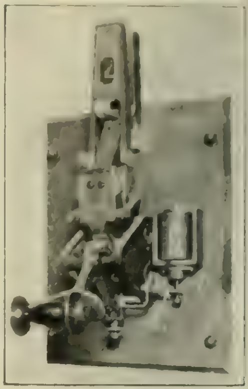


FIG. 13. CIRCUIT BREAKER WITH OVERVOLTAGE RELEASE

While practically every make of breaker varies in detail of construction, and in fact each manufacturer may turn out various designs of breakers, yet the principle of operation is practically the same in all, and the foregoing examples are typical of the devices usually employed.

Suggestions for the Semi-Diesel Engineer

On starting the engine, do not inject too much fuel oil. Two strokes of the hand lever should be sufficient. If an excessive amount of oil is used there is great danger of blowing the cylinder-head joint.

In old engines where the usual copper gasket fails to keep the head joint tight, try using asbestos wicking braided into a rope. This should be soaked in salt water and then covered with graphite and oil before using.

In installations where the starting torch is fitted with a heating coil, small carbon particles will choke the coil; a spare torch should be always on hand. The coil can be cleaned by soaking in lye water and then blowing out with air.

In starting a semi-Diesel engine, the torch should be forced to cause the ignition plug to be heated in the shortest possible time. Slow heating causes the entire cylinder to become hot. Since no cooling water is flowing, the cylinder-head gasket is often ruined by this.

The proper temperature of the ignition device, whether it be a bulb or plate or pin, depends on the compression pressure carried. In engines having a pressure of 70 to 90 lb. the bulb must be cherry red. Higher pressures require lower temperatures; in engines of 160 to 200 lb. compression, the bulb of plate need never be other than black in color.

Operation and Adjustment of Turbine Machinery
VIII—Packing Clearances

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

WHEN fitting carbon rings to small turbines of 100 kw. or under, it is well to make them slightly smaller than the shaft, say 0.002 in. or 0.003 in. in diameter. These rings will wear to normal size in two or three hours' operation and give better results than the most accurate fitting and measuring usually accomplish.

On large turbines this procedure would not be advisable, as vibration or heating would probably be set up This should not be done in the case of diaphragm packing in any machine, as the slightest binding of an interstage ring will quickly set up vibration. It should be borne in mind, however, that it is better to err in making the celarance over the shaft too small rather than too large. Harmful effects seldom happen if the ring is larger than the shaft by even a slight amount. The wear will rapidly increase the diameter to normal running fit.

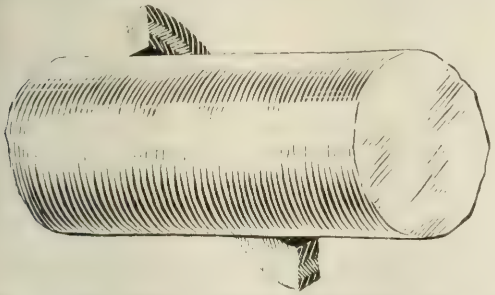


FIG. 1. IF THE METAL RING PACKING WILL NOT GO IN WITHOUT BREAKING, CUT EACH RING IN HALF AND STAGGER THE JOINTS WHEN INSERTING

Another kink in fitting packing is to have a mandrel made the exact size for which the carbon packing is to be fitted. The ring can be tried around this mandrel and fitted accurately without difficulty. A piece of iron pipe can easily be turned up to the proper dimension.

New packing from the factory is sometimes too large and can to advantage be made smaller by a few thousandths by the foregoing method.

Metallic or labyrinth packing is fitted in the same general way as carbon packing. The joint surfaces are often reduced most conveniently by placing the entire number of segments in a shaper and taking them down by machine. If the segments are quadrants, it is often possible to machine them both horizontally and vertically with one setting so that both surfaces can be finished without changing the setting of the clamp.

Be careful in boring the rings to see that the sawtooth surfaces are not too thick where they touch the shaft. It may be necessary to cut into each tooth to bring these to a sharp edge to make them wear easily when in contact with the shaft. If dowels are present, they should, of course, be removed from the joints while these surfaces are being machined and then replaced when the ring is assembled for boring. It may be noted that the joint surfaces are especially important in the last ring which is exposed to view, as any slight leakage in this ring will immediately be seen.

The axial clearance of the packing rings should be smaller than the groove in an axial direction of 0.003 in. to 0.006 in. If the clearance is less than this, rust and sediment are likely to cause the ring to stick. If the clearance is appreciably larger, it often happens that the steam pressure in the axial direction will not cause the ring to move tightly against the diaphragm surface. The engineer should check these clearances on new packing from the factory; ordinary judgment is all that is necessary in usual cases. Special cases may occur where the limits mentioned can be overstepped, but in general practice this is correct.

The joint surfaces should be held closely together by spring pressure to prevent leakage between them, and also for the reason that when they are forced apart the leakage between the shaft and ring becomes excessive. Spring pressure for holding the ring together should be from 2 to 4 lb. per square inch of area of the inner surface of the ring. Many cases have been noted where leakage was hard to explain but was remedied by this means.

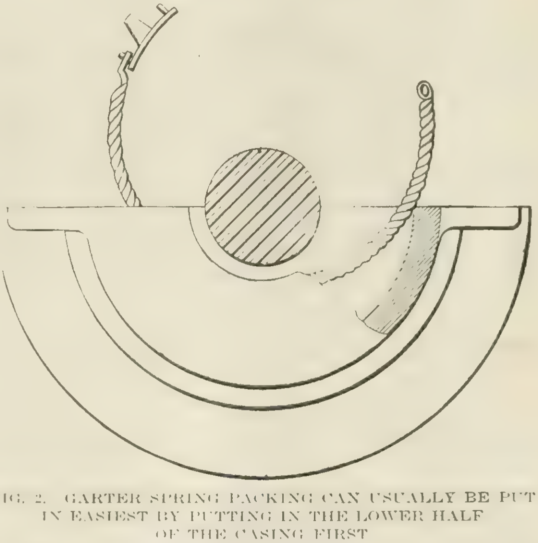


FIG. 2. GARTER SPRING PACKING CAN USUALLY BE PUT IN EASIEST BY PUTTING IN THE LOWER HALF OF THE CASING FIRST

Some manufacturers equip the last ring which is exposed to view with lap joints, which do not butt together. In other words, there is a clearance in the joints so that the ring is not arch-bound but bears upon the shaft throughout its whole extent, being held there by spring pressure. This plan is used only where practically no steam pressure can act upon the ring, and in refitting such packing the joints should be filed so that the ring bears firmly upon the shaft and is not archbound.

Shaft packing is seldom easy to assemble on account of the requirements of turbine design. The packing is necessarily placed in an inconvenient position. On account of conditions of the shaft the space is limited and a great deal of ingenuity is often required to assemble properly. It is frequently necessary to work on a machine just as soon as it has been shut down and to handle the parts while they are at a high temperature. Also, it is necessary to do a good job to prevent the appearance of leaking, which is the most noticeable defect that can occur on a machine. This matter, therefore, is worth a little thought and investigation.

The stuffing-box type of packing is refitted much like an ordinary packing gland. When the old packing has become hardened and worn, it should all be removed and new packing rings installed. The metallic rings which come already prepared are not easy to handle. Do not spread the ends apart in slipping them over the shaft, as this will cause the packing in the middle of the ring to become disarranged so that it will not assemble properly. Instead of spreading the two ends, bend one in one direction and the other in the opposite so that the strain is well distributed (see Fig. 1). If it is found that the ring cannot be assembled over the shaft without making it come to pieces at some place, it is better to cut it in half and assemble the various rings in the stuffing box with their joints staggered.

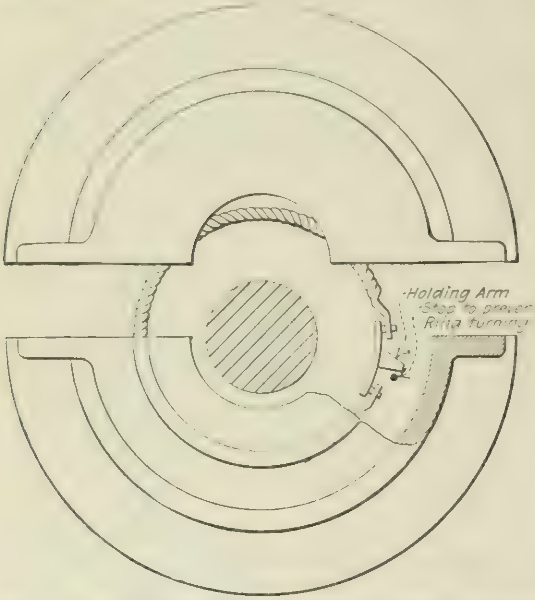


FIG. 3. WITH GARTER SPRING PACKING MAKE SURE THE KEY AND HOLDING ARM ARE PROPERLY LOCATED

Before assembling new packing, it is well to cover the shaft and gland with cylinder oil and powdered graphite. This assists in allowing the ring to take its proper position. Do not make it tight. It is best to tap the rings in place with a piece of wood and a light hammer and then bring the follower up fairly to the rings. Run the machine up to full speed and then shut down and tighten to the follower if necessary. The packing will heat immediately if tightened the least bit too much while the machine is running.

Packing of this kind often makes a popping sound when a small particle of steam leaks through. This is perfectly natural and should not cause apprehension. It is needless to say that old hard packing should not be left in the gland when new packing is installed. Also, a good cleaning should be given the various parts of the gland.

Garter-spring packing can usually be most conveniently assembled by installing the lower half of the packing casing first. The garter springs should then be pushed through the grooves (see Fig. 2). The packing rings can now be assembled, taking care that the proper joint surfaces match each other in accordance with the numbering on each joint. The springs can then be connected, making sure that the key and holding arm are properly located (see Fig. 3). The proper "dope" should now be applied to the joint surface of the packing casing itself, and the top of the casing can then be assembled and the entire casing bolted home.

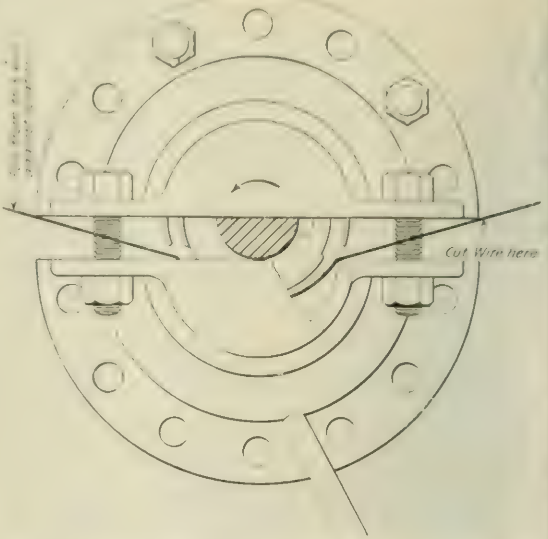


FIG. 4. AFTER THE TOP HAS BEEN PUT IN PLACE AND HELD BY A COUPLE OF BOLTS, THE WIRE IS CUT

The flat-spring type of carbon ring does not need much skill when the rings are placed in recesses in a turbine casing. Those rings, which are contained in the packing casing itself sometimes require considerable patience, ingenuity and skill in assembling. The first ring is assembled in a recess of the turbine casing. The second ring is contained in the packing casing itself. The upper part of the casing, which has been cleaned

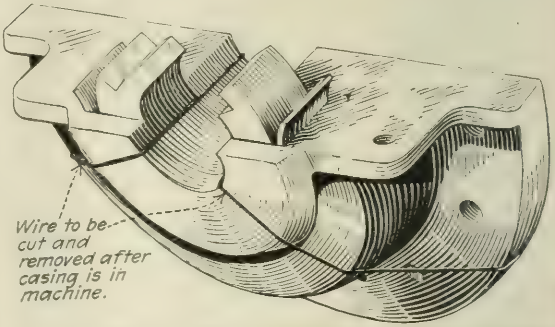


FIG. 5. PACKING RINGS, HOLDERS AND COPPER RIBBONS ARE PUT IN THE HOLDER AND HELD BY THE WIRE, WHICH IS PULLED OUT WHEN THE HOLDER IS PUT ON THE SHAFT

and covered with proper "dope," is assembled with one piece of carbon and holder in place. This is tied with a piece of wire, as shown in Fig. 4. After the top has been put in place and loosely fastened with a few bolts, the wire is cut and removed so that the carbons and

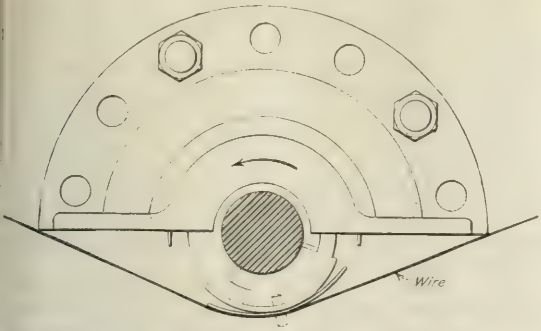


FIG. 6. PULL THE WIRE OUT AGAINST THE DIRECTION OF ROTATION OF THE SHAFT

holders are now in place. The other two pieces of packing ring, together with their holders and the copper ribbons covering the joints, are placed around the shaft and held tightly in place by a piece of wire, as shown in Fig. 5. The entire ring should be turned against rotation so that the stop on the upper holder will lack a quarter of an inch from touching the holder arm. The bottom casing, Fig. 6, can now be put on and brought into place, as far as possible without binding the wire; usually, an opening of ⅜ in. to ⅛ in. should exist between the joint surfaces of the upper and lower packing casing. The wire can now be cut with a pair of pliers on the proper side so that it can be pulled out in a direction against rotation. If it is pulled with rotation, the arms and stops are apt to bind the wire. Do not use a cord, as it may break off inside the casing.

The top part of the packing is shown as being assembled before the bottom part. This is often the necessary procedure, as nozzle chests or other parts of the turbine are placed just above the carbon-packing holder so that the top cannot be lowered vertically. This construction is indicated in Fig. 1. The top half must be placed in an inverted position against the bottom of the shaft and then rotated around it to the top position, where a few bolts can be entered and the wires cut as described. Whenever it is possible to assemble the bottom part of the carbon-packing holder first, this is usually the easiest method of procedure rather than beginning with the top half.

The wire should be about $\frac{1}{64}$ in. to $\frac{1}{32}$ in. in diameter, or No. 20 to 25 wire. A good quality of fishline of this size can be used, but ordinary cord or twine will not safely withstand the necessary pulling.

Checking Four-Wire Three-Phase Watt-Hour Meter Connections

By H. C. YEATON

Diagrams of connections are given for connecting a four-wire three-phase meter to the circuit, with both current and potential transformers, with current transformers only and also without transformers. Methods of checking the correctness of the connections are given in detail.

A FOUR-WIRE three-phase watt-hour meter consists of two elements, and each element has two current coils and one potential coil. One current coil of one element is connected in series with one current coil of the other element. As shown in the figures, current from all three phases goes through the current coils in the meter. Each of the potential coils of the meter is connected across one line and the neutral. As the current from all three phases goes through the meter, the meter will record correctly either a balanced or an unbalanced four-wire three-phase load. The connections shown in Fig. 2 are those for the meter when only current transformers are used, and Fig. 3 gives the connections when the meter is connected into the circuit without transformers.

When connecting the meter in the circuit, it should be ascertained that the potential transformer connected across line *A*, Fig. 1, and the neutral and the current transformer in line *A* are connected to the upper element of the meter. Likewise the potential transformer connected across line *C* and the neutral and the current transformer in line *C* must be connected to the lower element of the meter. Care should be taken that the current and potential transformers are connected correctly in regard to their polarity. Modern meter and instrument transformers have one primary and one secondary terminal marked, which indicates that if the instantaneous current flows into one marked terminal, it passes out of the other marked terminal. The secondary of a current transformer should at no time

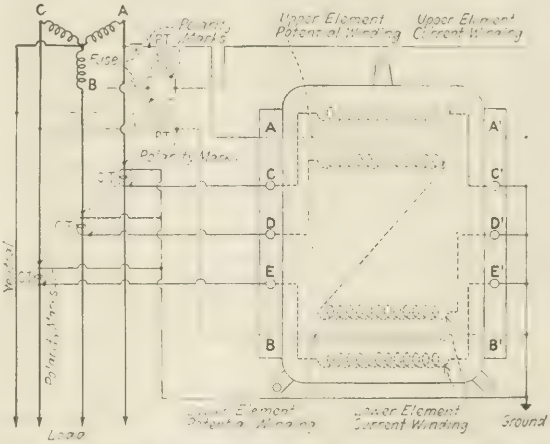

C
A
Polarity PT Marks
Upper Element Potential Winding
Upper Element Current Winding
Fuse
B
A
A'
PT
Polarity Mark
C.T.
C
C'
C.T.
D
D'
Neutral
C.T.
E
E'
Polarity Marks
B
B'
Lower Element Potential Winding
Lower Element Current Winding
Ground
Load

FIG. 1. METER CONNECTED TO CIRCUIT WITH BOTH CURRENT AND POTENTIAL TRANSFORMERS

be left open when there is current flowing through the primary of the transformer. If, for any reason, the secondary leads of a current transformer are disconnected from the meter, they should be connected together in some manner, so that there is no possibility

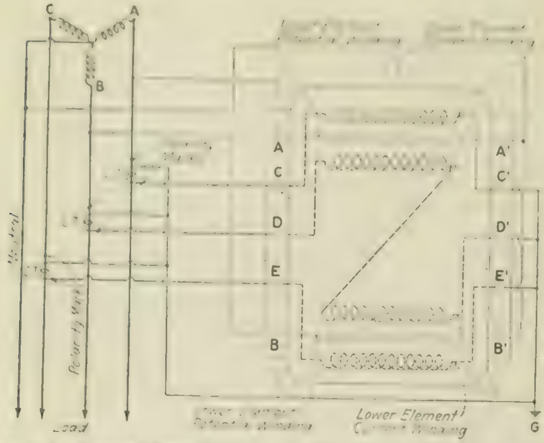


FIG. 2. METER CONNECTED TO CIRCUIT WITH CURRENT TRANSFORMERS ONLY

of the secondary circuit of the transformer being opened. To ascertain that the meter is connected correctly in the circuit, the following method may be employed:

After the meter has been connected in the circuit as indicated in the diagrams, disconnect the current leads of terminals *CC′* and *EE′*, Fig. 1, and if the remaining connections are correct the meter will rotate in the right direction if a load is on the circuit. If the potential coils *AA′* and *BB′* are connected wrong, the meter will rotate in a backward direction. To make the element rotate in the correct direction, it is necessary to reverse leads to both potential coils *AA′* and *BB′*. If the meter will not rotate in either direction, it indicates that the leads to one potential coil are incorrectly connected, and to the other are correctly connected. Now if the leads to the potential coil, that are connected correctly, are reversed, the meter will rotate backward, and it would then be necessary to reverse the leads to both potential coils *AA′* and *BB′* to obtain proper rotation of the meter. If, on the other hand, the leads to the potential coils that were incorrectly connected were reversed at first, the meter would rotate in the correct direction, and this would indicate that the connections to terminals *AA′* and *BB′* and *DD′* are right.

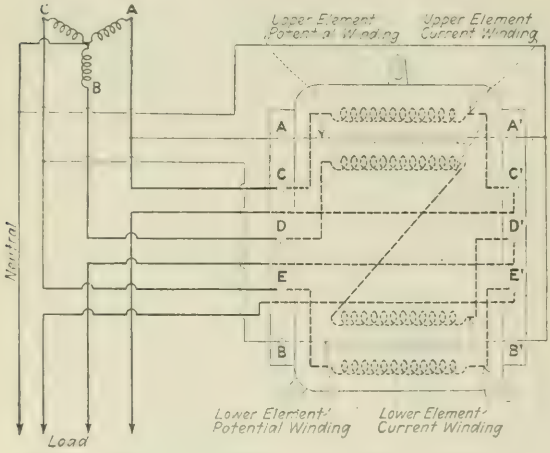
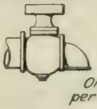
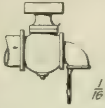
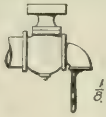
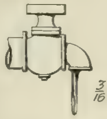
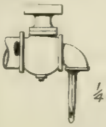

C
A
B
Lower Element Potential Winding
Upper Element Current Winding
A
A'
C
C'
D
D'
E
E'
B
B'
Neutral
Load
Lower Element Potential Winding
Lower Element Current Winding

FIG. 3. METER CONNECTED TO CIRCUIT DIRECTLY

The next procedure is to disconnect the current leads of the current transformer in line *B* from terminals *DD′* and connect the current leads from the transformer to the terminals *CC″* so that the moving element rotates in the right direction. Now disconnect the current-transformer leads from terminals *CC′* and connect the leads from the current transformer line *C* to the current terminals *EE′* so that the moving element of the meter will rotate in the right direction.

It is obvious, from the foregoing, that if each current coil is connected separately, with the potential coils of the meter excited, so that the moving element of the meter rotates in the right direction, then it is certain that the meter is recording correctly.

Amount of Oil Lost Due to Small Leaks

	One Drop per Second	1 Minute Loss	– $\frac{1}{10}$ Ounce
		1 Hour 〃	– 6 Ounces
		1 Day 〃	– 1 Gallon & 1 Pint
		1 Week 〃	– 8 Gallons
		1 Month 〃	– 34 Gallons
	Two Drops per Second	1 Minute Loss	– $\frac{1}{3}$ Ounce
		1 Hour 〃	– 20 Ounces
		1 Day 〃	– $3\frac{2}{3}$ Gallons
		1 Week 〃	= 26 Gallons
		1 Month 〃	– 2 Barrels
	Drop Breaking to Stream	1 Minute Loss	– 2 Ounces
		1 Hour 〃	– 1 Gallon
		1 Day 〃	– 24 Gallon
		1 Week 〃	– $3\frac{1}{2}$ Barrels
		1 Month 〃	= 14 Barrels
	$\frac{1}{16}$ Stream	1 Minute Loss	– $7\frac{1}{2}$ Ounces
		1 Hour 〃	= $3\frac{1}{2}$ Gallons
		1 Day 〃	= 84 Gallons
		1 Week 〃	= $11\frac{1}{2}$ Barrels
		1 Month 〃	= 50 Barrels
	$\frac{1}{8}$ Stream	1 Minute Loss	– 23 Ounces
		1 Hour 〃	– 11 Gallons
		1 Day 〃	– 260 Gallons
		1 Week 〃	= 36 Barrels
		1 Month 〃	= 156 Barrels
	$\frac{3}{16}$ Stream	1 Minute Loss	– 39 Ounces
		1 Hour 〃	= 18 Gallons
		1 Day 〃	= $8\frac{1}{2}$ Barrels
		1 Week 〃	= 60 Barrels
		1 Month 〃	= 255 Barrels
	$\frac{1}{4}$ Stream	1 Minute Loss	– 83 Ounces
		1 Hour 〃	– 39 Gallons
		1 Day 〃	– $18\frac{1}{2}$ Barrels
		1 Week 〃	– 130 Barrels
		1 Month 〃	– 555 Barrels

The Atlantic Lubricator

The Principle of the Prony Brake Briefly Explained

By Charles C. Phelps

The prony brake is one of the simplest pieces of apparatus, and still many of those who use it for determining brake-horsepower directly from the shaft do not understand how and why it works. This was shown to be the case when a number of engineering students were asked recently how they accounted for the heat that developed in the brake and was dissipated. For example, in the type of prony brake illustrated by Fig. 1 cold water is fed continuously into the groove within the rim of the wheel and is removed at a much higher temperature, if in fact it is not converted into steam. Most of the students admitted that they had never thought about the loss of heat and were of the opinion that some correction should be applied, for the heat generated certainly represented energy. Let us see why it is not necessary to do this.

All the power supplied by the rotating shaft is utilized in overcoming the friction of the brake. That being the case, there would be the same amount of friction whether the rope with the weight W attached to its end remained stationary while the shaft rotated at the speed of N revolutions per minute, or whether the shaft remained stationary while the rope (under the same tension) revolved around the shaft at the same speed of N revolutions per minute.

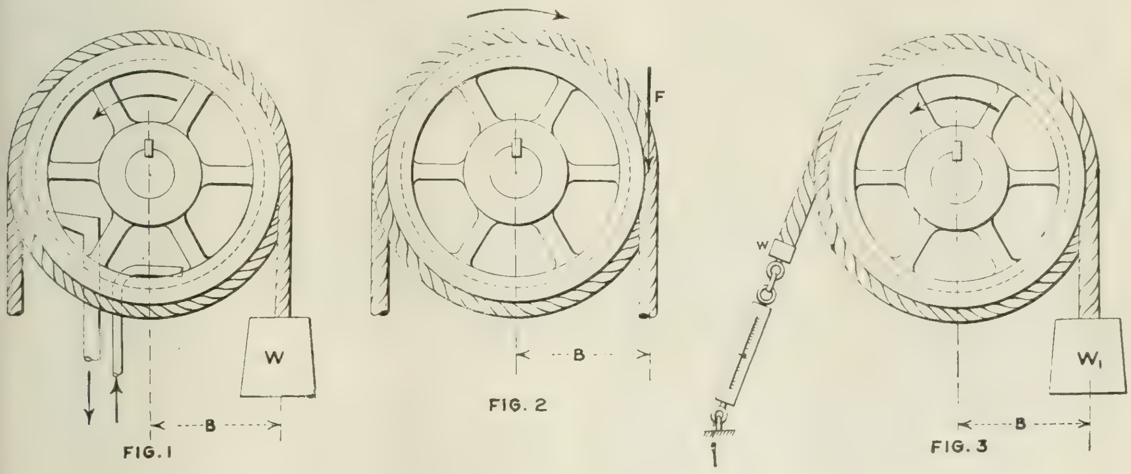


FIG. 1 FIG. 2 FIG. 3

SHOWING A FEW COMMON TYPES OF PRONY BRAKES

Fig. 2 illustrates the second case. Here the shaft is stationary, while the rope rotates in the direction indicated by the arrow. The conditions are exactly the same as they were in the previous case excepting that the weight W is replaced by a continuously acting force F equal in amount to W, but acting tangentially to the periphery of the wheel. The power applied by this force in causing the rope to rotate would be equal to the force F in pounds multiplied by the distance in feet over which it acts. In one revolution, for example, the force would act over a distance equal to the periphery of the wheel, or more exactly the circumference of a circle whose radius is the radius of the wheel plus half the diameter of the rope. This power would be $2\pi BF$, or $2\pi BW$ foot-pounds per revolution. Expressed in horsepower this would be $\frac{2\pi BWN}{33,000}$ = horsepower. The weight of the rope is not a factor because it is equally balanced in weight on either side of the wheel.

Knowing that it would require the same amount of power to overcome friction in case 1 as in case 2, all that is necessary to determine the brake-horsepower of the engine is to determine the weight W that will remain fixed in position, determine the number of revolutions per minute of the engine shaft, the diameter of the wheel and of the rope and apply the foregoing formula.

Many other variations of the arrangement shown in Fig. 1 are in use. For example, the loose end of the rope is sometimes conveniently attached to a spring balance as indicated in Fig. 3. When that arrangement is adopted, the net weight corresponding to W will then be $W_1 - w$. Other types use a lever clamped on one end to the rotating shaft with sufficient friction to produce the desired result and supporting a weight on the other end or having the other end either attached to spring scales or pressing upon platform scales. No matter what method is adopted, the principle is the same in general and the explanation already given holds.

Another question arises at this point. If lubrication is not properly attended to, will not that change conditions to a marked degree? It will, most assuredly, but that question will take care of itself unless the surfaces become so dry as to seize. For example, in the case of an engine closely governed for speed, the effect of better brake lubrication would be to reduce friction, allow the weight W to descend and to increase the spring tension w. Thus the factor $W - w$ would be reduced, showing that the engine developed less horsepower. On the other hand, if better lubrication of the brake wheel resulted in an increase in the engine speed, the true horsepower would still be determined, because the factor N in the formula would take care of that. These are some of the things into which young students do not inquire.

The Diesel Engine and the Indicator

THE majority of steam engineers are familiar with the indicator, and many are quite proficient in using it in setting valves. Unfortunately, this is not true in respect to the Diesel-plant operator, although the Diesel engine requires the employment of an indicator far more than does a steam engine. The average Diesel engineer attempts to secure satisfactory valve timing by setting the valves while the engine is not running. In view of the cold condition of the parts, it is necessary when adjusting the valve rockers to allow some clearance to take care of the expansion of these parts when the engine warms up. Nevertheless, even though some allowance be made, correct valve functioning is very seldom attained in the Diesel engine. In respect to the exhaust and admission valves, usually the timing is fairly correct; a few degrees angular variation in the opening or closure of these valves has but slight effect on the quiet running of the engine, although a very late exhaust opening will cause a decided drop in the capacity of the unit. The fuel-valve timing, on the other hand, is of serious moment. In almost any make of Diesel a matter of three or four degrees in the point of fuel-valve opening will affect the capacity and economy of the engine from 10 to 20 per cent.

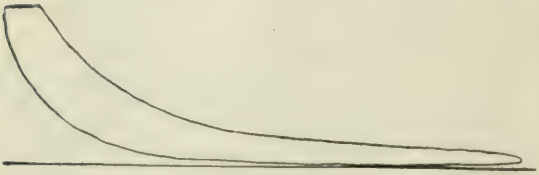


FIG. 1. PERFECT CARD

The indicator offers a ready means whereby the functioning of the various valves in the Diesel engine may be ascertained. Any misadjustment is revealed in the diagram. Engineers should become more conversant with the use of the indicator and with the interpretation of Diesel indicator diagrams.

Many of the more experienced operators can, or think they can, detect any improper functioning of the valve by the sound as the piston passes the top dead center. This is largely impossible, although a very early opening will be revealed by a severe pound as the piston approaches top center. The same sound is produced if the piston-pin bearing is slack. While the various types of Diesels are fairly consistent in the valve timing, all engines will require variation in the timing of the fuel-valve opening when the character of fuel oil changes. The point of opening is largely dependent upon the design of valve, size of openings in the atomizer discs, air pressure and compression pressure carried, and upon the characteristics of the fuel oil. It becomes apparent that the operator should not depend exclusively upon the valve timing as given by the engine builder, but should use an indicator and adjust the valves until a satisfactory diagram is secured. As with a steam engine, each defect in the valve timing produces certain peculiarities in the indicator diagram. In Fig. 1 is shown a card that is practically perfect. The fuel valve, which was set to open 5½ deg. ahead of top dead center, allowed the admission and combustion of the fuel to begin just as the piston reached top center. The rate of admission was such that the pressure behind the receding piston was maintained at a constant value.

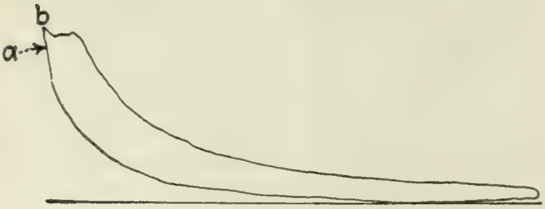


FIG. 2. CARD SHOWING EARLY FUEL INJECTION

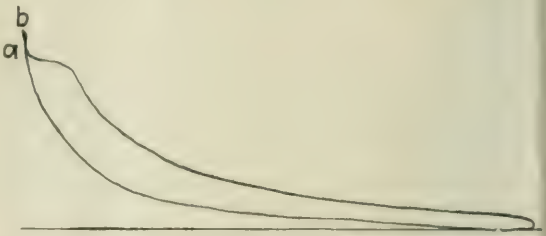


FIG. 3. ANOTHER EARLY INJECTION CARD

In Fig. 2 the diagram has a sharp peak at the end of the compression. The fuel valve opened early, and the combustion began before upper dead center was reached. The final cylinder pressure was considerably above the final compression value. It is easily understood that if the fuel starts burning while the piston is still on the compression stroke, the heat introduced into the rapidly diminishing cylinder volume may produce alarming pressures. Marine engines, especially while running at low speed, will show excessive pressures if the fuel-valve timing is not absolutely correct. Frequently, the peak at *b* is merely a line giving the card the appearance of Fig. 3. At first glance the line *ab* seems to be due to the inertia of the indicator parts, but changing the timing will show that the fuel valve has been early.

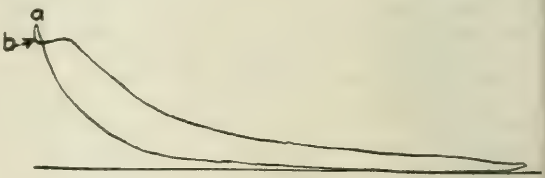


FIG. 4. EFFECT OF LATE FUEL-VALVE OPENING

Late fuel-valve opening compels the fuel-valve closure to be advanced so that the period of injection or admission is shortened. In Fig. 4 the fuel valve opened after dead center. The compression curve ended at *a*, and as the piston started on the power stroke, the cylinder pressure dropped sharply to *b*, where the fuel valve opened. Frequently, this line *ab* coincides with the compression curve, causing the diagram to resemble Fig. 3, where the timing was early. The proper precaution should be taken when a diagram similar to Fig 3 is secured; if the valve is early, a more advanced timing may cause the engine to pound. Undoubtedly, it is safer to set the valve late and then gradually advance the timing, taking indicator cards after each adjustment.

If a very low injection pressure is carried with a high compression, the card may have somewhat the appearance of Fig. 2. Usually, low injection air pressures produce a diagram quite like Fig. 5. Here the pressure is so low that the rate of introduction of the fuel is insufficient to maintain the cylinder pressure at a constant value.

When the engine is running under a light load such conditions are of advantage, since the low rate of fuel injection prevents the loss of air that occurs when a small oil charge is introduced very rapidly early in the period of fuel-valve opening. High injection pressure increases the velocity of fuel injection, and the consequent rapid combustion increases the heat in the cylinder at such a rate that the pressure experiences a decided rise. High air pressures often cause the indicator diagram to have the form of Fig. 6.

Frequently, the combustion line has a downward slope as in Fig. 7. This has the appearance of the ideal diagram as proposed by Diesel. At first glance the admission line seems to be an isothermal. The peculiar shape of this part of the diagram is traceable to the leaky condition of the piston rings. The gases were able to blow down past the piston almost as fast as the fuel was burned. Escaping gases in the crankcase and decided loss of power always accompany this condition.

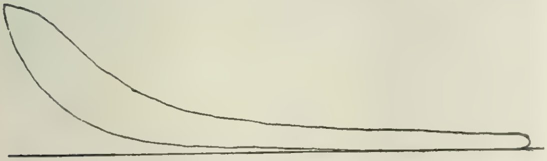


FIG. 5. CARD SHOWING LOW INJECTION-AIR PRESSURE

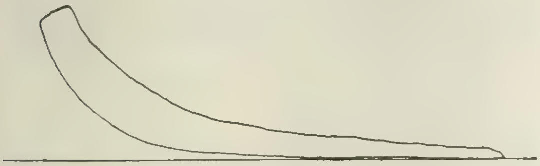


FIG. 6. CARD SHOWING HIGH INJECTION-AIR PRESSURE

High cooling-water temperatures will often cause the diagrams to appear quite like Fig. 8. The fuel, before admission to the cylinder, became so heated that the rate of injection at valve opening was very high. The pressure in the cylinder experienced a decided increase. The waves in the combustion and expansion lines are due to after-burning of the fuel.

The engineer of any plant containing a Diesel or semi-Diesel engine of over 100 hp. should invest in an indicator and at least once a month take a few diagrams. With these evidences of cylinder conditions before him it is quite easy to maintain the high efficiency of these types of engines.

Practically all engine builders are in a position to provide indicator rigging for their engines. In the event that this is impossible a mechanic can easily make a rig at a cost of less than fifty dollars. In the past too much has been taken for granted in the operation of internal-combustion engines. With fuel oil advancing in price, it is high time to give more attention to proper valve setting. In many Diesel-engined plants incorrect timing has increased the fuel consumption over 20 per cent; and even though the Diesel is an efficient machine, a 20 per cent saving in the fuel bill is not to be disregarded.

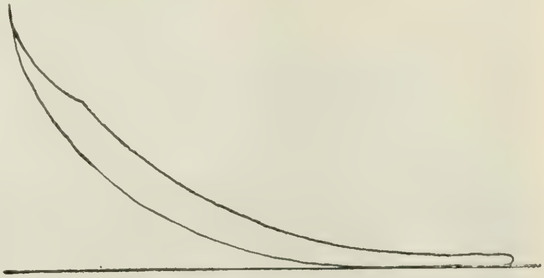


FIG. 7. EFFECT OF LEAKY PISTON RINGS

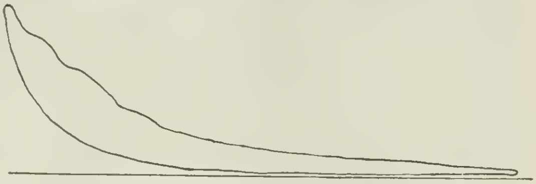


FIG. 8. EFFECT OF HIGH COOLING-WATER TEMPERATURES

The Bureau of Mines is receiving many requests for an expansion of its fuel-inspection work. This work has been increasing in amount and importance. Several foreign Governments have called upon the Bureau of Mines to supervise the inspection of the coal which they had purchased in this country. The Bureau recently entered into a co-operative agreement with the Sewall Point Coal Exchange for the inspection of coal destined for separate pools at tidewater. For a number of years the coal that was used by most of the Government departments has been inspected by the Bureau of Mines.

Bituminous coal, carried as revenue freight during the first three months of 1920 on class 1 roads, totaled 90,622,867 tons, according to figures just made public by the Interstate Commerce Commission. The figures given do not include tonnage carried on roads having annual operating revenues of less than $1,000,000. The anthracite shipments during the same period amounted to 17,304,993 tons. The coke movement aggregated 7,075,275 tons. Class 1 roads carry 90 per cent of the country's total tonnage.

Typical Fires in Stored Coal

By W. D. LANGTRY
President, Commercial Testing and Engineering Company, Chicago, Illinois

THERE is no excuse for property loss from the spontaneous combustion of coal. This is true whether coal is stored in bins, yards, basements—any kind of outdoor or indoor storage. The process of oxidation is slow, and there is ample time to discover whether the coal is heating or not and thus eliminate any danger before damage can be done. Trouble, in other words, can be detected long in advance before ignition of any surrounding building or material of an inflammable nature takes place. Coal heated from spontaneous combustion does not break into flame until it reaches about 650 deg. F. This heating can be detected in several ways—by odor, using a maximum thermometer or inserting iron rods into the pile and feeling them with the hand.

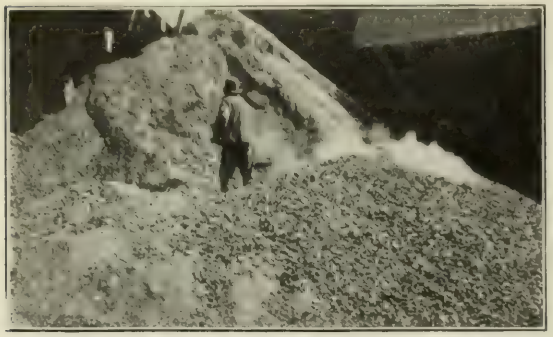


FIG. 1. FIRE STARTED IN THE MIDDLE OF A CONICAL-SHAPED PILE

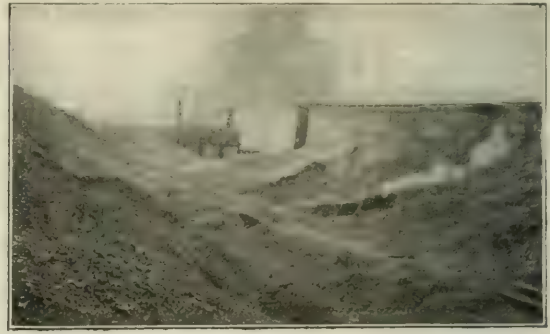


FIG. 2. FIRE STARTED JUST BENEATH A CRUST OF FINE COAL

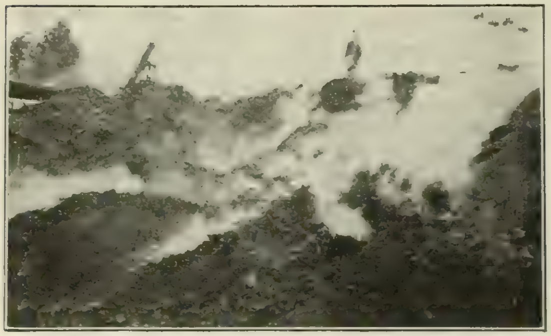


FIG. 3. TURNING OVER A BURNING COAL PILE

FIG. 4. COOLING A COAL PILE WITH WATER

There is a cause for every fire that starts in a coal pile from spontaneous combustion. Many theories have been advanced, many causes have been explained and chemistry has played its part in trying to solve the problem. Fires, however, will probably continue to appear in coal piles so long as the present methods of mining and sizing of coal are used and the present methods of unloading are followed. The consumer of coal or the dealer who places coal in his yard for storage hopes each year that he will "get by" without trouble, but in many instances he is hoping against hope. There is hardly a coal mined in the United States that has a "clean reputation" when it comes to spontaneous combustion; on the other hand, there is little coal mined that cannot be stored successfully if certain principles are followed and strictly adhered to.

During the summer of 1918 the Government rightly advised more storage of coal. In and about Chicago every coal yard, basement, specially constructed shed, vacant lot, etc., was well stocked. Much of this coal gave trouble from spontaneous combustion, affording a good opportunity for study. Pictures of many of the fires were made for permanent record, and conclusions were drawn as to what apparently caused the trouble. Much interesting information was obtained as to the history of the coal itself, how long it had been in storage and other facts that might help in arriving at the real causes of the fires.

All this work was carried on under the jurisdiction of the United States Fuel Administration for Illinois. Through the co-operation of the Chicago Fire Department prompt notification was given of all fires in storage coal both night and day.

The causes of some of the fires may be attributed to the nature of the coal itself, the method of piling, attempted ventilation and to sources other than the coal itself. Some coals are far more susceptible to spontaneous combustion than others. These coals in themselves are conducive to rapid oxidation. Generally speaking, a coal high in sulphur and with an iron pyrites content will disintegrate and crumble or air slack, like lime, in two to four weeks' time. Coal of this character should receive special attention during the whole time it is in storage if it is desired to avoid combustion trouble.

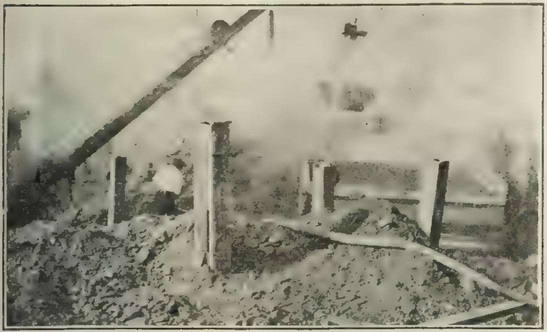


FIG. 5. A POOR ATTEMPT AT VENTILATING BY UPRIGHT VENTS

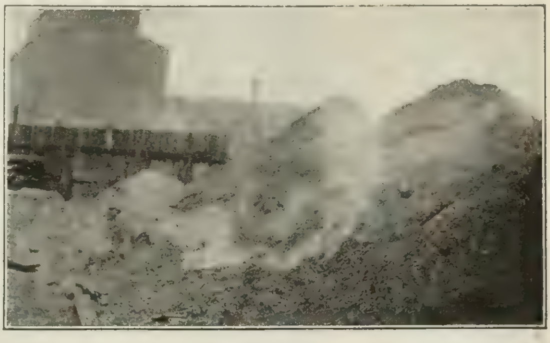


FIG. 6. A LATER VIEW OF FIG. 2, SHOWING PILE OF COAL BURNING TO ASH

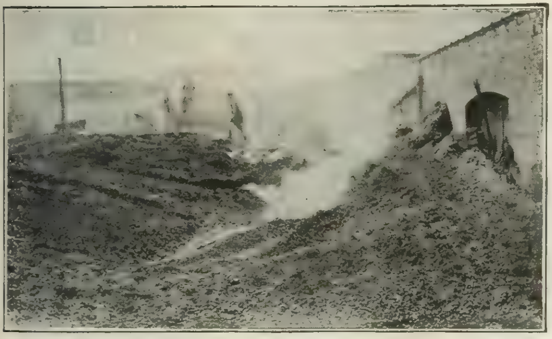


FIG. 7. ATTEMPTED VENTILATION. NOTICE THE TWO UPRIGHT PIPES IN PILE

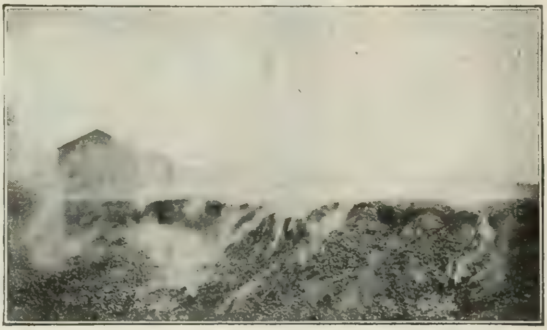


FIG. 8. THE COAL IN THIS PILE WAS ALMOST A TOTAL LOSS

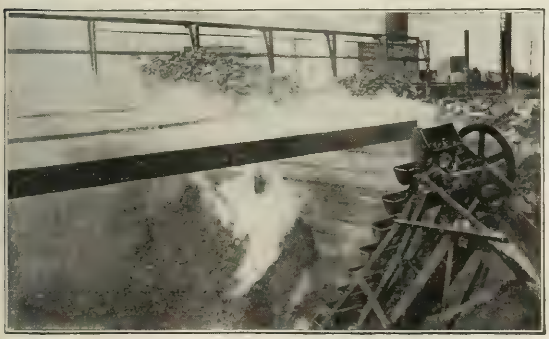


FIG. 9. FIRE THAT STARTED IN SCREENINGS

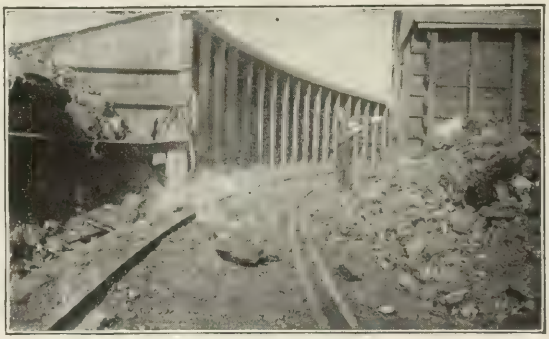


FIG. 10. FIRE THAT STARTED IN MINE-RUN COAL

It should be kept in mind that the finer the coal the more likely it is to catch on fire, the reason being that there are many more particles or surfaces of coal that are exposed to the oxidizing element, oxygen. Thus in storing coal care must be observed as to the method of unloading so that breakage during this operation is at a minimum. The present coal situation has made it almost impossible for consumers to accumulate storage piles, so that just now trouble from spontaneous combustion is at a low ebb. The pictures shown on this page and the one opposite are typical of what happens when the storage of coal is normal.

To obtain relief from excessive coal prices during the winter months, storage of coal is essential. To accomplish this with the minimum of loss from fires, considerable study must be made of the storage problems. With the coal prices prevailing during the past year no consumer or wholesale yard can afford to handle the stored coal in a haphazard manner. If spontaneous combustion could be wholly eliminated, a remarkably large saving would be effected.

Chief Engineer of the Hartford Steam Boiler Inspection and Insurance Company

SHERWOOD F. JETER

THERE were four hundred and fifty-seven boiler explosions recorded in this country last year, an average of more than one a day. Many lives were lost and damages amounting to millions of dollars resulted. This is an appalling number when one considers that by a little human foresight and precaution practically all could have been prevented.

One of the foremost engineers engaged in the work of safeguarding the boiler plant is S. F. Jeter, chief engineer with the Hartford Steam Boiler Inspection and Insurance Company. It is his duty to see that the conditions of operation and design in the boiler room are safe. When there is an explosion in which his company is concerned, he assumes charge of the technical end of the investigation.

Mr. Jeter is a Southerner, having been born in Columbus, Ga., in 1872. After finishing his elementary education, he entered the Georgia School of Technology and graduated with the class of 1893 with a B. S. degree in mechanical engineering.

Shortly after leaving college he went to Mexico City as chief electrician of the Mexican Telephone Co. He accomplished the seemingly impossible feat of a foreigner, unacquainted with the language of the country, handling work concerned solely with its lines of communication. When he returned from Mexico a year later, he became associated with the electric railways at Atlanta, Ga., and the Hartford Steam Boiler Inspection and Insurance Co. as an inspector. Later he became master mechanic of the Pittsburgh, McKeesport & Connellsville Railway Company.

It was after leaving the railroad at Connellsville that Mr. Jeter took up the occupation which has become his life work. In 1906 he became associated with the Bigelow Company, New Haven, Conn., as a mechanical engineer. While with this company he redesigned the (English) Hornsby water-tube boiler. He resigned in 1910, determined to stick to work connected with boiler design and operation. Accordingly, he re-entered the employ of the Hartford Steam Boiler Inspection and Insurance Company as inspector. He was soon made supervising inspector and later became chief engineer.

Mr. Jeter, who has been a contributor to *Power* for a number of years, is a member of the American Society of Mechanical Engineers and of the Boiler Code Committee of that society, of which he is one of the most active members, and has done much toward the formulation of adequete rules for boiler design and operation. At present he is chairman of the Hartford Branch of the A. S. M. E.

EDITORIALS

Popular Misconceptions Regarding Super-Power Stations

VARIOUS articles that have appeared in the daily press regarding the Government Super-Power Survey have spread some misconceptions of the proposed super-power plants of this system. In the first place, What is a super-power station? Many people believe that it is some wonderful new conception, "bigger, greater and grander than ever." A prominent power-plant designer recently answered the query as follows: "What we have been building for twenty years—a new station a little bigger than the usual run." This describes the new so-called super-power stations as well as any other definition. These plants will be somewhat larger than existing plants and with newer and larger machinery more representative of the latest practice. It must be remembered, however, that the super-power plant of today will very likely be regarded as a back number ten years from now. So the name "super-power" really carries no new idea of radical change in plant design or equipment, but merely one of relative size and modern machinery.

Another impression seems to have spread abroad that all these new power plants will be located at the mines so that the railroads will be relieved of carrying the coal needed by such stations. This idea seems very attractive, and the "man on the street" wonders why the engineers have not built plants at the mines long ago. He fails to recognize some engineering and economic facts in this connection. An adequate supply of cold water for use in condensers is as great a necessity in modern high-economy steam power plants as the coal itself. Big rivers in the coal districts are not numerous. The Ohio, Allegheny, Monongahela, Susquehanna and Delaware and a few of their larger tributaries form the only large available water supplies for condenser use in the coal fields. Furthermore, it is not possible to use the same water repeatedly in a series of power houses, even along these large rivers, for eventually it would become warmed up to a point where the desired high vacuum would be unattainable. It is therefore apparent that these super-power stations must be located on the large rivers where water is available, rather than at the mine-mouths themselves. The coal will then have to be loaded in cars and hauled to these plants. In certain cases this best available water supply may be at tidewater, as at present.

The economic factor involved in power costs is probably of greatest importance in influencing plant location. The public has been led to believe that because it is quite feasible to transmit electric power over long distances in certain cases this is also the most economical system. Estimates do not always bear out this assumption when the cost of franchises, right-of-way, transmission towers and wiring, transformer stations, etc., is considered along with the constant energy loss over these long lines. Many engineers who have studied this problem have concluded that it is cheaper in many cases to haul the coal to the more advantageously situated power plants at tidewater than to generate current near the mines and to transmit it to the industrial centers along the seaboard. Nevertheless, it is most desirable that plants near the mines be developed to the greatest possible extent, though these may be limited in both size and number.

These remarks apply only to the power stations themselves and not to the immense savings that are possible by interconnecting stations in a large super-power system and thereby improving the load factors.

Engineers would do well to dispel these misconceptions on every possible occasion, for sooner or later the public will learn why the "super-power plants at the mine mouths" are not always economically possible and will reproach the engineering profession for allowing this wrong impression to be spread abroad.

Educational Courses in the Industries

EDUCATIONAL courses for power-plant operators and construction and maintenance men in industries are being given serious consideration by many companies. It has frequently been found that costly delays are caused in getting equipment back into service in case of trouble, because those making the repairs lack the information that would enable them intelligently to go about interpreting and rectifying the difficulty. Where an electric motor is started by a manual-type starter, the troubles that can occur are generally easy to diagnose. But with automatic controllers the circuits may become very complicated and the combinations of conditions that may occur to give trouble are practically unlimited, and they may be so involved as to baffle, for a time, even those well versed in the equipment affected. Consequently, in handling such equipment it is very essential that everyone who has to do with the repairs and maintenance and, in certain cases, the operator of such apparatus, should be not only familiar with it, but also well grounded in its fundamental principles.

Just what form such educational courses should take is a problem for which various solutions have been offered. However, all education has for its basic purpose the teaching of people to think for themselves, and this requires a familiarity with fundamental principles. Before one is versed in the fundamentals of any subject, one's thinking on that subject must be at best mediocre. Consequently, in any educational course for training industrial workers the first essential is teaching the fundamentals of the subject that it is desired to have the employee familiar with.

The ideal course of instruction on any subject would be one that would give to the student a training equivalent to that obtained through many years of experience. This, however, is impossible of accomplishment as many experiences have shown. Nevertheless, this does not indicate that courses of instruction in industries for employees are not successful and of vital importance in increasing efficiency. The average employee is not inefficient from a lack of experience in the practical side of his particular vocation, but from limited knowledge of the fundamentals with which he is dealing. Therefore in a course of instruction for the electrical department employees it is not so much training one man to be a repairman, another an operator or a foreman, as it is teaching them the fundamental principles of electricity and magnetism and how to apply them to the various pieces of apparatus. After this has been done, if the man is of the right caliber, he will interpret these principles in the terms of whatever branch of the work he is following.

A wireman who has been made familiar with dynamo-electric machinery and controller circuits will be a superior employee to the one who is not and will be in a position to be promoted to departments that require this knowledge. On the other hand, an operator having this knowledge will in many cases be able to make small repairs on adjustments to the equipment he is handling, and thus prevent costly delays. Furthermore, his better understanding of the machinery that he is handling will prevent many of the abuses that equipment is often subjected to through a lack of appreciation of its limitations.

Low-Temperature Distillation of Coal in Rotating Ovens

IN THE face of a declining market in many commodities, the price of coal goes up instead of remaining constant or coming down. There may or may not be justification for this, but that is not the subject of this editorial. The condition points, however, to the seriousness of the fuel market.

Despite the great extent of our fuel resources all are agreed that our energies must be directed toward getting better results from quantities currently used than we now obtain. One more frequently meets men now who voice objection to the use of fuel oil for steam making in stationary power plants, an attitude that is not without some reason so long as the available quantity of this vital fuel appears to be less by far than we need; for as long as nations need navies and as long as ships are used, these should have first call on oil for steam making. Of course the navies of the great powers will forbid the use of oil for stationary power purposes immediately their own needs in the future are threatened. So in the future fuel oil will, in the nature of things, be regulated in its consumption far more closely than will coal.

Coal is a vital essential. Without it our civilization, as now carried on, would perish. This thought must be driven home to every man, woman and child to the end that as a nation we use it more efficiently, and that speculators and the unscrupulous have fewer opportunities to feast upon their skill.

We in America need to realize more generally that the universal use of raw coal, of the highly volatile bituminous grades especially, has in it many elements of economic waste. The byproducts of distilled coal are many, there is always a good demand for them, and new uses are frequently found.

Report comes from Germany that very material improvement has been made in the low-temperature distillation of coal by the use of the rotating oven, the oven being about the same as used in cement mills. The yield of tar is much greater than when the coal is distilled in producers, and on account of the lower temperature in the rotating furnace the valuable light hydrogens are not destroyed. The "half-coke," which is left after the tar has been distilled off, is said to lend itself well to burning on mechanical stokers, is welcomed for use in households and, moreover, it is easily briquetted.

An extensive report on the low-temperature distillation of coal in rotating ovens has been made by Doctor C. Roser, of Mülheim, and an abstract of this report will appear in an early issue.

Industry and Government Co-operating

GOVERNMENT investigations of direct interest to particular industries have often been curtailed by lack of adequate funds to continue the work. Recently the Bureau of Standards in its study of the physical constants of refrigerating materials found itself in this position and as a result has developed a new basis for co-operation which is encouraging.

The Bureau was confronted with the necessity of practically discontinuing certain parts of its work, particularly on the specific heat and the pressure-volume-temperature relations of superheated ammonia vapor. The American Society of Refrigerating Engineers was so advised and, as a result, has appointed two of the former members of the Bureau of Standards staff as research associates to continue work at the Bureau on these problems. It is expected that this arrangement will permit regular continuance of work on these important fundamentals of refrigerating technology. The results will thus be obtained promptly, and at the very minimum of cost, since the equipment and the facilities of the Bureau are afforded for the work without charge.

Doubtless there are in Washington many other investigations of great value to various branches of industry which are also suffering seriously from lack of sufficient attention or adequately trained personnel. It would seem that this new plan of affording the industries an opportunity to utilize the Government facilities should be more frequently followed. In cases where engineers find a deficiency in the Federal activities, it will be quite appropriate for them to ask themselves whether they alone are not to blame when there is this possibility of accomplishing good work by such a satisfactory co-operative arrangement.

How Much Do You Pay for Coal?

"COAL REVIEW," the organ of the National Coal Association, deduces from recent Department of Commerce figures "a cold-fact denial of the general indictment of the coal exporter on the ground that he has been reaping enormous profits."

The per ton value of American bituminous coal exported during the first seven months of 1920 was, according to this article, $7.29, including freight to the spot where the coal passes out of the country.

If this is all that the sellers of coal to foreign customers have been getting they ought not to be hanged.

But why was the United States Shipping Board compelled to pay eighteen to twenty dollars per ton?

Why were many of our industries compelled to pay much more than foreign customers?

How does this price compare with what YOU have been paying?

CORRESPONDENCE

Where Should the Beginner Start?

The possible results of an engine accident and a boiler accident cannot be compared. It is rare that an engine accident does great damage, and save in the case of a bursting flywheel it is usually confined to the engine room and the man in charge. A boiler explosion will probably wreck the building or buildings and may kill or injure many.

The responsibility resting on a fireman is far greater than that on the man caring for the engine. The general idea is that the man in the engine room is looking after the man in the fireroom, and that it is up to him to see that there is no low water or too high steam is true to a certain extent, but everybody knows that the care of the boiler is almost always given over to the fireman just as soon as the engineer believes that he is competent.

The engineer will stroll into the boiler room now and then to see if it looks nice and neat; if it does, he is usually satisfied. The man with the shovel is the first to see if any of the tubes are leaking and if anything about the boiler is not right, and he gets such important information first. He also has a better chance to study the effect of his firing and water-feed regulation than the engineer. The engineer knows all the regular noises of his engine room. If the note alters, he gets right after the reason if he is worthy of his job. The engineer has some warning as to possible trouble in the engine room, but the fireman generally has no intimation whatever of a serious accident.

The engineer takes his indicator diagrams, sets the valves to suit working conditions and at intervals takes diagrams to see if the valves remain adjusted, and that is about all he directly does in keeping track of the plant economy.

The fireman has to contend with weather and varying coal conditions. He has to keep the boiler clean both inside and out. Thanks to the electric light, a fireman can inspect the inside of a boiler thoroughly without having his lungs filled with lampblack and oil as in the olden days.

Some will say that a fireman is not the man to inspect a boiler. He should be, and if he is not competent to do so, he should not be rated as a first-class fireman. The fact that the fireman is bound to be rather dirty most of the time has given rise to the idea that his brains are small.

There is no doubt that the hard physical work of firing makes a man desirous of an easier job in the engine room, so he leaves his position of responsibility in the boiler room for the engine-room chair and thinks he has gone up.

I fear that Mr. Lane's idea of starting the fireman in the engine room would not work—not because it is illogical, but because the opinion exists that the direction of the fireroom is downward and not upward in the mechanical social scale. Although we are supposed not to have any class distinction, the engineering world, taking it as a whole, will say that the engine room stands higher in the scale of mechanical workers than the fireroom, and to controvert that sentiment is a hard job.

Of course there are engineers in charge of power plants who look after the boilers and engines with equal care, some giving even more care to the boiler end. Such men train up good firemen, who are stolen away by others. The fireman who is employed only to open furnace doors, shovel in coal and close the doors again and start up the feed pump full tilt when he sees the water lower than usual, does not command high pay.

Saluda, N. C. W. D. FORBES.

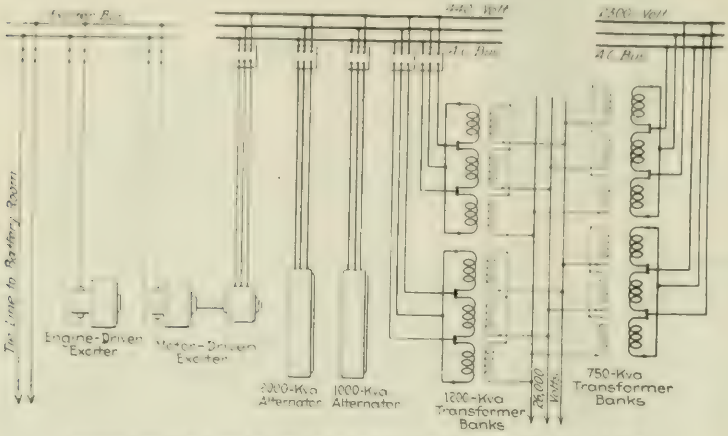
Battery Used To Get Alternator and Exciter Into Service

In the plant of which the figure shows a general layout there is one 1,000-kva. and one 2,000-kva. engine-driven 440-volt alternator, which can be excited either from a motor-generator set or an engine-driven exciter. Additional power is obtained from a utility company through two 1,200-kva. 26,000- to 440-volt and two 750-kva. 26,000- to 2,300-volt transformer banks. We also have three substations equipped with 2,300- to 440-volt transformers. One of these substations supplies current to two battery-charging sets, the direct-current side of each furnishing about 120 amperes at 110 volts.

Formerly all direct-current load in the factory was supplied from the exciter bus in the engine room, but recently a tie-line was installed and this load was transferred to one of the battery charging sets, since the other set could readily take care of all the battery load. This left the exciters to take care of the engine load alone. It frequently happened during thunderstorms that the incoming high-voltage line would be out of service for some time, and every time this occurred the motor-driven exciter would fall out of step and stop. Then the steam-driven exciter would have to be started and all the load possible was carried on the generators until the outside source came back into service.

The steam-driven exciter was under repair for several days when a thunderstorm occurred just at a time when the cupolas at the foundry were running full blast. The high-voltage line went out, shutting down all substations, of course, and also "dropping" the motor exciter, leaving the plant virtually without power. After some deliberation it was decided to send current from the batteries at the battery room over the tie-line to the engine room, 1,000 ft. away. When the fields were excited, the direct-current voltage dropped to about 60 volts, but we got sufficient emf. from the alternator to start the motor exciter. The direct-current side of the exciter was then paralleled with the battery, after which no trouble was experienced in getting the voltage up to 110 on the exciter bus. This, of course, gave full voltage on the alternator, and it did not take long to get the foundry back to work again, and two 72-in. cupolas were saved from dropping their bottoms. **Robert Hofstetter.**

Kenosha, Wis.



SCHEMATIC DIAGRAM OF POWER-PLANT EQUIPMENT LAYOUT

Fuel Waste Causes Failure of Central Heating Station

The communication by William M. McNeill, page 476 of the Sept. 21 issue of *Power*, will, I think, interest many engineers, inasmuch as it will call to mind plants that they have run under conditions similar to those depicted by Mr. McNeill, which are by no means confined to the past. Many power plants are still operating under equally uneconomical conditions.

At one time I was thoroughly familiar with a plant operated under the direction of a committee appointed by the city council. The plant was run as cheaply as possible, everything purchased was of the cheapest character, and nothing was purchased until it was necessary either to do so or shut down. It was the practice to line the boiler furnaces with ordinary red brick, which would soon crack and crumble and fill the combustion chamber with broken pieces.

The water used was exceedingly scaly, and a hard lime substance formed on the tubes and heads of the boilers, besides a large quantity of loose scales, which accumulated so fast that it was necessary to wash out each boiler once a week. They would not purchase a compound to counteract the scale, hence the spaces between the tubes next to the rear head were filled solid, with the result that many of the tubes were leaking. This leakage mingled with the soot baked on the tubes, and in some cases almost filled the openings to them at the rear end, which, of course, obstructed the draft. In many cases the tube ends that were beaded over the tube sheets were burned, and it was necessary to replace tubes every few weeks.

The outsides of the boiler settings were almost as bad as the insides, and in case the fireman should choke his damper very close after fuel had been placed in the fire, smoke would issue from almost countless openings, showing that the leakage of excess air in the furnace was exceedingly great.

The three generators were equipped with the old type of copper brushes, each machine requiring twelve, and the committee used to buy them in half-dozen lots.

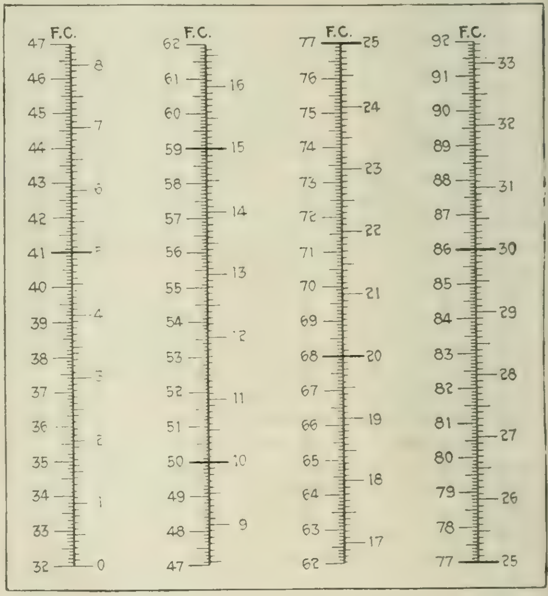
Other matters pertaining to operation were carried along in the same slipshod way, and it is doubtful if there was ever a competent engineer in charge of the plant. Eventually, it passed into the hands of a private company, which, after reconstructing much of the machinery equipment, has operated it in an efficient manner.

Chicago, Ill. **E. T. Bonnar.**

Thermometer Conversion Chart

It is not always convenient to have handy a conversion table of thermometer readings from degrees Fahrenheit to degrees Centigrade, therefore R. E. Gould, of the Bureau of Standards, has arranged in convenient form the accompanying chart for changing Fahrenheit to Centigrade readings ranging from 32 deg. F. and 0 C. to 92 deg. F. and 33.3 deg. C.

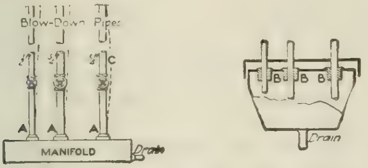
Washington, D. C. **R. McBride.**



THERMOMETER CONVERSION CHART

Improvement on Water-Column Blowdowns

In the original installation the water-column blowdown pipes of my plant were piped into a manifold without any slip joints, as at *A*. When the columns were blown down, the pipe would expand as represented by the dotted line *C* in the illustration. In order to eliminate this trouble, an expansion chamber was installed in which all expansion is taken up by the clearance on the inside. Brass sleeve *B* prevents water coming out of the expansion chamber around the pipes.



OLD AND NEW MANIFOLDS

Philadelphia, Pa. A. S. **Barker**.

Mechanical Stokers and Their Operation

Regarding the article on "Mechanical Stokers and Their Operation," published in the Sept. 7 issue of *Power*, I wish to state that the author is not quite accurate in his description of one of the stokers shown, in that the single-retort type is referred to in the text matter, whereas the illustration, Fig. 4, shows a multiple-retort stoker of new design. The stoker shown in Fig. 4 of the article properly belongs in the same classification with the multiple-retort gravity-feed stoker.

R. Sanford Riley, President,
Worcester, Mass. Sanford Riley Stoker Co.

Condenser Water in Low-Pressure Cylinder

Some time ago it was my privilege to see a near wreck of a vertical compound engine. It had been running for perhaps an hour without load, while being given a tryout. When it was decided that the test was satisfactory, the watch engineer closed the throttle and then stopped the air pump, opening a small vacuum breaker afterward.

In perhaps fifteen seconds there were at least six or eight distinct crashes and it seemed that something had let go. The chief engineer shouted to the watch engineer to start the air pump. He hastily opened the throttle on the air pump, and no more thuds occurred.

"For heaven's sake man, do you stop the air pump every time as you just did?" asked the chief.

"Sure," answered the watch engineer. "What do you suppose that noise was?"

"That was water between the piston and head," answered the chief, "and in a vertical engine it is a mighty serious thing. The head generally lets go in a horizontal engine, but the frame breaks in a vertical engine under such conditions."

"How can a vertical engine with the cylinders thirty feet above the condenser take water?" was the next question, and the chief explained it as follows:

"We know that theoretically the atmosphere will balance a column of water thirty-four feet high. In practice, a mighty good piston pump with small friction losses will draft water thirty feet. Perhaps this sounds a little bit bookish, but nevertheless I've seen it done. The weight of a gallon of water is 8⅓ lb. Its cubical contents are 231 cu.in. If the atmosphere is 14.7 lb. per sq.in. at sea level, then

$$\frac{\frac{14.7}{8\frac{1}{3}} \cdot 231}{12} = 33.9 \text{ ft.''}$$

"What about the low-pressure cylinder getting water?" asked the watch engineer.

"If you will just pay attention, I'll tell you how you just got that dose of water," said the chief as he sketched a pump, Fig. 1, drafting water thirty feet. Fig. 2 shows the same pump drafting water fifty feet.

"No use—it can't be done," said the watch engineer.

"It can be done if a hole is made in the pipe at the water line as at *A*," replied the chief. "If you suck in air at *A*, it breaks the vacuum to a great extent, of course, but the water and air will mix and the mixture will go up the pipe like smoke up a stack."

"How about thirty-three feet doing the balancing now?" asked the watch engineer. "The mixture doesn't weigh 8⅓ lb. to the gallon now, it weighs only about 3½ lb.," was the reply. "Using the same formula,

$$\frac{\frac{14.7}{3.5} \times 231}{12} = 80 \textit{ ft.}$$

"Now, if you are satisfied that a mixture of water and air can be lifted over thirty-four feet, what is to hinder a low-pressure cylinder on a vertical engine from lifting water in a mixture thirty feet or even forty feet? When you just tried out your engine, you had no load. The receiver gage showed about two or three pounds with the throttle wide open. When you started up, the vacuum didn't show very good, did it? No, and you had to close the cone almost tight on the injection. When you shut off the throttle, the vacuum went back through the receiver like a shot.

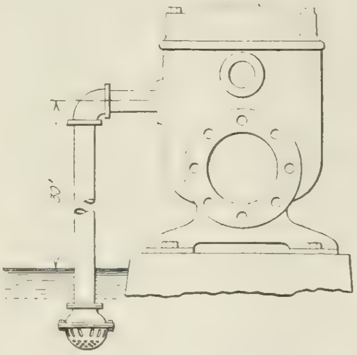


FIG. 1. PUMP WITH 30-FT. LIFT

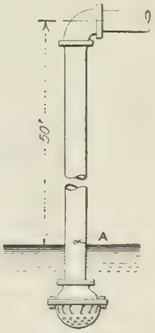


FIG. 2. WITH 50-FT. LIFT

"Stopping the pump didn't stop the vacuum in the low-pressure cylinder but in the condenser. The vacuum breaker acted like the hole in the pipe and up went the mixture. Deliberately stopping an air pump with the throttle shut on the engine but the engine still running is the most foolhardy trick I know of. Of course, an extra-large vacuum breaker is a remedy, but few air pumps or condensers are so equipped."

New York City. C. W. **Peters**.

Condenser-Tube and Cast-Iron Shell Disintegration

My attention was attracted to an article appearing in the Aug. 17 issue of *Power* entitled "Salt Water Leakage in Condensers," by Mr. Overend, in which he related his experience with some surface condenser and pump installations where the cast-iron shell was showing signs of disintegration, or rather, becoming soft and spongy and presenting what is commonly termed a change to graphite condition.

In an article that appeared in the issue of April 13, page 588, entitled "Prolonging the Life of Condenser Tubes," it will be noted that I assigned, as the reason for the rapid disintegration of bimetallic condenser tubes, the dissimilarity of the metallic groups entering into condenser assembly.

It was pointed out in this article that a difference of potential will be established with proper electrolyte conditions existing between the copper- or brass-alloy tube and the cast-iron shell.

The tube, always being electro-positive, is the element that suffers the most rapid metallic disintegration, and having observed many conditions of condenser-tube disintegration, I have noticed that in practically every instance where the tubes were subject to decomposition the shell of the condenser also presented signs of change in the state of iron, as outlined by Mr. Overend. I had long been of the opinion that the decomposition of the iron shell was closely associated with the disintegration of the tube, or in other words, that the tube disintegration produced a condition that would render the shell or cast iron also subject to decomposition. I hesitated, however, to advance this theory until such time as I was able to present some confirming results of experimentation in this line; and with this in mind, I have had constructed three groups of metals analogous in every respect to present surface-condenser assembly:

Group No. 1—Being two cast-iron plates permanently fixed to a standard section of condenser-tube sheet, bronze and properly drilled with standard clearance and provided with standard condenser ferrules. Assembly No. 1 being packed on one end with corset lace and having the tube expanded or rolled on the other end.

Group No. 2—Having identical cast-iron sides and identical tube sheet, but packed in the regular manner on both ends with corset lace.

Group No. 3—Being identical with assembly No. 2, but instead of being packed with corset lace, the section of tube is bonded at both ends with flexible metallic packing rings.

The 8-in. sections of tubes used for this experiment were cut from the same piece of standard ¾-in. condenser tubing as supplied by one of the large manufacturers.

These three assemblies were immersed simultaneously in a glass vat filled with distilled water to which had been added enough chemically pure salt to bring it to the density of sea water.

Two hours after immersion the water in the vat became muddy and indicated that a condition of corrosion was occurring, and after being immersed about one week, the section of tube employed in assembly No. 1 presented visible signs of attack, and in this assembly disintegration of the tube appears most rapid.

Assembly No. 2, in which the section of tube is packed on both ends with corset lace, and, therefore, being insulated, shows visible signs of attack, or disassociation of the metal, but not nearly so rapid as is the case with No. 1.

In both these assemblies an examination after three weeks' immersion shows very plainly that the cast-iron sides, which represent the shell, are subject to decomposition. There is a black deposit forming uniformly over the cast-iron plates of these two assemblies, which would indicate that the hydrogen that is evolved at the cathode is in some manner responsible for this condition.

Assembly No. 3, or the group on which the tube is bonded on both ends, presents no such appearance. The surfaces of the cast-iron plates are as bright as they were when they left the planer, and the tube employed in this assembly shows no change, the surface of the bimetallic tube remaining just as bright as when it was placed in the solution.

Placing a millivolt meter across the groups, we measure a slight difference of potential between the brass tube and the cast-iron plate of assembly No. 1. On assembly No. 2 the meter registers permanently 10 millivolts, but if the solution is slightly agitated or set in motion, as occurs when the water is being circulated or is in motion in the condenser, the difference of potential immediately rises from 10 millivolts to between 15 and 50 millivolts.

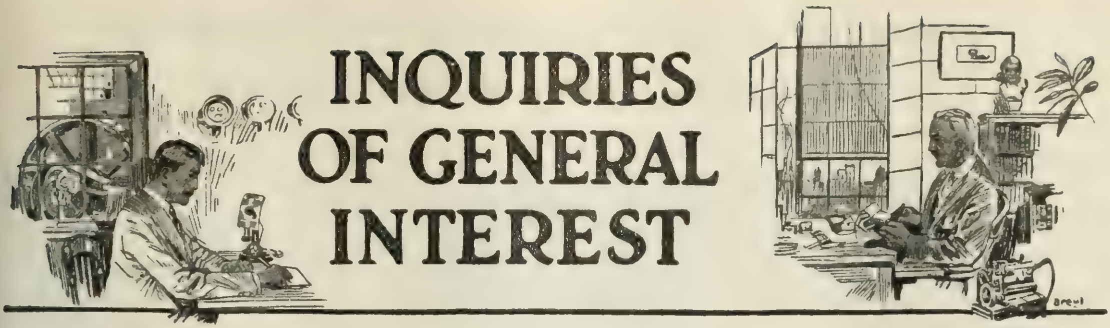
This difference can be easily accounted for by the fact that the cast iron develops a state of polarization when there is no agitation of the liquid; in other words, the hydrogen that is evolved, clings to the cast-iron surface in a film that is insulating in character and greatly increases the resistance, but the moment agitation is produced this film is broken up so that the maximum difference of potential due to the dissimilarity of the group may become established.

Connecting the millivolt meter between the tube and the cast-iron sides of assembly No. 3, in which the tube is bonded with the flexible metallic rings, there is positively no difference of potential indicated between this assembly, and this, in my opinion, is the reason why we do not get the signs of disintegration in that assembly. And likewise, the elimination of the bond between the metallic groups as cited in assembly No. 1 and assembly No. 2, is the reason we do get the signs of disintegration as outlined and occurring in those two assemblies.

I believe this is a subject in which engineers and manufacturers should become acutely interested, for the matter of tube disintegration and also the matter of cast iron where employed in condensers, pump casings, etc., are of great importance, and it is my firm conviction that these bad effects will be overcome only by the proper assembly of any bimetallic groups that enter into this apparatus in such a manner that the differences of potential that are bound to occur with these dissimilar groups will not produce the electrolytic breaking down of either the bi-metal or the disassociation of the cast iron.

It is hoped that interest may be aroused to the end that manufacturers will begin to look more closely into this theory and develop their own experiments to confirm or deny.

JULIUS N. WALTON,
Eastern Manager, Crane Packing Co.
New York City.



INQUIRIES OF GENERAL INTEREST

Lap of Steam Valve on Long-Range Corliss Cutoff—How much lap has the steam valve of a long-range double-eccentric Corliss engine when the wristplate is in mid-position? J. B.

When the wristplate is in midposition, the steam valve must have negative lap—that is, must be part way open. The lead is delayed by turning the eccentric backward from the 90-degree position, so the cutoff may act after the piston has completed one-half of its stroke.

Smoky Exhaust of High-Compression Oil Engine—What would cause a two-cycle high-compression hot-cup oil engine to have a smoky exhaust and preignition? C. M.

Both troubles result from imperfect combustion. With a good quality of oil, imperfect combustion and the resulting smoky exhaust may be due to excessive water cooling of the cylinder head and hot cup. So called preignition is pre-explosion of hydrocarbonaceous material that has been left over by imperfect combustion of a preceding stroke.

Reduction of B.t.u. per Pound to Calories per Long Ton—What would be the number of calories per ton of 2,240 lb. of coal containing 11,500 B.t.u. per pound? B. H. C.

The gram-calorie, or small calorie, is the heat required to raise the temperature of 1 gram of pure water from 15 to 16 deg. C. The kilogram-calorie, or large calorie, which is equal to 1,000 gram-calories, is the one generally employed by engineers and is equal to 3.968 B.t.u.; that is, 1 B.t.u. = 0.252 kilogram-calorie. Hence a long ton, or 2,240 lb., of coal containing 11,500 B.t.u. per pound would contain $2{,}240 \times 11{,}500 \times 0.252 = 6{,}491{,}520$ kilogram-calories.

Injury to Indicator from Use on Ammonia Compressor—Is an ordinary nickeled brass indicator damaged from use on an ammonia compressor? E. R. B.

There may be injury to an indicator from corrosion of brass valves or indicator cocks or three-ways left on the connections. Indicators and connections that are allowed to remain attached to the compressor cylinder for long periods of time should be made of iron or steel. But no serious damage will be done to a brass indicator when left connected only long enough to obtain diagrams, provided the instrument is cleaned with the same care that an indicator should receive after use on a steam engine.

Inexactness of Relations of Viscosimeter Tests—What are the respective relations of tests of the viscosity of oil obtained by Saybolt, Engler, Redwood and Tagliabue viscosimeters, and how are they obtained? H. S.

In each of the instruments the viscosity value is based upon the number of seconds of time taken by a set amount of oil to flow through an orifice that has been calibrated for the time required for the orifice to discharge the same quantity of water. There is no generally accepted tests for viscosity as various types of instruments are used, and the results with different instruments will often vary considerably. None of the types have orifices of exactly the same size. Unless the names of the designer and maker of the instrument used and the amount and temperature of oil used are stated, the results are almost meaningless. Therefore it is impossible to translate the readings of one instrument to that of another with any accuracy.

Trouble Pumping Hot Water Under Head—What causes trouble pumping hot water when the water flows by gravity to the pump? H. F. J.

If the piston displacement of the pump is faster than flow of the suction water can supply, there will be cavitation in the pump cylinder and suction passages to the pump in which the pressure becomes so reduced that the hot water bursts into steam of pressure corresponding to the temperature and the pump cylinder thereby becomes steambound. The remedy is to stop the pump, open all the drain valves on the water end of the pump and leave them open until the water flows free of vapor, and then start and run the pump slowly.

Pressure for Operating Heating Boiler—The boiler used for heating our building is operated at 85 lb. pressure, and the steam is supplied through a reducing valve at 10 lb. pressure. Would it not be more economical to operate the boiler at 10 lb. pressure and supply the steam direct. C. P. R.

There is neither loss nor gain of heat from passing steam through a reducing valve, excepting the small loss due to radiation, and therefore no difference in the economy of steam supplied to the heating apparatus. There is an advantage, however, in carrying a higher boiler pressure and supplying the heating apparatus at reduced pressure to better meet variations in the demands of the heating apparatus and, where necessary, for operation of a pump for boiler feeding or for handling the returns; but where these are unnecessary and there is no demand for high-pressure steam for other operations, it is safer and, on that account, better to operate a heating boiler at no higher pressure than necessary to supply the heating apparatus.

Size of Steam Outlets for Power Boilers—What is the method of determining the size of main steam outlets for boilers? W. G. S.

The minimum size of steam outlet suitable for a boiler is governed by the size of steam-pipe connection likely to be selected with reference to the permissible drop in pressure for maintaining the desired rate of flow of steam under the conditions of use. For power boilers the requirements usually can be met commercially by having the boiler outlet of diameter in inches equal to the square root of one-fourth of the boiler horsepower. Accordingly, the steam outlet appropriate for a 60-hp. boiler would be $\sqrt{60 \div 4} = 3.87$, or commercially, 4-in. diameter pipe size; for a 150-hp. boiler, $\sqrt{150 \div 4} = 6.1$ or 6-in. diameter pipe size; and for 300 hp., $\sqrt{300 \div 4} = 8.6$, or, commercially, 8-in. pipe size. With increasing use of higher pressures there is a tendency to use smaller piping and boiler outlets, because with steam of greater density less drop of pressure is needed to sustain the required flow of steam, and also because the drop for the necessary flow is a smaller percentage of pressure required at the point of delivery.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Association of Iron and Steel Electrical Engineers' Annual Convention

E. S. JEFFERIES,
President-Elect, Association of Iron and Steel Electrical Engineers

THE fourteenth annual convention of the Association of Iron and Steel Electrical Engineers, held in the Hotel Pennsylvania, New York City, Sept. 20-24, proved to be one of the most successful in the history of the association, both in technical value and in entertainment features. Among the important features was the exhibition of equipment used in steel mills, seventy-two manufacturing companies being represented.

At 10:30 Monday morning the convention was opened with a business session at which E. S. Jefferies, Elec. Eng., Steel Company of Canada, Hamilton, Ont., was elected president of the association for the year 1921. Other officers elected were: First vice-president, W. S. Hall, Elec. Eng., South Works, Illinois Steel Co., South Chicago, Ill.; second vice-president, C. E. Bedell, Elec. Supt., Wheeling Steel and Iron Co., Wheeling, W. Va.; treasurer, James Farrington, Elec. Supt., La Belle Iron Works, Steubenville, Ohio; secretary, John F. Kelley (re-elected) 513 Empire Bldg., Pittsburgh, Pa.; directors, Gordon Fox, Elec. Eng., American Steel and Tube Co., Mark Plant, Indiana Harbor, Ind.; L. F. Galbreath, Elec. Eng., West Penn Steel Co., Brackenridge, Pa.; S. L. Henderson, Elec. Supt., American Steel and Wire Co., Cleveland, Ohio, and W. C. Suppler, Elec. Supt., Tennessee Coal, Iron and Railroad Co., Ensley, Ala.

On Monday afternoon the first technical session was held, at which two papers were presented: "Practical Education of Steel Mill Electricians," by B. A. Cornwell, chairman Educational Committee. It has been realized that there is a pressing need for some course of instructions for repair men on electrical equipment in steel mills. Up to the present time there is apparently no textbook that meets these needs, therefore the educational committee co-operating with the electrical manufacturers are preparing such a book. In the papers are given sample pages intended for this book. The discussion brought out considerable difference of opinion as to what a course of this kind should consist of and how it should be given, the point being raised that a crane operator should be given different instructions from those of a wireman or an armature winder, and that there should be different grades of instructions for different classes of employees. For example, a gang foreman should have a higher training than that given the men under him. It was the general opinion that a simple, easily read textbook would be extremely valuable in giving such a course of instructions.

A second paper presented at Monday afternoon's session was "Relation of Standardization in Electrical Equipment to Safety," by Walter Greenwood, the point being made that standardization reduces accident hazards. The author said: "In the case of standards for cranes they include quality, convenience, etc., also uniform arrangement of controlling parts should be included. Individually considered, hazard

MEMBERS OF THE ASSOCIATION OF IRON AND STEEL ELECTICAL ENGINEERS AND THEIR FRIE is reduced by quality in that breakage cannot occur unless capacity is exceeded; capacity cannot be overtaxed where control is properly regulated. Uniform arrangement of controlling parts, manually operated, reduces hazard by reducing liability of operating the wrong movement. Convenience reduces hazard by making situations and parts easily accessible. Interchangeability reduces hazard and is classified with convenience, but going back from the operating end, interchangeability simplifies construction, and through efficiency in construction of interchangeable parts hazard is again reduced. Collectively considered, efficiency in maintenance reduces hazard. The same reasoning applies with equal force to all apparatus employed in producing commodities whether in the iron and steel industry or others.

TUESDAY'S TECHNICAL SESSION

On Tuesday only one technical session was held at which two papers were presented. "Power Transmission in Industrial Plants," by D. M. Petty, discusses this problem from the high-voltage sides only, low-voltage distribution from transforming station not being included. Power supply is divided into four sources—gas engines, steam turbines, reciprocating steam engines and public utility systems—each of which presents a somewhat different problem. The question of bus structures, transmission systems, electrical schemes of transmission, loop feeders, overhead versus underground transmission are gone into and the conclusion is drawn that the ideal transmission system is one "which transmits the necessary power to the producing departments of a plant at the lowest cost, with the least interruption and with the smallest hazard to the lives not only of those skilled in the art of handling electrical apparatus, but also of those entirely ignorant of its dangers."

In discussing the papers, the point was raised that with underground construction more copper is required on account of heating. However, as it is desirable to reduce the line losses to the lowest possible value, it is evident that the extra copper used is valuable in reducing the line losses.

"Underground Transmission," by A. L. Freret, was the second paper presented at Tuesday morning's session. In this paper three methods of installing underground conductors are discussed; namely, in a tunnel, in ducts, or by burying directly in the earth.

A paper, "Some Considerations in the Determination of Auxiliary Drives," by Gordon Fox, was presented and discussed at Wednesday morning's session. This paper sets forth certain factors influencing the selection and application of motors and control and considers the relation of the motor to the machine and work and suggests methods of procedure in the selection and application of motors to varied duties.

It was evident from the discussion of the paper that the tendency was toward using higher-speed motors and high gear ratios. The opinion was expressed that it was wrong engineering to connect the motor as directly as possible, and that the large slow-speed open-type motor is an abomination. Also some objection was raised to the forced ventilation of motors, since the motor might be cool on the outside, but hot-spot might exist in the winding, which would tend to increase the upkeep. However, there were those who did not object to the forced ventilation of motors.

REPORT OF ELECTRICAL DEVELOPMENT COMMITTEE

Of special interest is the Electrical Development Committee report, presented by the committee's chairman, E. S. Jefferies, at the Wednesday morning meeting. In this report an attempt has been made to cover electrical development as pertaining to steel mills for the last five years. It is stated that undoubtedly the most important electrical application has been the adoption of the Ilgner system of drive to reversing mills, the sentiment regarding electrically driven reversing mills having changed entirely since the first few were installed. A tabulation given shows that there are 34 of these equipments in use and 8 being built, requiring motors ranging in size up to 22,000 hp. maximum rating. The report calls attention to the fact that until recently all reversing drives ordered were for new installations only, while at present there are being built or installed four equipments to replace steam engines. A list of 76 alternating-current adjustable-speed sets that are in operation driving main rolls ranging in capacity up to 3,000 hp. is part of the report. This development has practically fallen within the last five years.

K. A. Pauly presented his paper, "The Reversing Electric Mill Considered from the Standpoint of Tonnage," at the Wednesday afternoon session. Until recently the question of tonnage in electrically driven reversing mills has been subordinated to systems of control having as their object the protection of the electrical equipment from peak loads. However, within the last year a number of electrically driven reversing mills have been going after tonnage records, and these have proved that they can produce tonnage equal to or greater than steam-driven mills.

In the discussion on this paper a monthly output of

UESTS OF THE UNITED STATES STEEL CORPORATION AT BEAR MOUNTAIN, NEW YORK

57,130 tons was given for one electrically driven reversing mill which it was estimated would roll 60,000 to 70,000 tons when it reaches its maximum. It was pointed out that the efficiency of the motor was secondary to the efficiency of producing steel. An interesting feature of the discussion was the question of shunt wound versus compound-wound motors, and from the points brought out it would appear that either type could be developed to produce equal tonnage records.

From the point of view of the power-house man one of the most interesting papers was "Some Economic Considerations in Design of Power Plants for Steel Mills," by T. E. Keating, presented at the Thursday morning session. An abstract of the paper and discussion will appear in an early issue.

A paper presented by R. H. Keil, at Thursday morning's session, "Current-Limit Reactance," emphasized how important the question of electrical-power-equipment protection had become in many of the large steel mills, where the power plant had reached proportions that compared with many central stations. The various schemes of connecting current-limiting reactors into the circuit are gone into and the results obtained from each method enumerated.

One of the most comprehensive reports presented was that of the Electric Furnace Committee, read by the committee chairman, E. T. Moore, at Thursday afternoon's session. This report covers 28 pages and should prove of exceptional value to those interested in the subject.

Friday morning's session was the closing technical meeting. At this meeting the Standardization Committee report was presented. This report embraces the sub-committee's reports on motors, cranes, controllers and illumination. In the discussion on this report the necessity of a standard specification for purchasing cranes was emphasized, but how far standardization should be carried in this direction was a question that apparently will require considerable more consideration for its solution. It was pointed out that if the association did not produce standard specifications for cranes during the coming year the United States Government would.

An entertainment and cotillon ball was given in the grand ballroom of the hotel Monday evening. On Tuesday afternoon the members and their friends were taken up the Hudson River to Bear Mountain on the Hudson River Daylight Line Steamer "Robert Fulton," as guests of the United States Steel Corporation. Dinner was served at the Bear Mountain Inn. On Wednesday evening the annual banquet was held in the grand ballroom of the hotel, at which Dr. Thomas Darlington was toastmaster. W. A. Berresford, president of the American Institution of Electrical Engineers, in addressing the gathering, outlined the new developments in engineering associations and pointed out how these could help the members of the Association of Iron and Steel Electrical Engineers. He urged affiliation with the Federated American Engineering Societies, Engineering Foundation, American Engineering Standards Committee, and National Research Council. F. B. Jewett, chief engineer, research laboratory, Western Electric Co., told about the development of the telephone during the last fifteen years. John R. Freeman, past president, American Society of Mechanical Engineers, who has recently returned from an extended trip in China, investigating the future possibilities of developing that country's waterways, gave an illustrated talk on the waterways of China. A. C. Dinkey, president, Midvale Steel Co., made a short address on the work of the association.

Interpretations of the A. S. M. E. Boiler Code

THE following answers to requests for interpretations of the Boiler Code have been prepared by the Boiler Code Committee, and approved by the Council, of the American Society of Mechanical Engineers. The formal inquiry and reply are given, together with explanatory references to the Code and illustrations where necessary for a better understanding of the interpretations as issued:

Case No. 269 (Re-opened)—Inquiry: If under the provision made in Par. 212*c* of the Boiler Code advantage is taken of the opportunity to increase the pitch of the staying for a cylindrical furnace, is it to be assumed that a portion of the increased load on the staybolt is to be supported by the resistance of the outer cylindrical shell to collapse, or must the staybolt be designed to carry the full load upon the stayed area of the furnace sheet?

The inquiry refers to a cylindrical surface subject to external pressure, such as the furnace in a vertical boiler. Par. 212*c* provides that the maximum allowable pitch of the stays may be computed by the following formula:

$$p_1 = p\sqrt{\frac{PR}{PR - 250T}}$$

phere p_1 = equivalent pitch for a cylindrical surface, p = maximum pitch for a flat surface as specified in Par. 199, P = maximum allowable working pressure in pounds per square inch, R = internal radius of furnace in inches and T = thickness of plate in sixteenths of an inch.

Par. 199 gives the following formula for flat stayed surfaces:

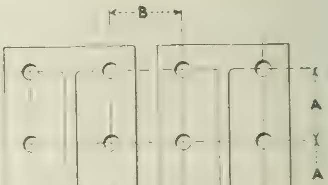
$$P = C \times \frac{T^2}{p^2}$$

where P = maximum allowable working pressure in pounds per square inch. T = thickness of plate in sixteenths of an inch. p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in inches, and C = a constant having different values for different thicknesses of plate and different types of staybolt heads.

Reply: The special provision made in Par. 212*c* for increased pitch is made possible by the additional strength afforded by the convexing of the plate. It is permissible under this rule to increase the spacing of the staybolts to p, in the formula, whereas the required cross-sectional area of the staybolts should be based on p.

In other words, the shape of the furnace structure is such that it would support a *part* of the load without any stays. Therefore the load on each individual stay is not as great as the increased pitch, and it may be assumed that it carries a load equivalent to that indicated by the smaller pitch that would be required if the plate were flat.

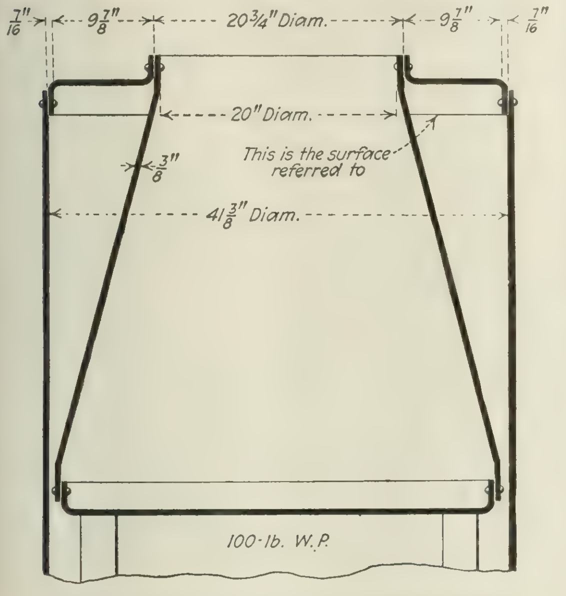
Case No. 307—Inquiry: Is it permissible to so locate the supporting lugs on horizontal return-tubular boilers where more than four lugs are required and under Par. 323 of the Code, must be set in pairs, that those in each pair come close together, or must the horizontal distance between the center lines of rivets attaching the adjacement lugs to the shell be at least equal to the vertical spacing of rivets that is required for lug attachments in Par. 323, as shown in the illustration?



CASE 307. RIVET SPACING WHEN SUPPORTING LUGS ARE SET IN PAIRS

In other words must distance *B* be at least equal to distance *A*? Par. 323 provides that horizontal return-tubular boilers shall be supported from lugs. The second sentence of this paragraph requires that no more than two of the rivets come in the same longitudinal line on each lug. The inquiry hinges on the weakening of the shell due to rivet holes if the two lugs of a pair are set too close together.

Reply: There is no requirement of the Code specifying the distance apart of the lugs forming pairs as required by the last sentence of Par. 323. It is the opinion of the committee, however, that in locating lugs in pairs on the shells of horizontal return-tubular boilers, it will be in conformity with the spirit of the second sentence of Par. 323 if the lugs of the pair are so spaced that the horizontal distance between the centers of the rivets which come nearest the adjacent edges of the lugs is at least 6 in. and not more than 12 in.



CASE 308. SUBMERGED-TYPE VERTICAL BOILER

Case No. 308—Inquiry: Under what rules in the Boiler Code should the top head of a vertical submerged-tube type of fire-tube boiler, such as shown in the illustration, be calculated to determine whether or not it requires bracing?

Reply: There is no rule in the Code specifically applying to such construction. However, in Par. 216, an allowance is made for surfaces located between tubes and shells. It is the opinion of the committee that it would be entirely safe to permit similar allowances in this case; that is, the distance between supported joints could be made 3 in. greater than the permissible spacing of staybolts for the corresponding plate thickness and pressure given in Table 4.

Table 4 in the Code gives the maximum allowable pitch in inches, of screwed staybolts, ends riveted over. These values are computed by means of the formula of Par. 199.

Case No. 309—Inquiry: Is it necessary to furnish test reports of the steel used in the tubes or flues of special type boilers which are formed of 18-in. lap-welded steel tubing, 15 ft. long, where the wall thickness is ½ in. and the weld meets the requirements of Par. 186?

Par. 186 refers to welded joints and provides that the ultimate strength of such a joint which has been properly welded by the forging process shall be taken as 28,500 lb. per sq.in. with steel plates having a range of 45,000 to 55,000 lb. per sq.in.

Reply: It is the opinion of the committee that the material used in the manufacture of lap-welded low-carbon steel tubing should meet the stipulations prescribed in Pars. 23 to 39 inclusive of the Code, which will make it necessary to furnish mill test reports of the material.

Pars. 23 to 39 inclusive contain the specifications for boiler-plate steel and provide for tests of specimens of the material with reports and marking of the plates with the strength, etc.

Case No. 311—Inquiry: Is it necessary under Par. 188 of the Boiler Code to use butt-strap joints in the construction of very small drums, say 10 or 12 in. in diameter, for pressures exceeding 100 lb. per sq.in? Such construction does not appear to be practicable for such small drums and neck pieces sometimes used to connect drums or shells.

Par. 188 provides that the longitudinal joints of a shell or drum which does not exceed 36 in. in diameter, may be of lap-riveted construction, but that the maximum allowable working pressure shall not exceed 100 lb. per sq.in.

Reply: Lap-riveted construction is prohibited by the Code rules, but it is the opinion of the committee that this should cause no hardship, as lap-welded or seamless pipe or tubes could be used provided such tubes or pipes are constructed from material which in its initial form of plate or skelp conforms to one or the other of the specifications for open-hearth steel given in the Boiler Code. No test would be required on the completed tube. (See Case No. 255.) Case No. 255 and Case. No. 218, to which it refers, provide that the materials of which headers and manifolds are made shall conform to one or the other of the specifications for wrought steel, but the reply to Case No. 255 specifically permits the omission of the flattening tests on the completed tube.

Case No. 312—Inquiry: Is it necessary in the construction of small Star-type water-tube boilers for steam heating which are to carry more than 15 lb. pressure at times, to drill the inside and outside ends of staybolts? It is believed that it was the intent of the committee to cover in this requirement the water legs at front and back ends which are considered as headers.

Reply: If the grate area is more than 15 sq.ft., the staybolts are less than 8 in. in length, and the pressure exceeds 15 lb., it will be necessary to drill the staybolts in order to comply with the Code requirements.

Installing Ammonia Shipping Cylinders

The Refrigerating Regulations Committee of the American Society of Refrigerating Engineers has sent the following notice to the builders, owners and operators of refrigerating equipment and members of the A. S. R. E.

The attention of this committee, which is drafting a code of regulations for the construction, installation, operation and inspection of refrigerating equipment, has been drawn to the fact that within recent months several explosions of anhydrous-ammonia shipping cylinders have occurred in establishments operating refrigerating equipment, which cylinders were said to have been emptied of their contents into the refrigerating system. One of these explosions resulted in the death of the engineer of the plant, and in another a laborer passing at the time of the explosion was seriously injured.

Careful investigations of these explosions have been made, and it appears that in each case the shipping cylinder was over-filled with ammonia from the plant, by the ammonia backing from the refrigerating system into the cylinders, leaving no gas space to take care of the expansion of the liquid ammonia with a rise in temperature, when the valve of the cylinder was closed. An explosion naturally had to occur.

The committee considers it of great importance that ammonia shipping cylinders should be connected to the refrigerating system in such a way that it will be impossible for anhydrous ammonia to back from the high-pressure side of the system into the cylinders. The Refrigeration Code, which will shortly be completed by this committee, contains a section which, if followed, will prevent such accidents. The section as now drafted reads as follows:

"Every refrigerating equipment shall be charged only through a connection located near the expansion valve on the *low-pressure side*.

"No shipping cylinder shall be connected to the refrigerating equipment except during the operation of charging."

This committee urges the builders of refrigerating machinery, consulting refrigerating engineers, owners and operators of refrigerating machinery, to adopt this regulation in the installation of new plants, and most respectfully requests that existing installations should be changed to meet this suggestion, in order that explosions and accidents of this kind may be prevented.

Fuel-Economy Symposium at Exposition of Chemical Industries

Included in the Sixth National Exposition of Chemical Industries held in the Grand Central Palace, New York, during the week ending Sept. 15, was a fuel economy conference. This is the first time in the history of chemical expositions that a section was devoted to fuel economy and an afternoon was given over to the reading of papers on this subject. Brief abstracts of the papers follow:

Burning Coal at 100 Per Cent B.t.u. Efficiency

W. O. Rankin

In this paper stress was placed on the economy of powdered coal due to the fact that when burning coal in the powdered form, the excess air necessary in ordinary coal to produce the flame conditions suited to particular requirements, can be eliminated, as the powdered coal is fed into the furnaces in a cloud where each particle quickly secures the air needed for combustion. The amount of excess air is always under control thus securing the greatest B.t.u. efficiency.

Saving Fuel by Controlling Chimney Losses

F. F. Uehling

Increased prices of fuel and difficulty in getting it at any price are two of the fundamental reasons why the subject of fuel economy is receiving more attention than ever before. No matter how fuel is consumed and no matter what kind of fuel is burned, whether solid, powdered, liquid or gaseous, the biggest loss is always due to the heat energy wasted up the chimney. Bulletin No. 205 issued by the Bureau of Mines says that "In the average boiler plant, 35 per cent of the heat in the coal burned under the boilers is lost with the stack gases. That is, out of every 100 tons of coal burned under the boilers, the heat of 35 tons literally goes up the stack." The loss up the chimney depends upon three factors; namely, excess air in the products of combustion, temperature of the products of combustion, and the amount of unconsumed fuel in the products of combustion.

Every kind of fuel requires a definite amount of air to burn it, depending principally upon the ratios of its carbon and hydrogen. Coal, the principal constituent of which is carbon, requires 12 pounds of air to completely consume each pound. All air that is used above that amount is excess air and places an unnecessary burden on the temperature possibilities of the furnace, and the amount of fuel consumed to obtain a required result increases in proportion to the amount of excess air used. In good practice 25 tons of air are used to burn one ton of coal. In poorly operated plants, this is sometimes doubled.

The exact amount of heat wasted by allowing the excess-air evil can be determined by the weight of the products of combustion per pound of fuel burned, and the temperature at which they leave the furnace or enter the stack. To reduce chimney losses to a minimum we must know whether or not the proper amount of air is being supplied, whether the air has been properly mixed with the fuel before it was ignited and whether too much heat is left in the products of combustion as they pass up the chimney. This can be determined with the assistance of fuel gas analyses and temperature measurements.

Fluid Heat Transmission

Alexander B. McKechnie

Heat transmission by hot oil embodies the desirable features and eliminates the objections of other methods for obtaining high temperatures. The quantity of heat delivered is under control at all times and temperatures are produced up to 550 degrees Fahrenheit without difficulty. This system is particularly adaptable to vessels with cast integral jackets usually built to withstand pressures of about 100 pounds. This point is readily understood when it is considered that 100 pounds of steam represents only 338 deg. F. The temperature can be controlled within close limits either manually or by thermostatic devices. The fire hazard is entirely removed as there is no flame in contact with the vessels and the absorber furnace, the only place where the flame exists, is isolated from the manufacturing equipment and sometimes it is even placed in a separate building. Experience has taught the superiority of the closed system. By a closed system is meant one in which the hot oil does not come in contact with the atmosphere. If it were allowed to do so it would rapidly oxidize and soon become too viscous to flow freely. Provision must be made for expansion of the oil as the circulating oils generally used have a coefficient of expansion of about .000486, which means about a 25 per cent volumetric increase in 500 deg. F. rise. An expansion tank is placed at the end of a stagnant line at the proper point in the system, which takes care of this point very satisfactorily.

Reducing Conduction and Radiation Heat Loss

S. L. Barnes

This paper brings out the fact that during the past few years the rapidly increasing prices and the scarcity of fuels of all kinds have focussed the attention of engineers upon the necessity for utilizing as much of the heat generated in high temperature equipment as possible. As a result of investigations it has been discovered that it is impossible to eliminate entirely the passage of heat through walls, arches, bottoms, doors, etc. It has been demonstrated that the reduction of heat radiation results in important advantages, such as increasing the capacity of the equipment with no increase in fuel consumption; making temperatures more constant and uniform throughout the apparatus; decreasing the time required to bring equipment to working temperature; lengthening the life of the refractories by eliminating the necessity for overheating in the combustion zone and providing much more comfortable working conditions for operating by reducing temperatures around furnaces. Mr. Barnes then explained that the company which he represents has experimented with a brick composed principally of earth which is practically pure silica. It is claimed that only one-tenth of the heat transmitted through a given thickness of ordinary brick would pass through the same thickness of this brick. Tests to determine the shrinkage and melting points made by Professor Edward Orton, of the Ohio State University, and those conducted by the Bureau of Standards, Washington, show that the insulating brick will withstand temperatures up to 1,650 deg. F. This heat resistance is ample if the bricks are properly installed and protected with sufficient refractory material.

Refractory Cement—Life Insurance for a Furnace

F. W. Reisman

This paper touched briefly the high spots of the uses for varied types of metallurgical and other furnaces where plastic high-temperature cement now replaces the use of fireclay. A number of stereopticon views illustrating the lecture were shown.

Reducing Fuel Consumption

Wm. R. Van Nortwick

Many plants are wasting money through lack of attention to the continually decreasing conductivity of the boiler. The ideal design of a steam generator would be one in which the fire would come in direct contact with the water with no wall or metal between. The very operation of the boiler tends to transmit the heat units from the fire to the water with a constant decrease in efficiency and increase in fuel consumption to accomplish a given result. This is due to the soot deposited on the tubes and the scale deposited in the boiler from the water.

Materials which are in suspension may often be filtered out. Such material of this character as passes into the boiler may to a great extent be removed by the surface blowoff. Where the principal scale-forming material is bicarbonite of lime, magnesium or iron, beneficial results may be obtained by means of the application of heat to a temperature of 212 deg. for periods of sufficient length to drive off the carbon dioxide, leaving a mono-carbonate, which is insoluble in water and which is therefore precipitated and removed from the feed water. Most waters contain material other than the carbonates, so that this treatment only partially removes the trouble, allowing the harder sulphates to be introduced into the boiler.

Oil Consumption of Turbo-Generator Sets

The amount of oil used by turbo-generator sets varies greatly, according to the size of the unit, the attention given it, whether there are any leaks in the system, etc. The accompanying chart enables one to find the number of barrels of oil used per year on direct-connected turbo-generator sets. In making this calculation 108 machines were used. The chart while, of course, representing an average, gives an idea of the estimated yearly consumption of a new machine.

In regard to using the chart, take, for example, a 4,000-kw. unit operating 120 hours per week. Following along the horizontal line to the number 4 and then up to where this vertical line cuts the incline marked 120, and following this intersection to the left, it will be found that such a machine should use fifteen barrels of oil a year. This result may be checked by calculating on the assumption of 0.3 of a gallon per ten thousand kilowatt-hours. The rated kilowatt hours per week are 4,000 × 120 = 480,000. The oil used per week is, therefore, 48 × 0.3 = 14.4 gal., and the oil used per year is 14.4 × 52 = 748.8 gal., or practically 15 barrals as given by the chart—*The Atlantic Lubricator*.

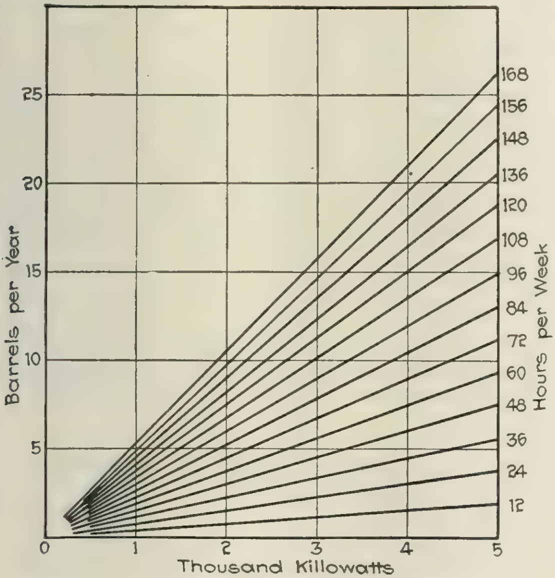


CHART FOR ESTIMATING ANNUAL OIL CONSUMPTION OF TURBO-GENERATOR SETS

Rules and Suggestions for Firemen and Boiler-Room Helpers*

For Firemen

Upon coming on watch, immediately observe steam pressure, water level in boilers and general conditions. Blow down water from water column to be sure it is working properly.

All coal and ashes are to be weighed and the time of coal loadings to be entered upon report sheet, the back weighing to be made at end of each shift and the back weight to be charged to the fireman coming on duty.

After boilers have been cleaned and in service four days, they are to be blown down once each day thereafter at about 8 or 9 o'clock in the morning. The engineer on watch is to be called at this time, and the extent and method of blowing down is subject to his approval.

Flues to be blown twice each day, on the first and second shifts, as soon as convenient after coming on duty.

Any defect in any boiler, steam pipe, feed pump or any apparatus in the boiler room should be reported at once to the engineer on watch.

In the event of heavy call for steam, such as a large fire and the fireman thinks he cannot hold steam with the boilers in use, he should report to the engineer at once.

Although it is not intended to lay down any hard and fast rule for firing, nor to discourage individual method if such method can be shown to be better than these, yet it is thought that a very good method of procedure is as follows:

Keep grates fairly clean, and preferably so by the use of shaker grates (although it is known that with some coal and conditions of fire it may be necessary to clean with slice bar and hoe). Fire at rather frequent intervals, say 7 to 10 minutes; firing at long intervals, say 12 to 15 minutes, is not good practice and is not approved. Manage damper and quantity fired so that the fires will not burn down dead and leave air holes at the time of next firing. In general, the least damper opening and draft you can use will be found most economical. When the draft is so great that fire burns down in holes, then heat is lost simply by heating the air drawn in at such points and does no good whatever.

It is suggested that the fireman learn to notice the draft gage, just as he observes the steam gage. It will indicate the need of shaking grates, the presence of air holes in fire when they burn too low, etc.

It is recommended that the firing be done as rapidly as possibly consistent with the proper spreading of the coal, so that the doors will be open as short a time as practicable; also when about to clean by the slice and draw method, all tools that are to be used should be right at hand before beginning to clean, and put away after the cleaning is finished and the door shut.

Firemen will answer the emergency call bell by reporting at once to the engineer.

If a fire alarm catches you with dirty fires, it is probably best to shake grates or clean at once and to do so as quickly as possible, even if you cannot take time to make the cleaning as complete as usual.

It is requested that the firemen, so far as is consistent with their other duties, shall keep the fireroom, coal shed, etc., in a neat and tidy condition. This also applies to the toilet room; always leave it in at least as good condition as you find it.

Fireman will sign his name to the recording steam charts on space that he is on duty.

For Boiler-Room Helpers

Follow our usual practice as to washing and cleaning boilers. As a general thing about three weeks is a proper length of run. Wash out all scale and mud, then pick off all scale that can be gotten at, and wash out again. In the case of the Stirling, the tubes may be turbined each cleaning, or the turbining may be omitted if conditions justify it.

Inspect boiler carefully for defective tubes, tubes needing rolling, bags in shell, or any leaks at any point. Also note the presence or absence of oil or grease in boiler and report to chief engineer. The tubes of tubular boilers should be brushed with wire brush when these boilers are cleaned.

Boiler setting should be frequently inspected by the candle method for air leaks. Fill any cracks or defects with a mixture of asbestos and fireclay.

The condition of baffles should be noted when Stirling boiler is cleaned and repairs made as needed.

The non-return valves provide against return of steam to a boiler that is being cleaned. Follow present practice in seeing that all valves on the feed or blowoff lines that can communicate with any supply of steam or hot water are closed. Also, until some other method is provided, wire the wheels of such valves so that they cannot be opened.

If the cleaning work takes you into a boiler alone, you should always notify the engineer on watch or other responsible party of the fact, and of which boiler you are working in.

When a boiler is being cleaned, the fusible plug should be inspected and cleaned, both on the outside and inside; if it seems defective, it should be replaced by a new one.

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*Abstracted from paper by Dow W. Gwinn, read at 39th Annual Convention of New England Water Works Association.

Annual Convention Smoke Prevention Association

On Tuesday morning, Oct 5, the Smoke Prevention Association will assemble in annual convention at the Hotel Sherman, Chicago. An excellent program has been arranged. The morning session will be devoted to registration and addresses of welcome. On Tuesday afternoon there will be papers on "Smoke Prevention in Stationary Plants," by Nathaniel B. Wales, combustion expert; "Some Essentials in Smoke Prevention," by L. R. Pyle, of the Locomotive Fire Box Co.; "Chimneys and Chimney Draft," by Thomas S. Clark, chief engineer of the Alphons Custodis Chimney Co. The evening entertainment will be a theater party.

On Wednesday morning there will be papers on "A Suggested Solution of the Municipal Smoke Problem," by Dr. E. Vernon Hill, chief sanitary inspector of the City of Chicago; "Modern Development of Powdered Coal Burning," by Henry Kreisenger, of the Bureau of Mines; "Powdered Coal Practice," by H. A. Savage, of the Combustion Engineering Corporation. In the afternoon papers on "Heating Boilers and Furnaces" and "Power-Plant Design and Ventilation," by Prof. A. C. Willard of the University of Illinois, and "Smoke and Some of Its Effects on Health," by Dr. W. A. Evans, will be followed by an inspection trip to the Municipal Pier.

Thursday will be railroad day; the papers are as follows: "Value of Brick Arches in Smoke Prevention," by J. T. Anthony of the American Arch Co.; "Homely Talk to Railroad Men on Smoke Prevention," by H. T. Bentley of the Chicago & Northwestern R.R.; "Organization and Teamwork," by Harry Cluer, superintendent of fuel economy, Chicago, Rock Island & Pacific R.R. At the afternoon session the papers are: "Smoke Prevention With Locomotive Stokers," by A. N. Willsie, of the Locomotive Stoker Co.; "The Railroad Situation," by Samuel O. Dunn, editor of *Railway Age;* "Railroad Smoke Prevention," by D. R. MacBain, general fuel superintendent of the New York Central R.R. An automobile trip through the parks followed by dinner at the Marigold Gardens completes the program for the day.

On Friday morning there will be a business meeting and election of officers, followed by a sightseeing trip through the Stock Yards.

Magnetic Clutches on Synchronous Motors for Steel-Mill Drives*

In spite of the well-recognized benefits to be derived from the use of synchronous motors, they have not been widely used in steel mills on account of their poor starting characteristics under load and the strong prejudice on the part of the operators against the use of auxiliary clutches to allow the motor to be started without load. This prejudice, as directed against the mechanical clutch, has been justified by many sad experiences, the reliability being low and the maintenance high. Furthermore, even were the mechanical clutch satisfactory from an operating point of view, it is not adapted for remote or automatic control, and therefore would practically limit the use of the motor to continuous-driving applications.

The magnetic clutch, purely by reason of its name, "clutch," has fallen heir to the ill repute of the mechanical type, and for this reason it has not been widely accepted by steel men as the solution of the problem. It is not, however, subject to the maladies of the mechanical clutch, nor does it share the latter's limitations as regards control. In such cases as it has been used, it has proved eminently satisfactory and has made the use of synchronous motors thoroughly practicable.

Synchronous motors with magnetic clutches have been thoroughly proved out for several years in units up to 600 hp. in the rubber industry for driving mixing rolls and in the cement industry for driving tube mills. This service is quite comparable to steel-mill service.

The combination has also been successfully applied to the driving of pumping machinery where the motor runs continuously and the pump is automatically started and stopped by means of a switch in the clutch circuit operated by a float or by the accumulator weights, according to the nature of the operation. In the case of accumulator service the added advantage of this arrangement is that it entirely eliminates the unloading device, which is the source of more or less trouble. For this reason alone the clutch has frequently been used in such service in connection with ordinary squirrel-cage motors.

The magnetic clutch has the characteristic that its torque builds up gradually, requiring from one to three seconds to attain its maximum value, according to the size. This insures an easy engagement without shock or tendency to pull the motor out of step. The maximum torque is a fixed quantity which cannot be increased by any adjustment within control of the operator, so that the action is always the same and the cheapest class of labor can operate safely.

The only adjustment is for lining wear, and this cannot be improperly done. When the lining is worn out, it can be replaced in fifteen minutes without in any way dismantling the clutch or shafts, so that delay to operation from this cause is not to be feared.

The clutch requires direct current for its operation. This can be taken from the exciter of the synchronous motor. The amount of current required will not exceed 750 watts for the largest unit that would ever be required by this service.

In addition to its primary purpose of loading the motor, the clutch often serves as a safety device, making it possible to cut off the motor and thus eliminating the high inertia parts so that a quick stop may be obtained in case of emergency. This is of particular value in driving roll stands.

Large Sum for Industrial Research

Great problems of industrial research are to be worked out at New York University with the co-operation and financial support of leading American universities.

In the new Engineering School buildings of the University, the erection of which is made possible by the $500,000 donation of the late Mrs. Russell Sage, the large corporations of the country are endowing research fellowships. The names of many large corporations who, either with cash or its equivalent in equipment, are to take part in this latest application of research to industry will shortly be made public.

This movement represents the alliance of industries in related fields for the purpose of carrying out research work in the technical laboratories of the University. Although some of the basic industries have their own laboratories for research and Government facilities are offered to others, it has been found that many experimental investigations can be carried out in the laboratories of such institutions as New York University.

The New School for Social Research, 465 West Twenty-third St., New York City, has established a course of study, conference and research on the Social Function of the Engineer, which will be given during the coming scholastic year, beginning Oct. 13. The course will comprise a series of Wednesday evening lectures and conferences covering the relations of the trained engineer to the present social order. Experienced engineers in various fields of endeavor will contribute to the lectures and conferences. O. S. Beyer, Jr., consulting engineer, formerly of the University of Illinois and a graduate of Stevens School of Technology, will administer this course. The tuition fee for the course has been fixed at twenty dollars.

The City Council of Wilmington, Del., has passed an ordinance providing for the examination and licensing of stationary engineers.

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*Electrical-Development Committee Report, presented at the fourteenth annual convention, Association of Iron and Steel Electrical Engineers, New York City, Sept. 20-24.

Society Affairs

The Executive Committee of the American Welding Society (New York) has recommended that a New York Section be formed to operate separately from the parent organization.

The American Association of Engineers has opened offices in Boston at 50 Broomfield St., Room 305. Fred C. Lewis is temporary managing secretary and also recording secretary.

The California State Assembly of A. A. E. is assisting J. C. Whitman, chief examiner of California Civil Service Commission, in making a preliminary classification of engineering service in that state. Members of the assembly are obtaining comment on the tentative classification from various corporations and individuals throughout the state.

The American Electric Railway Association will hold its thirty-ninth annual convention in Atlantic City, Oct. 11-15. Eugene McAuliffe, president of the Union Colliery Co., of St. Louis, and formerly manager of the Fuel Conservation Section of the United States Railroad Administration, will speak on "Problems of Fuel Supply."

Baltimore Chapter, A. A. E., on Sept. 17 held a mass meeting attended by 350 leading Baltimore engineers. Mayor Broening, chief engineer, Henry Perrin, chairman, John Greiner of the Port Development Committee, and others told how the engineers could assist in inducing the citizens of Baltimore to adopt a bond issue for improving the harbor and other public works of Baltimore.

The Committee on Ethics and Compensation of the San Francisco Chapter of A. A. E. recently adopted a resolution calling for increases in Federal engineering salaries to the following: Junior engineer, minimum $1,800, maximum $2,700; assistant engineer, minimum $2,700, maximum $4,000; senior assistant engineer, minimum $4,000, maximum $5,000; engineer, minimum $5.000, maximum $7,500.

Charleston Chapter, A. A. E., has protested to the Secretary of the Navy regarding the recent salary awards which resulted in a net decrease in salaries of some of the technical employees in the Navy. The communication requests a reconsideration of the case. The award was a 5 per cent flat increase, but the establishment of half holidays without pay except during the summer months resulted in a net decrease in salary of 1½ per cent.

The Waterbury Section, A. S. M. E., will hold the first meeting of the season Saturday, Oct. 2, at Stevenson, Conn., where, at the invitation of Irvin W. Day, vice president of the Connecticut Light and Power Co., the members will inspect the company's new hydro-electric plant at Stevenson on the Housatonic River about eight miles above Derby. The trip to Stevenson will be made by automobile, leaving the Waterbury Club at 12:45 p.m. Members of other engineering societies are cordially invited to participate in this trip.

The Empire State Gas and Electric Association will hold its Sixteenth Annual Convention at the Hotel Utica, **Utica**, N. Y., Oct. 7 and 8. The following papers will be read: "Selling in a Small Community," H. K. Stein, superintendent, Genesee Light and Power Co.; "Importance of Meter Testing," F. J. Murmann, superintendent of meters, Westchester Lighting Co.; "Service Charge Rate," A. Parshall, consulting engineer; "Financing Utility Properties," R. M. Searle, president, Rochester Gas and Electric Corp.; "Consumers' Viewpoint," G. I. Vincent, engineer, Syracuse Lighting Co.; "Coal Situation," G. N. Snider, coal traffic manager, New York Central R.R. The entertainment committee has arranged a dinner, golf tournament and an automobile trip to Trenton Falls.

The Cleveland District Section of the Association of Iron and Steel Electrical Engineers' program for 1920-21 includes the following: Meetings — Oct. 11; paper, "Trouble of the Electrical Operating Man," by A. W. Mohrman, assistant electrical superintendent, Trumbull Steel Co., Warren, Ohio. Nov. 8; paper, "Slip Regulators vs. Notchbacks," by Gordon Gage, chief electrician, American Rolling Mill Co., Middletown, Ohio. Dec. 13; paper, "Continuous Rated or 50-Degree Rise Motors," by L. F. Adams, electrical engineer, power and mining department, General Electric Co., Schenectady, N. Y. Jan. 10, 1921; paper, "The Proper Selection of Carbon Brushes," by L. A. Heath, engineer, Morganite Brush Co., New York, and John S. Cavitt, Electrical Engineering and Manufacturing Co., Pittsburgh. Feb. 14; paper, "Scientific Combustion Control for Boiler Furnaces," by M. G. Benjamin, Benjamin Engineering Co., Cleveland. March 14; paper, "Electric Propulsion Ships," by W. E. Thaw, Westinghouse Electric and Manufacturing Co., Pittsburgh, April 11; paper, "Electrical Clearing of Gases as Applied to Blast Furnaces," by N. H. Gellert, president, Gellert Engineering Co., Philadelphia. May, inspection trip, to be outlined later. June, the annual outing.

Miscellaneous News

A Fifteen-Year Program, involving the expenditure of $200,000,000 in the development of 750,000 horsepower of electric energy from the water of the Kern and San Joaquin Rivers, Big Creek and Huntington, Sjaver and Florence Lakes, was announced recently by the Southern California Edison Company.

The Southern California Edison Co. has asked the Railroad Commission for authority to sell its electrical distribution line on the Base Line Road, San Bernardino County, to the Ontario Power Co. The price is given as $12,500. The Ontario company serves the cities of Ontario and Uplands and contiguous territory. It is said transfer of the distribution line will render unnecessary the building of another line by the Ontario company and that the transfer of ownership can be accomplished without injury to the public.

Capitalists of San Antonio, Tex., interested in the Syndicate Power Co., organized heretofore with a capitalization of $20,000,000, are endeavoring to complete arrangements to finance their enterprise this year and begin actual construction during the winter on hydro-electric plants that will generate a total of 48,000 kw. One dam is partially under construction, and there are four other dam sites available on the Colorado River at and near Marble Falls, Tex., where the first hydro-electric installation will be placed. Engineers have estimated the cost of the plants now in view at $12,000,000.

Business Items

The American Steam Conveyor Corporation announces the change in its corporate name to the "Conveyors Corporation of America." There is no change either in the personnel or policy of the company.

The R. H. Beaumont Co., 319 Arch St., Philadelphia, contractor for conveying and hoisting systems and complete power plants, has opened an office at 230 Fifth Ave., Pittsburgh, Pa. Thomas Widdop is in charge.

Trade Catalogs

"B-G Standardized Material Handling Machines" is the title of a new 32-page catalog now ready for distribution by the Barber Greene Co., Aurora, Ill. Self-feeding bucket loaders, portable belt conveyors and permanent belt conveyors handled by this company are described and illustrated by photographs in the catalog, a copy of which will be sent to anyone interested on request.

The Reading Iron Co., of Reading, Pa., has ready for distribution a new 31-page catalog entitled "Reading Wrought Iron Pipes." A brief history of the iron industry since the time the metal was first discovered until the present time is contained in the booklet. This is followed by a description, accompanied by illustrations, of the modern processes as carried out by the Reading Iron Co. A copy will be sent on request.

The Story of Gasoline is the title of a new 38-page booklet now ready for distribution by the Atlantic Refining Co. The book contains an account of various stages necessary for refining gasoline. Illustrations are given of the equipment used by the company for refining this product. A description of the proper method of using gasoline in an automobile engine, adjustment of carburetor, etc., is given. The booklet closes with a diagnosis of various sorts of engine trouble and remedies.

The Engineer Co., 17 Battery Place, New York City, has just received from the printer a new 30-page catalog entitled "Modern Practice in Combustion Control," which should prove of interest to engineers, particularly those interested in the subject of combustion. A brief history of the science of combustion is given and also a description of the principles, apparatus and operation of balanced draft. Photographs and line drawings illustrate the text.

New Construction

PROPOSED WORK

Mass., Boston—The Lighthouse Supt. will receive bids until October 15 for installing new boiler on Light Vessel No. 47.

Mass., New Bedford—The Bd. Educ. will receive bids until October 13 for a 2 story, 170 x 250 ft. school on Rochambeau St. and a 2 story, 153 x 270 ft. school on Mt. Pleasant St. Steam heating systems will be installed in same. LaBrode & Bullard, 255 Union St., Archts.

Mass., Wakefield—Lee & Hewitt, Archts., 1123 B'way, New York City, will soon award the contract for a 1 story, 40 x 50 ft. boiler house here for the Heywood Bros. and Wakefild Co., Gardner.

Conn., Glenville—The United States Finishing Co., Greenville, will soon award the contract for a 1 story, 40 x 110 ft. boiler plant. Day & Zimmerman, 611 Chestnut St., Philadelphia, Pa., Archts.

N. Y., Brooklyn—The Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until October 6 for an underground electric light and power distrbiuting system.

N. Y., Marcy—The State Hospital Commission, Capitol, Albany, will soon award the contract for the installation of a heating system and generator set in the Utica State Hospital here. Noted Sept. 28.

N. Y., Rome—The Rome Wire Co. is having plans prepared for a 560 hp. heating plant including 2 Heine horizontal water tube boilers with Wetzel mechanical stokers, American Steam Corp.'s ash conveyor, Link Belt Co. coal handling equipment, pumps, and feed water heaters, etc. R. M. Fraser, Asst. Mgr.

N. J., Asbury Park—Lester R. Weller & Son., 21 Corlies Ave., received bid for a 1 story ice plant, garage and office from the American Federal Masonry Co. at $20,000.

N. J., Glassboro—The State, Trenton, received bids for a 41 x 49 ft. power plant including 4 boilers from the Standard Constr. Co., 1713 Sansome St., Philadelphia, $20,000; G. Dose, 43 West 27th St., New York City, $28,000.

Pa., Harrisburg — The City, Commonwealth Bldg., has retained James H. Fuertes, Consult. Engr., 140 Nassau St., New York City, to prepare plans for a pump station including engines, etc. About $273,000.

Md., Annapolis—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to install boiler plant equipment and piping.

Md., Baltimore—The Bd. of Awards received bids for furnishing and installing feed pumps, renewing tubes in boilers and installing additional tubes in the power house at the Bayview Hospital, from H. A. Kries & Sons Co., 6 Lombard St., $15,279.

D. C., Washington—The Sacred Heart Church, c/o F. V. Murphy, Archt., 1413 H St., will soon award the contract for a 1 story church including a steam heating system on 15th St. and Park Place. About $1,000,000.

N. C., Ashville — The J. G. Stikeleather Syndicate, c/o Herts & Robertson, Archts., 331 Madison Ave., New York City, plans to build a hotel including a steam heating system. About $1,500,000.

Ala., Birmingham—The Corona Coal Co. plans to install a 200 kva. rotary converter and a 100 hp. hoist. L. M. Adler, Genl. Mgr.

Tenn., Memphis—The Memphis Hotel Co. plans to construct a hotel including a steam heating system. About $2,500,000. G. S. Parker, Mgr. W. L. Stoddart, 9 East 40th St., New York City, Archt. and Engr.

O., Cleveland—The Central Y. M. C. A., c/o C. V. Thomas, Secy., East 22d St. and Prospect Ave., plans to build an 8 story Y. M. C. A. addition including a steam heating system. About $1,000,000. Hubbell & Benes, 4500 Euclid Ave., Archts.

O., Cleveland—The City c/o E H Long Archt City Hall is in the market for one 40 hp motor and seven motors of 4 to 8 hp each

O., Cleveland—The Crowell & Little Co 1951 East 57th St, plans to build a 10 story 150 x 170 ft commercial and office building including a steam heating system, on East 13th St and Chester Ave About $1,250,000

O., Cleveland—S Gurss 1261 East 99th St, plans to build a 1 story theatre including a steam heating system on Euclid Ave east of 79th St About $250,000

O., Cleveland—St Hyacinth's Church, c/o Rev Redmer East 61st St and Francis Ave is having plans prepared for a 1 story, 40 x 80 ft boiler house One 200 hp boiler will be installed in same About $25,000 W C Jansen, Electric Bldg Archt.

O., Cleveland—Bd Educ., c/o L W Jones, Pres., Chagrin Falls, plans to build a 2 story school including a steam heating system in Orange Township. About $300,000

O., Ravenna—The Warren Hotel Co., c/o F. E. Robinson, 537 Guardian Bldg., Cleveland, plans to build an 8 story, 75 x 100 ft. hotel here, including a steam heating system. About $400,000. Moulthrop & Nichols, 5716 Euclid Ave., Cleveland Archts.

Ill., Chicago—Philipsborns, 511 South Paulina St., is having plans prepared for a 7 story, 126 x 170 ft addition to mail order house including a steam heating system on Harrison and Paulina Sts. About $1,300,000 A. S Alschuler, 28 East Jackson St., Archt.

Ill., Chicago—The Republic Life Insurance Co., 108 South La Salle St., is having plans prepared for a 6 story, 75 x 130 ft. office building including a steam heating system on Washington and Sheldon Sts. About $250,000

Wis., Racine—The Bd. Educ. is having plans prepared for a 3 story addition to the Washington School including an intermediate high school and a power house. About $340,000. E. B. Funston Co., Robinson Block, Archt.

Iowa, Clinton—The Clinton Gas & Electric Co. plans to install additional turbines to develop 3,500 kw. power.

Minn., Minneapolis—The Bd. Educ., c/o G. F. Womrath, Supt., City Hall, received bids for installing a steam heating and ventilating system in the Clinton School addition, from Bjorkman Bros., 712 South 10th St., $41,399; Conner Bros. Heating and Plumbing Co., 711 6th Ave., North, $42,819; Western Heating Co., 13 East 36th St., $43,148.

Minn., St. Paul—The city received bids for 1 vertical triplex motor driven pump of 350 gal. capacity per minute against a total 150 ft. head, single acting, belt for 150 lbs. pressure, from the Power Equipment Co., 212 North 3d Ave., Minneapolis, $2,910 (with extras, $3,078); Robinson, Cary & Sands Co., 4th and Waconta Sts., $3,510; Northwestern Electric Equipment Co., 176 East 6th St., $3,574.

Kan., Portis—J E Kissel, City Clk., plans to expend $30,000 for waterworks improvements including a 5 hp electric motor, direct connecting unit etc

S. D., Mitchell—The city plans to install a steam heating system in the proposed 1 story, 187 x 300 ft corn palace auditorium on North Main St and 6th Ave

N. D., Fargo—The Elks' Lodge, No. 260, plans to build a clubhouse including a steam heating system About $250,000

Tex., San Angelo—The San Angelo Water, Light and Power Co. plans to install additional equipment in its plant here.

Okla., Enid—The Enid Masonic Temple Association, 202½ North Main St., will receive bids until November 15 for a 4 story, 100 x 150 ft. temple. Contracts for the installation of heating and plumbing systems in same will be sublet. About $325,000 R W. Shaw, Bech Bldg., Archt

Okla., Eufaula—The Pioneer Electric & Power Co. is in the market for second-hand equipment for the manufacture of ice including ammonia tanks, piping, hoists, etc.

Oka., Oklahoma City—The Okahoma Terminal Elevator Co. plans to build a 62 x 150 ft. elevator building. Electric power will be installed in same. About $600,000. P. L. Jackson, Secy.

Col., Denver—The School Bd. received bids for the installation of a heating system in the proposed 2 story, 158 x 340 ft. Morey Junior High School on 14th Ave. and Emerson St., from McCarty-Johnson Heating Co., $89,031; and in the proposed 2 story, 125 x 350 ft. junior high school on South Washington and South Pearl Sts., from Johnson Davis Plumbing and Heating Co., $90,000. Noted August 10.

Utah, Provo—The Goshen Bay Irrigation Co. plans to install electrically operated pumping plants and drainage systems in connection with the proposed irrigation and drainage project.

Wash., Cedar Falls—The City Council of Seattle plans to build a 1 story, 44 x 64 ft. power house here to include the installation of generating unit and transformers. About $1,000,000. Daniel Huntington, Archt. Noted June 1.

N. B., Grand Falls—The New Brunswick Electric Power Commission plans to build a power plant here in addition to the power developments at Shogomoc and Musquash. C. O. Foss. St. John, Chief Engr.

Ont., Windsor—The School Bd. plans to build a 2 story, 180 x 200 ft. school including a steam heating and ventilating system About $400,000. Mayor Winter, Chn.

CONTRACTS AWARDED

N. Y., New York—The Clinton Hall Association, 1375 Astor Pl., has awarded the contract for altering a 7 story store, library and office building including a steam heating system to Hegeman Harris, 185 Madison Ave., at $265,000.

Pa., Nanty Glo—The Lincoln Coal Co. has awarded the contract for furnishing 300 hp. electric current to the Pennsylvania Central Light & Power Co., Altoona

Pa., Philadelphia—The Carver File Co., 3231 Frankford Ave., has awarded the contract for a 1 story, 25 x 18 ft power house on Tacony and Buckius Sts to W Steele & Sons Co., 16th and Arch Sts

Pa., Philadelphia—The Cramp Shipbuilding Co., Richmond and Norris Sts has awarded the contract for a 2 story, 60 x 120 ft power house addition to Fred A. Havens, 815 North 19th St

Ala., Birmingham—Loew's Enterprises, 1492 Bway., New York City, will build a theater here, including a steam heating system About $600,000 Work will be done by day labor.

O., Cleveland—The Cleveland Ry. Co., Leader-News Bldg., has awarded the contract for a 1 story, 46 x 72 ft. electric substation at East 152d St. and St. Clair Ave. to W. I. Thompson & Son Co., 5103 Euclid Ave. About $100,000. Noted April 20.

O., Cleveland—The Jacob Lamb Baking Co., 4919 Lorain Ave., has awarded the contract for a 1 story, 30 x 50 ft. boiler room, to the Lehder Constr. Co., Engineers' Bldg., at $25,000. Noted September 21.

O., Grafton—The City has awarded the contract for a pumping station to Dobson-Maines Co., Pittsburgh, Pa., and for two deep well pumps to the Cleveland Pump & Supply Co., Guardian Bldg., Cleveland. Noted Feb. 16.

O., Linden (Columbus P. O.)—The Bd. Educ., Tower and High Sts., has awarded the contract for the installation of heating, plumbing and ventilation systems, etc., in the proposed school here to S. A. Effwein & Co., West Broad St., at $45,552.

O., Springfield—The Bd. Educ. has awarded the contract for a 2 story, 110 x 128 ft. school including a steam heating system on Maiden Lane to Paul R. Yeazel, 2233 Columbus Ave., at $241,745.

Wis., Florence—The city has awarded the contract for furnishing 3 centrifugal motor driven pumps, from 100 to 500 gal. per minute capacity, 2 operating panels equipped with automatic controllers, meter and oil switches, 1 electric siren and 1 small air compressor, to the Allis-Chalmers Mfg. Co., West Allis St., at $4,810. Noted July 27.

Minn., Pipestone—The City has awarded the contract for a 1 story pumping station to Hunt & Sons, at $13,718. Noted July 7.

S. D., Sioux Falls—The Diocesan College has awarded the contract for the construction of a 2 story, 40 x 60 ft. service building and a 60 x 60 ft. (underground) heating and power plant to Carson & Smithkey, Sioux Falls, and for furnishing refrigeration and power equipment to the L. E. Pollard Co., 423 South 5th St., Minneapolis, Minn. Noted March 9.

Mo., St. Louis—The Gerst Bros. Meat Co., 3823 Lucky Ave., has awarded the contract for a 1 story, 35 x 50 ft. engine room at 3811-15 Lucky Ave. to Gillespie & Daly, International Life Bldg., at $12,000.

Tex., Austin—The State Bd. of Control has awarded the contract for installing a heating plant in the proposed hospital on West 6th St. to John L. Martin, 408 Congress Ave., at $46,490.

Ore., Portland—The Eastern & Western Lumber Co., foot of 21st St., North, will build a power plant. About $25,000. Work will be done by day labor.

Need Competent Help?

See Pages 96 to 112

Let the
"SEARCHLIGHT"
Help You

See Pages 96 to 112

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in.	85c per ft.
Common, 2½-in.	30%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft	$0 60	$0 40	$0 30

Steam—Discounts from List

First grade 20% Second grade 30% Third grade 45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	30–10%		

LEATHER BELTING—Present discounts from list in fair quantities (½ doz. rolls):

Light Grade	Medium Grade	Heavy Grade
30%	25%	20%

RAWHIDE LACING
For cut, best grade, 25%, 2nd grade, 30%.
For laces in sides, best, 79c per sq. ft.; 2nd, 75c.
Semi-tanned: cut, 20%; sides, 83c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	1 70
Duck and rubber for piston packing	1 00
Flax, regular	1.20
Flax, waterproofed	1 70
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1.50
Rubber sheet	.50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 30
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1 05

85% magnesia high pressure		List +5%
For low-pressure heating and return lines	4-ply	50% off
	3-ply	52% off
	2-ply	54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	8½	6 6	8@ 9	8½	13¼
Fiber or sponge	8½	8 6	12@ 15	8½	20
Transmission	10	8 1	12@ 15	8½	20
Axle	.	4.8	6@ 6½	5¼	7¼
Gear	6½	6.1	8@9	5¼	8½
Car journal	12(gal.)	4 7	23@ 25	8½	8½

COTTON WASTE—The following prices are in cents per pound.

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	15.00@ 17 00	13 00	16 00	11.00 to 14 00
Colored mixed	9 00@ 14.00	9 00 to 12 00	12 00	9 50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13¼	13¼ x 20½
Cleveland	$55 00	$65 00
Chicago	41 00	43.50

LINSEED OIL—These prices are per gallon

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$1.25	$2.25	$1.22	$2.37
5-gal. cans	1.40	2.40	1.47	2.57

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	15 50	17 00	13 00	14 50	15 50	13 00
25- and 50-lb. kegs	15 75	17 25	13 25	14 75	15 75	13 25
12½-lb keg	16 00	17 50	13 50	15 00	16 00	13 50
1-lb. cans	18 50	20 00	15 00	16 50	15 00	15 00
5-lb. cans	20 50	22 00	16 00	17 50	16 00	16 00

500 lb. lots less 10% discount; 2000 lb. lots less 10–2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	List net	40%	30%
Tinned	List net	40%	30%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York $6 00 Chicago $5.62 Pittsburgh $4 50

Structual rivets, same sizes:

New York $7 10 Chicago $5.72 Pittsburgh $4 60

REFRACTORIES—Prices in carlots:

Bauxite brick, 56% alumina, f.o.b. Pittsburgh	per 1000	$160
Chrome brick, eastern Shipping points	net ton	100@ $110
Chrome cement, 40@45% Cr_2O_3	net ton	55@ 60
Chrome cement, 40@45% Cr_2O_3 in sacks	net ton	60@ 65
Clay brick, 1st quality, fire clay, 9-in. shapes, Pennsylvania, Ohio and Kentucky	per 1000	55@ 60
Clay brick, 2d quality, fire clay, 9-in. shapes Pennsylvania, Ohio and Kentucky	per 1000	45@ 50
Magnesite brick: 9-in. straight	net ton	110
Magnesite brick: 9-in. arches, wedges and keys	net ton	121
Magnesite brick: Soaps and splits	net ton	134
Silica brick: Chicago district	per 1000	65@ 70
Silica brick: Birmingham, Ala	per 1000	56@ 61
Silica brick: Mt. Union, Pa	per 1000	55@ 60

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90 00	90 00	57.00	79.00	60.00	60 00
Commercial	50 00	50.50	21.00	17.50	15.00	13.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$20.00	25.50–30.00
Cleveland	20.00	20 00
Chicago	21.00	16.50

In coils an advance of 50c usually is charged

Domestic iron (Swedish analysis) is selling at 12c. per lb.

SHEETS—Quotations are in cents per pound in various cities from warehoues also the base quotations from mill:

	Large Mill Lots Pittsburgh	St. Louis	Chicago	San Francisco	New York Current	New York One Yr. Ago
Blue Annealed						
No. 10	$3.55@ $7.50	$7.09	$7.02	$8.65	$7.23@ $8.00	$4 57
No 12	3 60@ 7 55	7 09	7 07	8 70	7 28@ 8 05	4 62
No 14	3 65@ 7 60	7 09	7 12	8 75	7 33@ 8 10	4 67
No 16	3 75@ 7 70	7 09	7 17	8 85	7 43@ 8 20	4 77
Black						
*Nos. 18 and 20	4 15@ 8 30	8 10	7 80	10 60	8 41@ 9 80	5 30
*Nos. 22 and 24	4.20@ 8.35	8.10	7.85	10.65	8.46@ 9.85	5.35
*No. 26	4 25@ 8 40	8 10	7 90	10 70	8 51@ 9 90	5 40
*No. 28	4.35@ 8.50	8.10	8.00	10 80	8.61@ 10.00	5.50
Galvanized						
No. 10	4 70@ 8 50	9 60	8 50		8 91@ 11 50	6 20
No. 12	4.80@ 8.60	9.60	8.60	11.35	9.01@ 11.50	6.25
No 14	4 80@ 8 60	9 60	8 60	11 35	9 01@ 11 60	6 30
Nos 18 and 20	5 10@ 8 90	9 60	8 90	11 65	9 26@ 11 90	6 60
Nos. 22 and 24	5 25@ 9 05	9 60	9 05	11 80	9 41@ 12 05	6 75
*No. 26	5.40@ 9 20	9.60	9.20	11.95	9.56@ 12.20	6.90
†No 28	5 70@ 9 50	9 60	9 50	12 25	9 86@ 12 50	7 20

*For painted corrugated sheets add 30c. per 1000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card

Steel			Iron		
Inches	Black	Galv	Inches	Black	Galv
BUTT WELD					
¾ to 3	45 to 57½	41½ to 44	⅜	15½ to 25½	+1½ to 11
			½	19½ to 29½	1½ to 11½
			¾ to 1½	24½ to 34½	8 to 18½
LAP WELD					
2	47 to 50½	34½ to 38	2	20½ to 28½	6½ to 14½
2½ to 6	50 to 53½	37½ to 41	2½ to 6	22½ to 30½	9½ to 17½
7 to 12	47 to 50½	33½ to 37	7 to 12	19½ to 27½	6½ to 14½
13 and 14	37½ to 41				
15	35 to 38½				
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
¾ to 1½	52 to 55½	39½ to 43	¾ to 1½	24½ to 34½	9½ to 19½
2 to 3	53 to 56½	40½ to 44			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	45 to 48½	33½ to 37	2	21½ to 29½	8½ to 16½
2½ to 4	48 to 51½	36½ to 40	2½ to 4	23½ to 31½	11½ to 19½
4½ to 6	47 to 50½	35½ to 39	4½ to 6	22½ to 30½	10½ to 18
7 to 8	43 to 46½	29½ to 33	7 to 8	14 to 22½	2½ to 10½
9 to 12	38 to 41½	24½ to 28	9 to 12	9½ to 17½	5½ to 2½

BOILER TUBES—The following are the prices for carload lots, f.o.b. Pittsburgh

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	15 to 40½	1½ and 1¾ in.	+20
2½ to 3¼ in.	10 to 30½	2 and 2¼ in.	+10
2¼ in.	4 to 24	2½ and 2¾ in.	+1
1¾ to 2 in.	+4 to 19½	3 and 3¼ in.	−1½
		3½, 4 and 4½ in.	8

Standard Commercial Seamless—	Per Net Ton	Cold Drawn or Hot Rolled	Per Net Ton
1 in.	$327	1¾ in.	$207
1¼ in.	267	2 to 2¼ in.	177
1½ in.	257	2½ to 3¼ in.	167
1¾ in.	207	4 in.	187
		4½ to 5 in.	207

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond. M Ft	Three Cond. M Ft	Two Cond. Lead M Ft	Three Cond. Lead M Ft
No. 14 solid	$ 95 00 net	$138 00	$164 00	$210 00
No. 12 solid	135 00	170 00	225 00	265 00
No. 10 solid	185 00	235 00	275 00	325 00
No. 8 stranded	285 00	375 00	520 00	500 00
No. 6 stranded	400 00	500 00	560 00	

From the above lists discounts are

Less than coil lots	+ 5%	+ 15%
Coils to 1,000 ft	− 5%	List Net
1,000 ft. and over	−10%	7%

BATTERIES, DRY— Regular No. 6 size red seal, Columbia, or Ever-Ready

	Each, Net
Less than 12	$0 48
12 to 50	41
50 to 125 (bbl.)	38
125 (bbl.) or over	35

CONDUIT, ELBOWS AND COUPLINGS—These prices are in 100-lb. lots, f. o. b. New York, with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
Size, In.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs
½	85 00	93 50	22 00	524 60	6.65	7 30
¾	11.50	126 50	29 00	32 00	11.25	12 37
1	170 00	187 00	41.00	45.00	15.50	17 00
1¼	230 00	253 00	52 00	57 00	20 70	23 60
1½	275.00	302 50	70 05	78 00	25.00	27 50
2	375.00	403 00	130.00	145 09	33 70	37.00
2½	585 00	613 80	210.00	235 00	47 50	53 00
3	765.00	841 50	560 00	620 00	70 00	78 00
3½	920 00	1,012 00	1,350 00	1,485 00	92 00	114 00
4	1,170 00	1,287 00	1,469 00	1,617 00	115 00	140 00

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
3/16	250	$0 05½	
¼	250	.06	
⅜	250	.09	
½	200	.12	1000 ft. and
⅝	200	.15	over.... 40% off
¾	150	.18	Coils..... 30% off
1	100	.25	Less coils, 20% off
1¼	100	.33	
1½	Odd lengths	40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.43
D. P. M. L.	.21	T. P. to D. P. S. B.	.26
T. P. M. L.	.33	T. P. S. B.	.38
D. P. S. B.	.23	T. P. D. B.	.64

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0 50	$1 30	$1.68
T. P. M. L.	70	1.70	2 40
D. P. S. B.	.63	1 60	
T. P. S. B.	1 15	2.40	
D. P. D. B.	1.10	3 00	
T. P. D. B.	1 90	5.40	
T. P. to D. P. D. B.	1.30	3 80	

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.

No. 18 cotton twisted	$25 00
No. 16 cotton twisted	29.00
No. 18 cotton parallel	32 00
No. 16 cotton parallel	39.50
No. 18 cotton reinforced heavy	43 00
No. 16 cotton reinforced heavy	50 00
No. 18 cotton reinforced light	37.50
No. 16 cotton reinforced light	43 00
No. 18 cotton Canvasite cord	30.00
No. 16 cotton Canvasite cord	33.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
425-amp. to 600-amp.	10	5.50

600 Volt	Std. Pkg.	List
5-amp. to 30-amp.	100	$0 40
35-amp. to 60-amp.	100	60
65-amp. to 100-amp.	50	1 50
110-amp. to 200-amp.	25	2 50
225-amp. to 400-amp.	25	5 50
450-amp. to 600-amp.	10	8 00

Discount	
Less than 1-5th standard package	15%
1-5th to standard package	28%
Standard package	45%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$5 25
0-30 ampere, less than standard package	6 00

LAMPS—Below are present quotations in less than standard package quantit

Straight Side Bulbs Mazda B—				Pear-Shaped Bulbs Mazda C—			
Watts	Plain	Frosted	No. in Package	Watts	Clear	Frosted	No. in Package
10	$0 40	$0 45	100	75	$0 75	$0 80	50
15	40	45	100	100	1 10	1 25	24
25	40	45	100	150	1 55	1 70	24
40	40	45	100	200	2 10	2 30	24
50	40	45	100	300	3 15	3 40	24
60	45	50	100				12
				500	4 60	4 90	12
				750	6 50	6 90	8
				1,000	7 50	7 95	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0 28
Composition 2-piece attachment plug	36
Swivel attachment plug	.20
Current taps	.45

RUBBER-COVERED COPPER WIRE— Per 1000 ft. in New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$11.50	$14 25	$17.00	$28 50
12	14 96	18.50	21.45	35.00
10	20 62	24.75	28.05	46 00
8	28.90	33.30	38.50	66 00
6		......	58.75	.
4		......	80.75	. .
2		......	111 00	.
1		......	154.00	...
0		......	181 50	. .
00		......	220.00	....
000		......	265 00	......
0000		......	330 00	......

Prices per 1000 ft. for Rubber-Covered Wire in Following Cities:

	Denver			Birmingham			St. Louis		
	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$15.64	......	$38 45	$12.23	....	$38.64	$15.64	.....	$38 45
10	24 50		.	27.60	....	65.57	24.50	.....	58.70
8	33 48	$56 81		38.64	....	87.33	33.48	. .	..
6		77 17	......	69 12	.		..	56.81	.
4		108 10	......	..	$107.42	...	......	77.17	..
2		142 00	...	...	138.46	...	......	108 10	...
1		167 70	....	....	178 52	....	......	142 00	.
0		198 20	..	...	217.09	...	......	167.70	
00		234.60	......	. .	263.57	...	......	198.20	
000		279 60		.	320.44	...	......	234.60	.
0000					389.17	...	......	279.60	.

Pittsburg—23c. base; discount 50%. St. Louis—30c. base.

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap			⅜ In. Cap		
Key Each	Keyless Each	Pull Each	Key Each	Keyless Each	Pull Each
$0 33	$0 30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	+50%
1-5th to standard package	+20%
Standard package	−10%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	55c. lb
No. 18 B. & S. regular 1-lb. coils	56c. lb

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 56c. lb., 100 lb. lots	52c. lb
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c. lb
Wire solder, less 100 lb. 47c. lb., 100 lb. lots	42c. lb
Soldering paste, 2 oz. cans	$1.50 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1 02	$1.36
60	.74	1.22	1 84	2.44
100	1.50	2.50	3 76	5.00
200	2.70	4.50	6 76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4 40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+ 5%
$50 to $200 list value	−10%
$200 list value or over	−15%

POWER

Volume 52 New York, October 12, 1920 *Number* 15

Two Ways of Telling a Story

CRABS walk backward, the Chinese read backward and some men tell stories "wrong end to." Others begin in the middle and ramble toward both ends simultaneously.

A few days ago such a man rushed up to the chief engineer's desk and blurted: "It broke off and I can't drill it out. I only pulled easy on it, and the dingbusted thing let go and nearly spilled me. Anyway the spool was cracked and——".

The chief was working on an estimate for some new piping. Even had the story been logically presented, he would not have gathered the drift at once. With what patience he could command, he requested that the story be retold, starting at the beginning. Then the man began in the middle. "Why the spool on the left hand—no the right hand I guess it is,—piston rod broke——."

"I see," the chief interrupted, "You have been working on a pump. What one?" And by shooting in a question each time the story strayed, he at length learned what had happened.

Lack of logic, lack of tact, lack of appreciation of the other fellow's state of mind are deficiencies which irritate in any sort of interview.

A short time later another repair man walked up to the chief's desk. He waited until the chief came to a stopping place and turned for the story. Then: "I have been working over in building K basement on that twin vertical engine that runs the centrifugal pump. On the side next to the wall the crankpin appears to be loose."

He obtained attention, located his work and then explained his trouble. It is easy to listen to a story told so logically, so simply and directly. The man who can tell his story in that way generally finds the door open for him.

Take your own case. When you go up to the manager's office to talk matters over, have you prepared your story? Are you satisfied that it is logical? Have you gathered all the necessary data? Have you appreciated his viewpoint? If you have done these things, you will be much more likely to succeed. You will be more welcome next time.

Contributed by WILLIAM E. DIXON

New Studebaker Boiler Plant at South Bend

Modern Boiler Plant Supplying Steam for the New Factory Unit Erected To Manufacture the Studebaker Light-Six Automobile. The Plant Has an Initial Capacity of 4,160 hp. and Is Well Equipped with Labor-Saving Devices and Instruments To Indicate the Operation

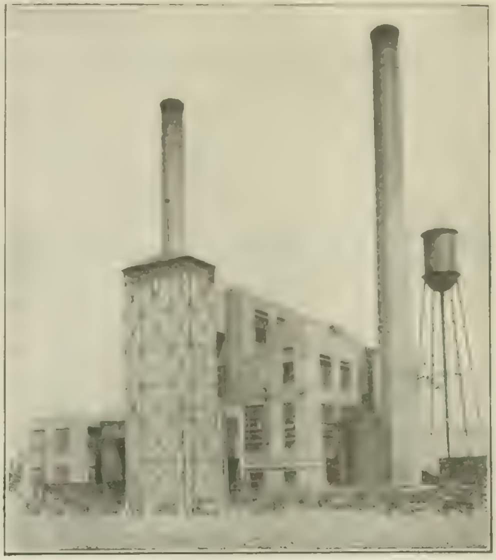


FIG. 1. EXTERIOR OF NEW STUDEBAKER BOILER HOUSE

THE latest addition to the Studebaker-plant system is the new fifteen-million-dollar unit at South Bend, Ind., now practically completed, for the building of the Studebaker light-six car. It consists of five buildings of mammoth proportions laid out and equipped for efficient manufacture. They will include assembly and sub-assembly buildings, both four-story structures, a forge shop, machine shop and press shop accommodating the stamping department. This group of buildings has a floor space of 1,206,800 sq.ft. They are served by 153 miles of electric wiring, 6,640 ft. of water mains, 6,169 ft. of sewer lines and 3,081 ft. of tunnels for carrying steam, water and electrical lines to and between the various buildings. They are equipped with 12 freight elevators, 4 passenger elevators and 34 traveling cranes.

To serve this factory unit is the purpose of the new boiler plant. Steam is supplied to the forging hammers, annealing ovens and other mechanical equipment. It is also utilized to pump water and oil to the various departments, as well as to heat the buildings. Steam is generated at 175 lb. pressure and superheated 75 deg., although it is utilized for the most part at 125 lb. pressure.

During the heating season the exhaust from the hammers is sufficient for the heating, excepting in the coldest weather, when it is supplemented with live steam. In the two four-story buildings there is both direct and indirect heating, and direct radiation only in the other buildings. The heating is done by a vacuum system bringing back the returns to the boiler house. In the indirect system the fans and the pumps for circulating the water to wash the air are motor-driven. These, in brief, are the present services of the boiler house. The heating load is estimated at 2,355 boiler-horsepower and the demand for industrial steam at 3,480 boiler-horsepower. Compressed air at 100 and at 50 lb. pressure is supplied the shops by four synchronous-motor-driven compressors using purchased current, but plans for the future call for a complete generating plant to care for all the South Bend properties and the provision of a spray pond to conserve cooling water.

Fig. 1 is an exterior view of the boiler house, with the coal-conveyor tower in the foreground. On either side are water-softening plants, and at the extreme left is the engineer's office. Back of this is the compressor room. The boiler house is of neat, substantial brick construction, well provided with glass area for light and ventilation. Fig. 2 shows that the boilers are placed four on each side of a central firing aisle. In the present building there is room for two additional boilers on either side, and future plans call for an extension, when it is needed, that will house eight additional boilers. The present building, then, is planned for twelve 520-hp. water-tube boilers having an aggregate capacity of 6,240 horsepower.

As previously stated, the operating pressure is 175 lb. gage, and the superheat 75 deg. Each boiler is equipped with a six-retort underfeed stoker, chain-driven from a lineshaft on either side in the basement. There are two vertical engines on each shaft, one acting as a reserve unit. Forced draft is supplied by two turbine-driven fans on either side, both connected to a common duct running the full length of the firing aisle. The duct is dampered so that a division of the service may be made between the two fans as desired.

Reference to Fig. 5, a sectional elevation through the boiler room, will show that the furnace has been made large to burn the Indiana coal used in the plant. The bottom of the front tube header is twelve feet above the floor. The volume of the furnace is approximately 900 cu.ft. As the equivalent grate area of each underfeed stoker is practically 100 sq.ft., the furnace volume per square foot of grate area reduces to 9 cu.ft. Assuming that 50 lb. of coal will be burned normally per square foot of grate per hour, the furnace volume becomes 0.18 cu.ft. per pound of coal burned. This allowance is no more than is needed for the high-volatile coals of the Central West, particularly when the boilers are to be operated above rating as is the intention at this plant.

An innovation has been made in the baffling, which is of the horizontal type. The lower row of tile originally placed on the third row of tubes has been raised to the eleventh row and the opening at the top baffle changed end for end, the final passage of gases being along the drum to the outlet. With this arrangement benefit is obtained of the direct radiation from the fire.

In Fig. 6 are shown a plan view and front elevation of the smoke flue, or breaching, which is made of steel covered on the outside, and it is of tapering section as it proceeds toward the stack. It will be seen that there is a breaching on either side, serving each row of boilers and discharging into a brick stack 10 ft. in diameter at the top and 200 ft. high. The breaching is rectangular in section and at the stack has an opening of 81 sq.ft. as compared to 78 sq.ft. for the stack, the latter being designed to serve the six boilers that eventually will be located on one side of the present firing aisle, or five boilers to each of four stacks when the extension is constructed.

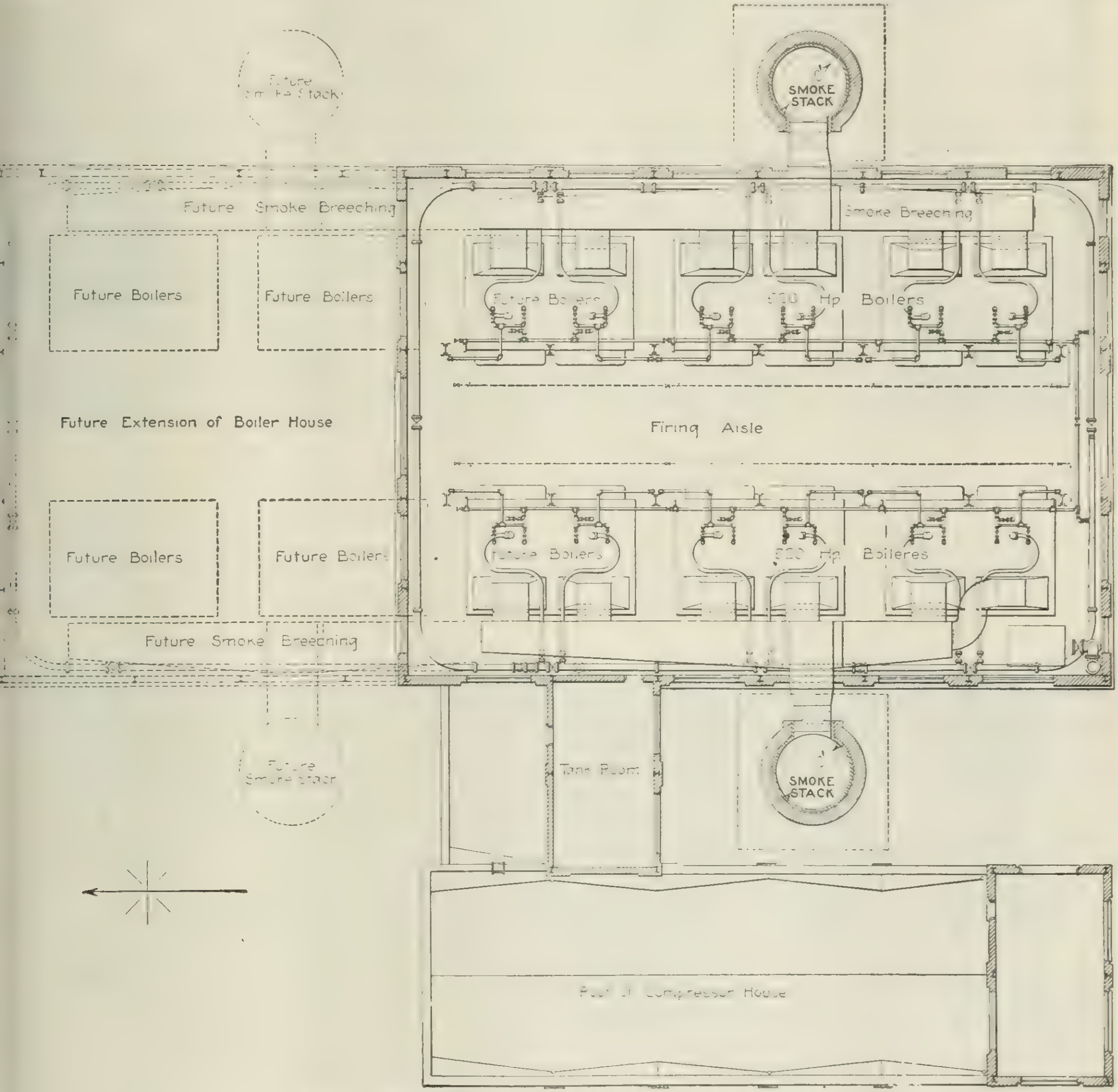


FIG. 2. GENERAL PLAN OF THE NEW BOILER HOUSE

Reviewing boiler dimensions, it will be found that per hundred square foot of steam-making surface, an allowance has been made of 2 sq.ft. of equivalent grate area and 0.26 sq.ft. of flue cross-section, 0.25 sq.ft. of stack area; and reversing the viewpoint, 7.64 sq.ft. of equivalent grate area per square foot of stack.

Each boiler has an individual damper, and there is a stack damper as well. There is a flow meter for each unit, with the indicating dial on the boiler front and the integrating and recording meter in the chief engineer's office. Draft gages show the draft at the uptake and over the fires. The boiler equipment also includes the usual pressure gages, water columns, return valves, mechanical soot blowers, etc.

The plant has two sources of boiler feed water—deep wells on the premises and the city supply, which also comes from wells near the St. Joseph River. The water is hard and contains a great deal of encrusting solids, particularly calcium carbonate. To eliminate this scale-forming matter, two water-softening units have been provided. These are on either side of the coal-conveyor tower. The water is softened by the cold process, and lime and soda ash are the chemicals used. The water contains on the average about 24 grains of scale-forming matter per U. S. gallon and this in the softeners is reduced to, at the most, 6 grains per gallon. From the softeners the water flows under float con-

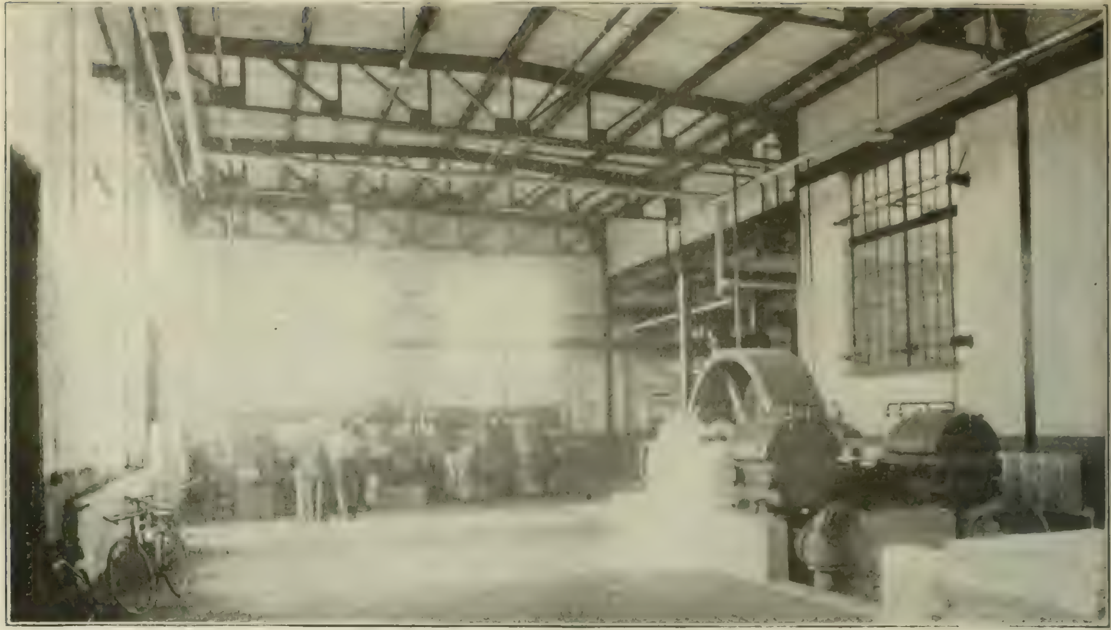


FIG. 3 THE THREE SYNCHRONOUS MOTOR-DRIVEN AIR COMPRESSOR UNITS

trol into a large receiving tank, which also receives the returns from the heating system. During the summer the softeners must work to capacity, as the return water is negligible, but in the colder months they are required to supply only the makeup, amounting to approximately 15 per cent of the boiler-feed water. Water from the receiving tank is elevated to a 6,000-hp. open feed-water heater by either of two turbine-driven centrifugal pumps. Turbine-driven boiler-feed pumps take their suction from the heater

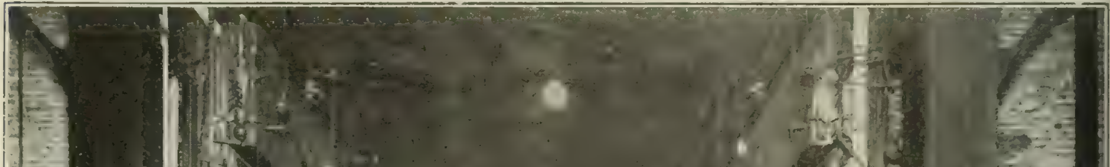


FIG. 4 CENTRAL FIRING AISLE OF THE BOILER ROOM

and force the water to the boilers through a loop feed line. In each leg there is a venturi metering nozzle so that the water may be measured irrespective of the path it takes to the boilers. Provision has been made also to feed the boilers through the blowoff if it becomes desirable due to a mishap to the usual feed-water inlet.

Coal comes to the plant in railway cars and may be unloaded to ground storage by a locomotive crane or directly into a track hopper discharging on an inclined apron conveyor which delivers the coal through a single-roll crusher to a continuous bucket conveyor arranged at right angles to the firing aisle. The coal is trans-

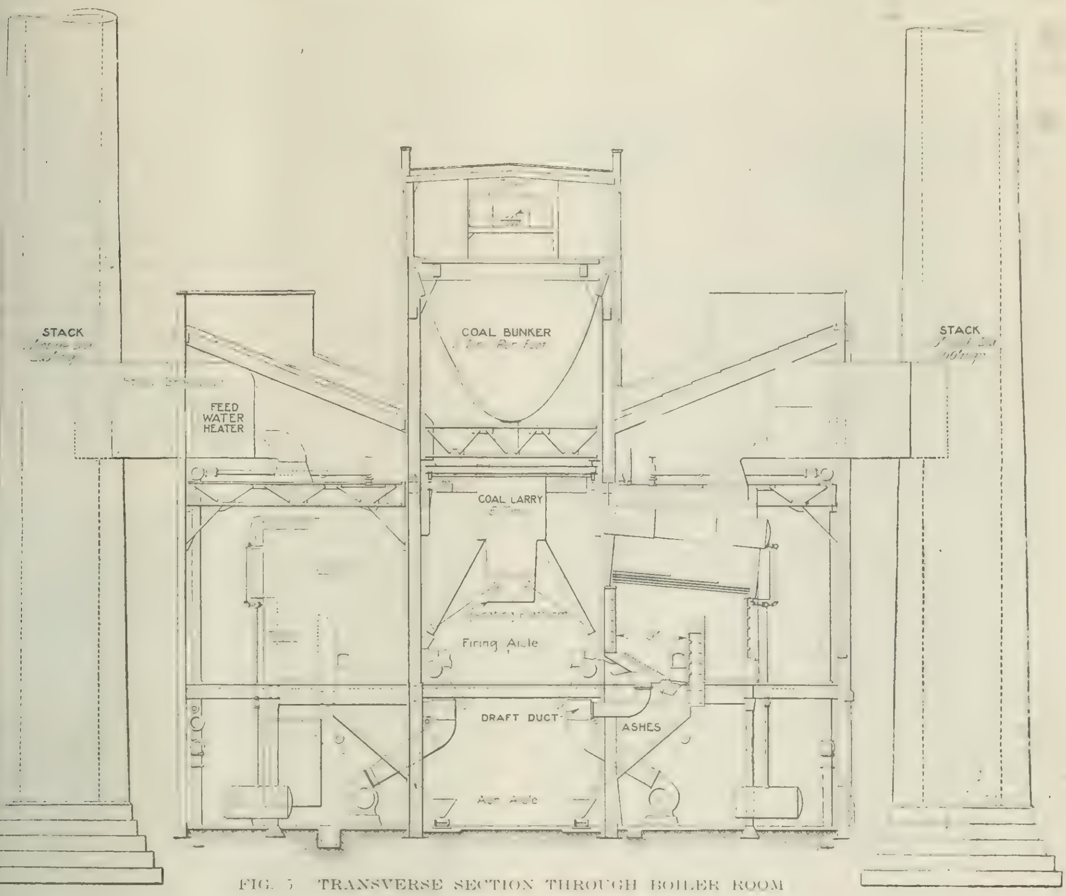


FIG. 5 TRANSVERSE SECTION THROUGH BOILER ROOM

PRINCIPAL EQUIPMENT OF NEW STUDEBAKER BOILER HOUSE

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Water-tube	520 hp	Generate steam	175 lb. pressure, 75 deg. superheat	Heine
3	Stokers	Underfeed	Six-retort	Serve boilers	Engine-driven through lineshaft	Taylor
4	Fans	Pressure	....	Forced draft	Driven by Terry turbines	American Blower Co
2	Stacks	Radial-brick	10-ft. diam., 200 ft. high	Serve boilers		Custodis
1	Weigh larry	Traveling	5-ton..............	Weigh coal	Motor-driven. ...	Beaumont
1	Bunker	Parabolic	1,100 tons...........	Coal reserve for boilers..........	Steel concrete-lined	Palmer-Be
1	Crane.........	Locomotive...	16-ton, 15-ft. radius	Handle coal in storage yard		Brownhoist
1	Conveyor	Apron	24-in	Coal from track hopper to crusher	Motor-driven	Jeffrey
1	Coal crusher...	Single-roll.......	40 tons per hr	Crush stoker coal	Motor-driven	Jeffrey
1	Conveyor.....	Continous-bucket.	40 tons per hr	Elevate coal	Motor-driven	Jeffrey
1	Conveyor	Belt	18-in	Distribute coal to bunker	Motor-driven	Jeffrey & Palmer-Be
2	Cans	Industrial	18-cu.ft	Remove ashes		Beaumont
1	Hoist	Skip	2-yd	Elevate ashes to overhead tank	Motor-driven...........	Beaumont
3	Pumps	Centrifugal	400-g.p.m	Boiler-feed	Turbine-driven, 578-ft. head, 3000 r.p.m....................	Alberger
2	Pumps	Centrifugal	750-g.p.m	Feed water from [illegible]	Turbine-driven, 2700 r.p.m	De Laval
1	Pump.. . .	Centrifugal	250-g p.m	Domestic hot water	Driven by Lincoln motor, 15 hp., 1750 r.p.m.....................	Alberger
1	Heater	Open	6,000-hp	Heat feed water		Cochrane
2	Air compressors	Simple	22x20-in.	Compressed air for shops	40-lb. G. E. syn. motor driven 220-hp., 600 r.p.m..............	Ingersoll-Rand
1	Air compressor	Compound	22x14x16 in	Compressed air for shops	100 lb. Westinghouse syn. motor, 264 hp., 225 r.p.m..................	Ingersoll-Rand
1	Air compressor.	Compound	25x15¾x18-in	Compressed air for shops	100 lb. Elect. Mach. Co. Syn. Motor, 234 hp., 200 r.p.m........	Ingersoll-Rand
2	Water softeners	Cold-process	6,000 gal. per hr	Soften feed water	24 grains per U.S. gal. to 6 gr	Dodge

Crane Steam Valves, Crane Water Valves, Cadman Everlasting Blowoff Valves, Kelley & Jones Return Valves, Bayer Soot Blowers, Hays Draft Gages, Republic Steam Flow Meters, Builder's Iron Foundry Venturi Meters, Ashcroft Steam Gages, Corliss Steam Traps, Ashton Safety Valves.

ferred to a belt conveyor running the full length of the firing aisle and discharging into an overhead steel bunker having a capacity of about 1,100 tons, or 11 tons per foot of length. The bunker is a parabolic design and is made of steel lined with concrete. From it the coal is delivered to a traveling weigh larry of 5-ton capacity, and it is discharged to the stoker hoppers as required. The larry is motor-driven, as are the coal conveyors previously mentioned, the capacity of the conveying equipment being 40 tons of coal per hour.

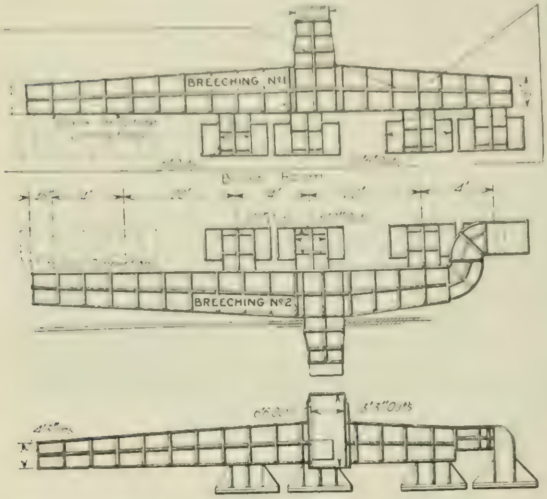


FIG. 6. PLAN AND FRONT ELEVATION OF COVERED STEEL SMOKE BREECHING

In addition to the coal supply the fuel-oil distribution system makes it convenient to burn oil under the boilers. Underground concrete tanks furnish storage for approximately 1,000,000 gal. of oil, which is constantly forced through a circulating system under 40 lb. pressure, by steam pumps located in an aisle between the tanks. The tanks are provided with steam coils which aid in keeping the oil fluid. During a recent coal shortage four oil-burning nozzles using steam as the atomizing force were installed in each boiler and the boilers carried their usual overloads. The nozzles were installed at the boiler front, the sloping stoker face was covered with a checkerwork of firebrick, and a target at right angles to the flame was laid against the bridge wall. The boiler furnace became incandescent and proper combustion of the fuel in the furnace resulted.

Ashes from the stokers are dropped through power dump plates into a pit with a sloping bottom, so that the contents will slide readily into an industrial car, which travels on a track leading outside of the boiler-room basement to a skip hoist. The latter elevates the ashes into a steel tank placed over one of the numerous side tracks for delivery to railway cars. The basement being at ground level makes such a plan feasible.

For its capacity the plant is thus well equipped with labor-saving devices and is of thoroughly modern design. Those responsible for its operation are: G. H. Ahlborn, superintendent of power, and R. G. Kroft, chief operating engineer.

Smith Mechanical Gas Producer

A new type of gas producer in which the fuel is distributed mechanically over the bed and the poking done automatically in preference to hand manipulation, has been developed by the Smith Gas Engineering Co., of Dayton, Ohio. From coal of widely varying composition and firing characteristics, it is designed to produce clear cold gas of constant quality so desirable for gas-engine use or for distribution through a system of piping for industrial heating purposes. The basic essentials that have been observed in the new design are a deep fuel bed 4 ft. to 5 ft. thick, uniform distribution of air to the fuel bed, constant proportions of air and steam in the blast under all conditions of load, moderate rate of gasification to avoid clinker, viscous tar or lampblack, and ease of inspection and manipulation without the escape of obnoxious gases.

In a producer the combustion zone ordinarily extends about 18 in. into the fuel bed. The temperature of the gas leaving this zone is obviously that of the zone itself, but if the fuel bed is 5 ft. deep, as is the usual practice in the producer under discussion, the hot gases must pass through 3½ ft. of descending fuel and give up a considerable portion of their heat to the coal. At the top of the producer the gas is cooler, and when fresh coal is distributed over the top of the bed, it is not exposed immediately to the higher temperature of the fire. The coal is thus distilled slowly, avoiding the production of viscous tar and lampblack; besides, the heated coal above the combustion zone provides a reservoir of heat that may be quickly gasified to take care of overloads and insure an uninterrupted flow of gas.

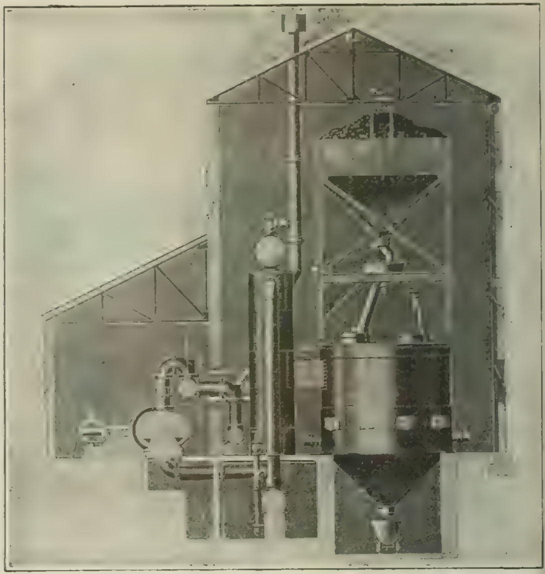


FIG. 1. NEW DESIGN OF SMITH GAS-PRODUCER PLANT DESIGNATED AS TYPE G

Reference to Fig. 2 will show that the fuel bed is supported on cast-iron grates which are manipulated by steam pressure when it is desired to clean the fire. The entire cross-section of the bed is exposed to the action of the air and water vapor mixture and the bed is of uniform thickness, so that no greater resistance to draft passage is offered at one point than at any other.

To secure at all loads a constant proportion of water vapor in the air drawn into the generator, the draft is held constant and the air, by thermostatic regulation, is maintained at the temperature at which it will take up the desired amount of water vapor.

One of the essentials of a successful producer is a moderate rate of gasification. This is accomplished by providing ample grate area. It is impossible to secure continuous operation where hard driving is necessary, because rapid firing means high temperatures, which in turn result in clinker troubles and shutdowns.

Operating the producer under suction permits inspection and manipulation without exposing the operators to the dangers of poisonous gases. The gates and ashpit can be inspected by opening the doors provided for the purpose, and the top of the fuel bed can be seen by opening peek-holes in the generator top without permitting the escape of gases. If the ashpit doors are open for any length of time while the producer is under load, the pressure of the incoming air can be balanced by the use of a steam jet or power-operated blower attached to the saturator inlet. This insures saturation of the air, and the same gas-making conditions are maintained during the grate-cleaning period as in normal operation.

Earlier types of Smith gas producers were square or rectangular in cross-section, and increased capacity was obtained by the addition of similar units. Reference to Fig. 1 will show that the new type is circular, the change being brought about to make possible the mechanical charging and poking of the fuel. The producer top is supported by structural-steel framing and is suspended from a roller bearing to minimize the friction from rotation. A water seal is provided around the top of the producer shell, and sway rollers are spaced around the periphery of the rotating element to take care of unbalanced loading.

In the top two rotating turrets eccentrically located with respect to the generator axis have been provided. Within one of these turrets is mounted a steam-operated poker, while the other turret contains a fuel-distributing device including arrangements for feeding the coal in varying quantities and for dropping it uniformly over the fuel bed. The poker cylinder is also placed eccentrically on the turret and at an angle slightly off the prependicular. When the poker is extended and in the "out" position it will reach the generator lining, and in the "in" position, the center of the fire.

A small steam engine mounted on the generator serves to rotate the top, the charging turret and the poker turret, the motion being effected intermittently by means of ratches devices. During the "out" stroke of the turning engine, pawls for moving the top and the poker turret engage, causing these two rotating parts to advance. On the "in" stroke of the engine these parts are at rest and the charging turret advances. While the poker turret and the top are at rest, steam is admitted automatically to the poker cylinder and the poker itself is forced down into the fuel bed and withdrawn in much the same manner as a man would poke the fire by hand. The cycle is repeated in regular and continuous order. The speed of the poking operation, however, is under the control of the operator, as he can vary the speed of the engine which rotates the top and can engage or disengage the poker and charging turret at will.

The cleaning and cooling apparatus supplied with the new producer are of standard design. Upon leaving the generator the gas is conducted through a brick-lined downcomer to a primary cooler of the static type, where its temperature is reduced to that most suitable for the efficient operation of the tar extractors. The gas then passes to a low-pressure main, from which it is discharged to the inlet of the gas pump. The latter is of the positive type, designed to operate under a maximum pressure of 5 lb. per square inch. The gas is then delivered by the pump under sufficient pressure to overcome the resistance of the tar extractors and the friction in the line. Power for operating the pump is furnished by a direct-connected steam engine controlled by a governor automatically adjusted to vary the speed of the pump to meet the demand for gas, so that no holder or gas storage is required.

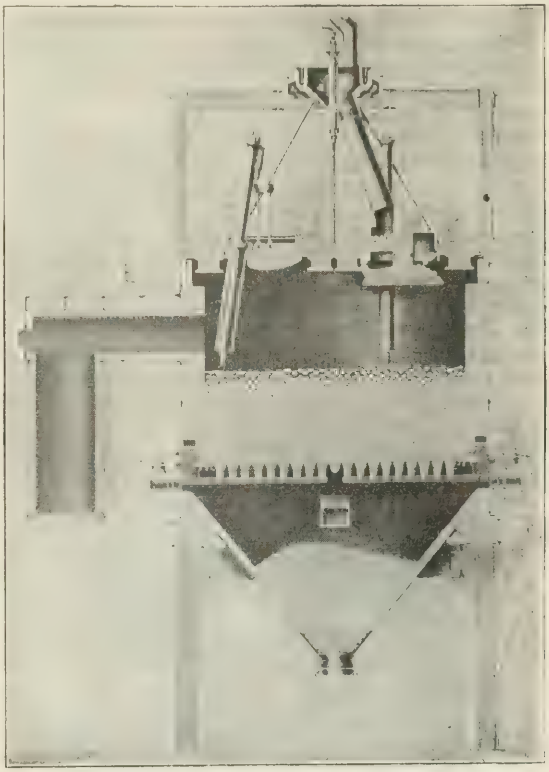


FIG. 2. CROSS-SECTION OF TYPE G GENERATOR, SHOWING THE AUTOMATIC STOKING AND POKING EQUIPMENT

The tar extractors are of the familiar spun-glass type, and a suitable number are provided with each producer to permit replacing diaphragms without interfering with operation. The tar is dropped from the gas main immediately beyond the extractors. The gas passes on through a secondary cooler of the static type, which is designed to reduce the gas temperature to that of the atmosphere.

At present the new producer is made in three sizes, the generators being 9, 14 and 16 ft. in diameter with capacities to gasify 800, 1,600 and 3,000 lb. of coal per hour, respectively.

Maintenance of Carbon Circuit Breakers

Action of Circuit Breaker When Opening—Care of Contacts an Important Feature in Satisfactory Operation—Causes of Heating and How To Prevent It—Care of Attachments and Other Features in Circuit-Breaker Maintenance

By W. M. AUSTIN
Supply Engineer, Westinghouse Electric and Manufacturing Company

THE maintenance of carbon-break circuit breakers can broadly be divided into two main divisions: namely, keeping the breaker in condition to open the circuit without material damage to itself under the predetermined conditions of opening, and keeping it in condition to carry its rated load without more than the standard allowable temperature rise.

In all modern carbon circuit breakers there is a main brush or other form of moving contact, and one or more other contacts whose function is to carry the current for a very short time after the main moving contact separates from the main stationary contact. An arc, therefore, will not be drawn between the main brush and the stationary contact, and the brush will not be damaged and will be able to carry the rated load successfully when the circuit breaker is again closed. Some breakers have, in addition to the main contacts, secondary contacts, tertiary contacts and final carbon contacts, between which the arc is broken. *T*, *S* and *M*, Fig. 1, show respectively the carbon secondary and main contacts. The diagram, Fig. 3, shows the shape and relative position of each of the contacts for a breaker of large ampere capacity in the three important stages of breaking the circuit as follows:

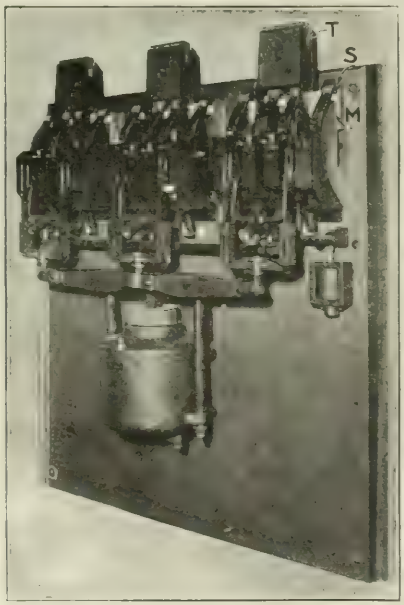


FIG. 1. ELECTRICALLY OPERATED THREE-POLE, 12,000-AMPERE CARBON CIRCUIT BREAKER

1. Contacts outlined by dotted lines show main brush opened, secondary contact on point of opening, and tertiary and carbon contacts not changed from closed position.

2. Contacts indicated by double shading show main and secondary contacts open, tertiary and carbon contacts still closed, but one set of contacts has slid down on the other set.

3. Contacts shown by single shading indicate the tertiary contact open and carbon tips about to finally break the circuit.

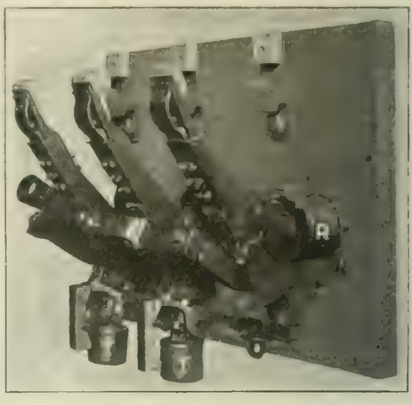


FIG. 2. THREE-POLE BREAKER WITH INVERSE-TIME ELEMENT AND UNDERVOLTAGE RELEASE

These contacts, as they open successively, increase the resistance in the circuit and to a certain extent limit the value of the current at the time the carbon contacts open. However, if the resistance in the contacts is too large when the brush opens, the brush will draw an arc and the resulting scars will lessen the ability of the brush to carry full load thereafter.

When breaking any considerable current, there is always an arc between the carbons, and when the carbons are so roughened and burned that the contact resistance is very high, there will be an arc between the tertiary contacts. When the arcing on the tertiary contacts has taken place enough times, the contact resistance has become high enough to cause arcing on the secondary contacts when they open. If secondary contacts become sufficiently roughened by the arc, the brush and main stationary contacts will begin to arc when the breaker opens. It is therefore necessary, in order to keep the breaker in condition to carry its rated load without getting too hot, to keep the parts of the breaker that are used to open the circuit in good condition also.

Whenever the secondary or the tertiary contacts become rough, the breaker should be opened at the first opportunity and the contacts filed until they make a good contact. If the carbons are burned so that the contact area is materially lessened, they should be dressed to make as good contact as is possible. If they are broken or very badly burned so that they cannot be put in good condition, new carbons should be installed.

Likewise new secondary and new tertiary contacts should be put on when they are worn or burned out.

Properly designed and installed breakers will carry their rated amperes without overheating as long as the contact resistance between the main moving (brush) and stationary contacts remains normal, unless some other electrical connection is defective. One cause of overheating of circuit breakers is the use of insufficient lead capacity or the use of a hot ammeter shunt too near the breaker. Another cause of overheating is defective contact between parts of the conducting material other than the main (brush) contact; for example, nuts clamping terminals or busbars to the studs may have poor contact with the studs or with the terminals or busbars. This poor contact may be due to insufficient contact pressure, insufficient contact area, or oxidized or corroded contact surfaces. If the contact pressure is not enough, it is obvious that tightening the nuts is the remedy. Insufficient contact area may be due to untrue surfaces on the nuts, studs or busbars or terminals, or too small or too few nuts. Contact surfaces that were true when made may become untrue by being battered, raising high spots on the surfaces. When the amount of battering is small and the surface is plain, the best way is to carefully file off the high spots; if the injury is serious, it is best to machine the surface. Where the threads on the studs are battered, they can usually be partly restored by filing away the high spots with a small three-cornered file.

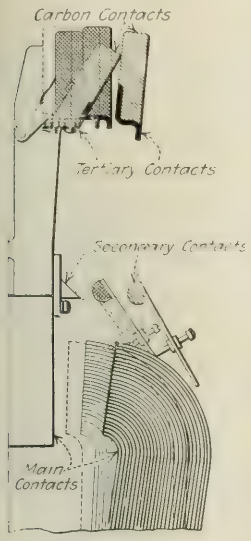


FIG. 3. CONTACTS FOR CIRCUIT BREAKER FIG. 1

Oxidized and corroded surfaces of threads on studs and nuts may be cleaned by rubbing with a brush, a piece of cloth, or waste dipped in a mixture of water and powdered pumice stone, or some other finely ground scouring material.

Overheating may be due to a defective soldered joint. It often happens that a soldered joint that was good when made has been partly broken by too great a mechanical load on the joint, the heat then developed has melted the solder, causing it to run out. A soldered joint may be spoiled similarly by an overload, causing the solder to melt and part of it to run, rendering the joint incapable of carrying its rated load thereafter.

The most frequent cause of overheating of carbon circuit breakers is bad contact between the main moving and stationary contacts. Poor contact on the main (brush) contacts may be due to any or all of the three causes; that is, insufficient pressure, insufficient area in contact and oxidized, corroded or dirty surfaces. Any carbon circuit breaker, if allowed to stand without attention, will heat up when loaded, owing to oxidation. It should be opened occasionally and its contact surfaces cleaned; if this cannot be done, it should be applied very conservatively. If the brush has insufficient contact pressure, adjustments should be made to secure the required pressure. If the whole or nearly the whole contact area of the brush does not touch the opposing contact, it will be necessary to refit the brush with a file or otherwise, so that it makes contact as intended.

A good way to determine whether the brush and opposed contacts are touching each other is to mark the brush with a soft pencil and then close the breaker with a piece of thin paper between the main contacts. If the whole area is making contact, every lamination of the brush will make an impression on the paper. If there are spots where the brush does not touch the stationary contact, blank spaces will show on the paper.

If the contact surfaces are oxidized or corroded, they should be cleaned with fine sandpaper. A good way to hold the sandpaper is to tack it to pieces of hardwood as shown in the upper sketch of Fig. 4. Dirty contact surfaces can be cleaned readily by the use of alcohol, gasoline, ammonia, water and soap, or other solvents.

It is important to note that breakers with semi-eliptic brushes usually give more trouble with the contact between the brush and bottom stud than they do between the brush and top stud. This is due to the fact that in most cases the bottom end of the brush and the contact surfaces of the bottom stud are not as accessible as the top stud and the top end of the brush, resulting in more or less neglect of the bottom contact. The lower sandpaper holder, Fig. 4, is made especially for use on the lower stud and lower end of the brush, where it can be reached only from above.

Transferring Circuit Breakers

A prolific source of trouble with carbon circuit breakers is the transfer of the breaker from the base on which it was mounted in the factory to a panel of a switchboard. Most carbon circuit breakers depend on the base to hold some of the parts in proper relation to each other. The bolt holes in the panel are usually one-sixteenth to one-eighth inch larger than the bolts so as to enable the various parts to be shifted slightly to bring them in line with each other. Any good mechanic ought to have no difficulty in transferring a breaker from one panel to another, but if he has never done a similar job before, he will have to exercise much care until he has become familiar with the apparatus so that the moving parts will be free and the brush and other contacts properly adjusted.

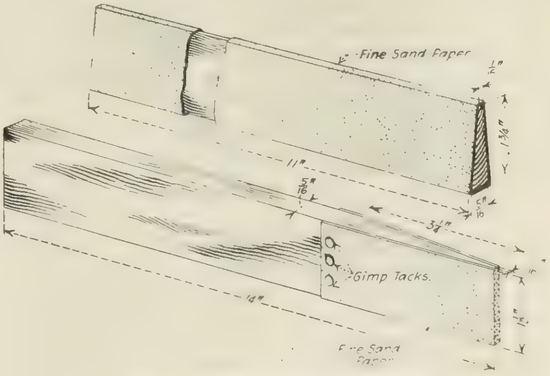


FIG. 4. SANDPAPER HOLDER

Circuit breakers are usually provided with an overload trip, and often with a shunt trip, an undervoltage trip, an underload trip, a reverse-current trip, or an inverse-time-limit overload trip. Some circuit breakers are also provided with a closing coil.

Undervoltage trip coils and the shunt coils for the reverse-current trip are subjected to their rated voltage continuously. When this voltage is large, the coils are sometimes protected by an external resistance. The use of an external resistance permits winding the coil with larger wire, making it stronger and more durable.

Undervoltage coils and reverse-current shunt coils (with their resistances when used) are designed to withstand a definite line voltage. If they are subjected to a voltage much in excess of the rated voltage, they will finally attain a temperature which will destroy the insulation of the coil.

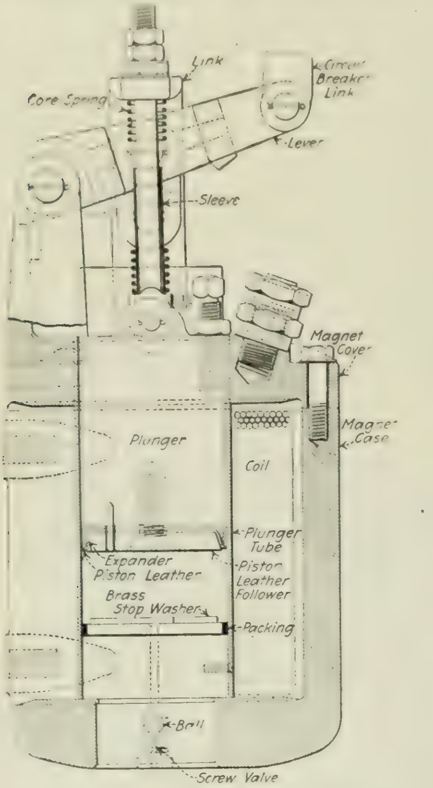


FIG. 5. CLOSING MAGNET WITH AIR DASHPOT

Alternating-current undervoltage coils usually are connected so that voltage is removed from the coil when the circuit breaker opens. Where alternating-current undervoltage coils remain in circuit after the breaker opens, a means of retrieving the armature to its closed position by the opening of the breaker is provided, as explained in the article, "Circuit-Breakers—Principle of Operation," by Victor H. Todd in the Oct. 5 issue. This prevents undue current flowing through the coil owing to open magnetic circuit and consequent overheating. Careful inspection should be made to see that complete retrieving is obtained.

Shunt-trip coils and closing coils are subjected to the voltage of the control circuit only during the time of opening and closing of the breaker. If the breaker is closed and tripped a good many times in a short period, excessive heating of the coils may result. Voltage must not be kept on such coils continuously.

Closing coils are usually designed to close the circuit breaker between certain maximum and minimum voltages. These limits are usually as wide apart as it is reliable and safe to operate. If the voltage is lower than the minimum, the circuit breaker is liable not to close; and if it is above the maximum, it is liable to cause damage to the breaker on account of the excessive speed of closing. Especially, it is liable to break the carbons.

When figuring the actual control voltage that will exist at a breaker, account must be taken of the drop in the control wires. The range of voltage marked on the nameplate means the voltage at the coil terminals, therefore the control-bus voltage must be selected with this in view.

In order to stop the breaker at the end of the opening stroke, a friction spring device and buffer are sometimes provided. To be effective, the friction buffer should be so adjusted as to give sufficient pressure between the surfaces to retard the break so that it will not bound back or hit too hard at the end of the opening movement. On electrically operated breakers care must be taken not to have too much friction or the breaker will fail to close on the minimum operating voltage.

DASHPOTS USED ON SOME BREAKERS

On some heavy electrically operated breakers, dashpots are used to lessen the shock due to closing on the higher part of the control range (See Figs. 1 and 5). Such dashpots usually have adjustable valves. The valve should be set to give best operation at the control voltage used on each particular breaker. Regular inspection should be made and the piston leather kept oiled and clean and the valve passages free from dirt. Before being put in operation, this whole piston and valve mechanism requires inspecting to see that no dirt or refuse from packing has accumulated and that all parts are free from rust, etc.

"Inverse-time-limit" tripping is usually accomplished by attaching some kind of dashpot to the moving element of the tripping magnet such as at *T*, Fig. 2. Two kinds of dashpots have been used for this purpose. In the piston dashpot, Fig. 6, a piston is arranged so as to move slowly for some distance against the resistance of the working fluid, then the fluid ceases to offer resistance and the remainder of the movement is very rapid, tripping the breaker at or near the end of the movement. The action of such a dashpot usually is varied by the adjustment of a pin valve. The sucker disc dashpot, Fig. 7, consists of two surfaces in intimate contact, the contact surfaces being immersed in oil or other viscous fluid. One of these surfaces is movable and is attached to the moving element of the trip magnet. Unless the pull of the trip magnet is as great as or greater than the product of the atmospheric pressure in pounds per square inch, and the area of contact in square inches between the contact surfaces, the moving member will be held without appreciable movement until the oil or other fluid can flow between the surfaces, the time required to separate the surfaces varying approximately inversely as the pull and directly as the viscosity of the oil. If the time limit is too short, it can be lengthened by using a more viscous oil.

To keep the inverse-time limit in good working order, it is necessary that the oil be kept clean. A single particle of dirt between the two surfaces of the sucker dashpot will sometimes reduce the time nearly to zero.

The engaging surfaces must be protected so that no high spots appear on either surface. If imperfections appear in the surface due to bruising or other cause, all high spots should be removed with a scraper. Experience has shown that satisfactory operation can be had with the oil one-quarter inch deep above the stationary surface.

With defective adjustments it may happen that when the moving element of the overload, reverse-current, or shunt-trip magnets moves to trip the breaker, the breaker fails to open. One reason for this happening is that the moving element strikes the latch too early in its movement; that is, before it has accumulated enough energy to open the latch. In cases like this, adjustments should be made so that the latch is freed just before the moving element of the magnet strikes the stationary element.

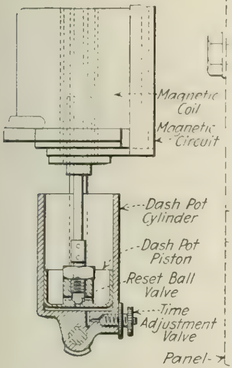


FIG. 6. PISTON DASHPOT

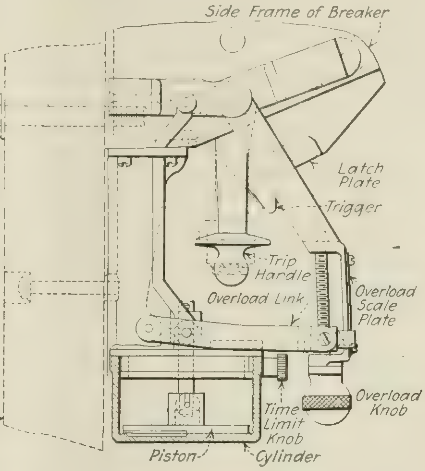


FIG. 7. SUCKER DASHPOT

Any circuit breaker has a little oil put on each pin or shaft when it is being assembled. In time this oil works out. Before the bearing becomes dry, one or more drops of oil should be applied and worked into the bearings. All excess oil should be thoroughly wiped off so as to prevent the accumulation of dust or dirt. If this oiling is done regularly, there will be no danger of the breaker failing to open when it is unlatched by the trip magnet or by hand.

Determination of the Radiation Correction of a Throttling Calorimeter

By Ralph I. Alexander

Whenever a throttling calorimeter is used to determine the quality of steam, the fact must not be forgotten that a certain amount of the heat content of the steam is dissipated to the surrounding air. This radiation often introduces a considerable error in the final determination of the quality, no matter how well the calorimeter may be protected by insulating felt or asbestos.

In order to make proper allowance for this error, the following method, after the late Professor Spangler, and used with various modifications since, has been found successful as applied to boiler tests. The sample pipe of the calorimeter should be placed between the boiler and the stop valve, never after the stop valve. At the conclusion of the boiler test the fires should be banked, firedoors left open and the top valve closed tight.

The result of these adjustments is to stop the boiler from steaming, but owing to stored heat in the setting and water, the pressure will be very slow to drop. During the first hour following the stopping of the test, the drop in pressure will be practically nil. Whatever steam is formed will be dry and saturated. It should be noted that while the stop valve has been closed the position of the calorimeter allows it to continue in operation, and it should be allowed to function for an hour after the completion of the boiler test. At the end of this time readings should be taken upon both thermometers of the calorimeter and also from the manometer, which is always used to give readings of steam pressure on the discharge side of the calorimeter.

No boiler test should be conducted without obtaining as a part of the data, readings from the barometer. This barometer reading added to the manometer reading as just determined. will give the absolute pressure in inches of mercury at the calorimeter discharge. If more convenient for use in the steam tables, this reading of inches of mercury may be transposed to read in pounds per square inch by multiplying by 0.491. With this reading and the temperature of the steam discharging from the instrument, the steam tables may be consulted to determine the total heat content of the steam at this point in the calorimeter. It will of course be necessary to find this reading of heat content in a table for superheated steam.

The reading of the steam pressure in the boiler is found by noting the pressure on the steam gage. The pressure gage should be calibrated, in order that the true reading may be known. Because under the conditions of the test the steam in the boiler is dry, again consulting the steam tables (saturated steam tables), the total heat for the given gage pressure will be found.

The basic principle on which the throttling calorimeter depends for its success is that there is no heat loss due to the passage of steam through the orifice plate. Therefore the two total heat values, as previously determined, should be equal. It will be found by comparison that such is not the case, and the difference in the two results is the radiation loss of the calorimeter. It will amount to several B.t.u., depending upon how well the calorimeter is insulated. This correction should now be added to the total heat content of the steam discharging from the instrument as previously determined during the boiler test. The solution for the quality of the steam may then be determined from the formula

$$x = \frac{(i + R - q)}{r}$$

in which

x = Quality of steam (unknown);
i = Total heat of the superheated steam on the discharge side of the calorimeter in B.t.u.;
R = Radiation correction, or loss of the calorimeter expressed in B.t.u.;
q = Heat of the liquid of the boiler steam expressed in B.t.u.;
r = Heat of vaporization of the boiler steam expressed in B.t.u.

It may be added that the reason for using two thermometers, one on each side of the throttle plate, is to determine the proper correction of the temperature reading of the thermometer on the discharge side of the calorimeter. The error in this case is due to stem exposure. Both thermometers should preferably be of the same pattern, of the same length, and with the same scale. They should be placed in thermometer wells of equal depth. While the calorimeter is in operation, it will be noticed that the reading of the thermometer on the high-pressure side will record lower values than the temperature of saturated steam corresponding to the boiler pressure as indicated in the steam tables. Notice on both thermometers the height that the mercury stands above the top of the thermometer wells. If the thermometers are identical in type these measurements may be made as the number of degrees of exposed mercury as indicated by the scales of the thermometers. The error, as just determined, of the thermometer reading on the high-pressure side is multiplied by the ratio of the two measurements of stem exposure. The result will give the thermometer correction to be applied to the temperature reading from the discharge side of the instrument. The following example illustrates:

Temperature reading from high-pressure side of instrument, deg. F.	336.5
Steam pressure, absolute, lb.	116
Temperature of steam corresponding to pressure, deg. F.	338.7
Difference of temperature readings, deg. F.	2.2
Temperature reading on low-pressure side of instrument, deg. F.	348.3
*Stem exposure on high-pressure side of orifice plate (336.5-80) deg. F	256.5
*Stem exposure on low-pressure side of orifice plate (348.5-80) deg. F.	268.3
Error to be applied to thermometer reading on low-pressure side of orifice plate $\left(\frac{268.3}{256.5}\right)(2.2)$ = deg. F.	2.30
Correct reading of each thermometer, deg. F.	
High	338.7
Low	350.6

*The thermometers in this case were immersed in thermometer wells to the 80 deg. reading.

In any series of calorimeter readings it is always good practice to interchange thermometers after each reading, the object being to equalize the error when the readings are averaged at the end of the test.

Some Points About Dense-Air Refrigerating Machines

By W. D. Forbes

The use of what are known as chemical ice machines, such as ammonia and CO_2, is without any doubt the most economical means of obtaining ice or of chilling rooms artificially. The use of free air is well known to the students of refrigeration, but it is not well understood by many of them.

While the system of air as a refrigerating medium is more expensive, there are conditions where air is preferable to chemicals. The conditions may be broadly stated as where power is cheap, where water power is obtainable, where the plant is far from places where chemicals are produced, where the shutdown of an ice plant because of a lack of chemicals would be serious.

The theory of free air refrigeration is simple. It requires a compressor cylinder, an expander cylinder and power to work both. In the United States Navy the dense-air ice machine has been used for years. To explain how a machine of this character works, I will describe one of the most widely used of this class.

Standing at the cylinder end of the machine, a compressor cylinder is found mounted on a substantial bed at the right; on the left is the expander cylinder, while between them is a steam cylinder which furnishes the power.

At the far end of the bed is a single-throw crankshaft mounted in bearings supported in jaws cast with the bed. The crank is connected with the steam cylinder, and on the two overhung ends of the crankshaft are mounted two heavy flywheels, in which are the crankpins for the connecting rods of the compressor and expander cylinders. These flywheels have their connecting rods coupled in the usual way to the crossheads, only the compressor cylinder crosshead has its pin extended out right and left and to these two extensions are connected a water-circulating pump on the left and an air primer pump on the right. Above the bed, and supported on the two outside cylinders and brackets cast on the back of the main bearing supports, is a cooler in which is a copper cooling coil. Of course the ends of the cooler, which is a cylinder, are closed with heads. Two eccentrics are fitted on the crankshaft and they work two rocker shafts supported on the bed, and the rocker shafts in turn work the two main and the two cutoff valves of the compressor and expander cylinders as well as the single slide valve of the steam engine.

THE CYCLE OF OPERATION

The cycle of the machine is as follows: The steam engine turns the crankshaft, and its two flywheels actuate both compressor and expander cylinders. The compressed air, which has become heated by being compressed, passes from the valve chest through copper connections, to the copper cooler coil; water supplied by the water pump surrounds the coil. The hot compressed air, cooled somewhat, is then led through a moisture separator in the front end of the cooler head, on through a copper pipe back to the valve chest of the expander, and here, as it is of considerable pressure, it aids the steam engine in turning the machine.

The expanding of the compressed air, coupled with the work it has to do on the piston of the expander, results, of course, in a low temperature. The cold air is then led by pipes to an oil separator, which extracts most of the lubricating oil used in the cylinders. The cold air then passes on to an ice-making tank, which, however, is connected to the main line leading to the chillroom, so that it can be cut out when no ice is wanted. From the chillroom coils the cold air is returned to the valve chest of the compressor cylinder, thus completing the cycle, which is a closed one.

The primer pump resupplies any air that seeps out of the system. If the system could be kept absolutely tight, the primer pump would not be needed except in starting the machine. The primer-pump plunger is hollow, and at its front end several small inlet holes meet the bore; at the back end a foot valve is screwed into the plunger. This pump partakes of the same motion as that of the compressor piston and rod and pumps air into the system through a check valve whenever leakage occurs, thus automatically working only when needed. The primer-pump body is built into the compressor-cylinder casting, which is water-jacketed, the bore being made with a removable liner, and the same water pump furnishing the cooling water for the cooler keeps the jacket water moving; thus the primer-pump body is also cooled as well as the cylinder.

The piston of the compressor is provided with two cup-shaped leather packings, held in their places by two followers, the cupped packings looking away from each other. These packings are also used in the same way in the expander. Aboard ship it has been found more satisfactory to drop off the direct-connected water pump and connect the water-cooling system with the bilge or some other pump, for in southern regions the water being warm, a greater volume is required than can be obtained through the connected pump.

When the system is in working order, the gage of the compressor should show 270 lb., while the gage of the expander should show 60 lb., and this relation should be closely maintained if good work is expected.

In manufacturing the machines, the valves are set first by empirically determined positions, then indicators are used to set them finally. I suggest to anyone in charge of this air type of machine not to try to reset the valves without using indicators. The valves in the Allen machine are of the slide type. I made some experimental runs with valves of this type and then changed them for single-acting valves in the compressor, and found that the economy of the latter, as regards refrigeration, was just a little better than with the former, but the self-acting valves showed an economy of power.

SMALL AIR LEAK WILL IMPAIR EFFICIENCY

In running a dense-air machine, those in charge must closely care for the tightness of the system. A small air leak will run the efficiency of the system down, or if there is any bypassing of the air in the compressor or expander, the system will at once give trouble.

The oil used in the compressor should be one suited to withstand the heat of compression, while that used in the expander must withstand the cold, which can be and is often brought below zero F. I have seen a plant put out of action by having these two grades interchanged. Of course the bearings of the machines require oil of the usual character for such work. Both expander and compressor cylinders are oiled by special sight-feed oilers or cups, as are the piston rods and valve stems of both the cylinders. The oil for the piston rods feeds into an oil ring set about the middle of the metallic packing. Metallic packing is also used on the valve stems, which are furnished with oil rings.

When it comes to taking charge of an air ice plant, the things to look out for are at first perplexing, as a drop in pressure may occur from many causes. The first thing to do is to see if the primer-pump foot valve is working, also its check valve. The first may be listened for and the second also. If the check valve is not working, a few smart blows on its body will often start it; if the foot valve of the primer pump is not acting, it must be taken out, cleaned and perhaps ground. To do this the cap must be taken off the pump body, the forward nuts of the plunger cast adrift from the extension of the crosshead pin, and the plunger backed out. Care should be taken not to disturb the position of the two nuts on the reduced part of the plunger, as in returning it its end may strike the cap and wreck it or the foot valve. Grind the foot valve or check valve with ground glass; do not use emery.

To detect leaks, all joints, piston rods and valve stems must be soap-watered, the joints of the valve chests and cylinder covers not being overlooked. The pipe joints throughout must be gone over, not only at the machine, but at the ice tank, grease trap and chillroom.

The gaskets of the valve chest and cylinder heads are all metallic and are made up with litharge. To remove the pistons, a socket wrench is required and care must be taken not to shift the pistons' positions, as a head may be knocked out if they are not exactly replaced. It will be noticed in this machine that there is an adjustment provided for the pistons, and by slacking back on the capscrews in the crossheads the piston rods can be turned in the crossheads, and a wrench is provided to fit the squares milled on the piston rods for the purpose. The followers and bull rings are provided with small tapped holes into which rods are screwed to remove these parts easily.

To replace the leather packings of the pistons is an easy job, but care should be taken to have the hands clean, as a little grit on the leathers will scratch the polished surface of the bores and injure them. The leathers come cut to size and in neatsfoot oil, and all that has to be done is to form them up a little with the fingers and shave the edges nicely. After the pistons are made, the valve chests should be opened and the valve faces examined. The compressor valves give much trouble by cutting, and if the lubrication is not thorough, the faces of both valves and seats will cut in a few minutes. False seats are sometimes fitted in the valve chests and the surfaces of the main valve seat are awkward to reach and scrape, but the machine will not give proper refrigeration unless the valve seats are all in first-class condition. The main valves of the cylinders have crooked ports, and their passages are tested to see that the walls are solid, as sometimes these walls leak. If the machine does not keep up pressures or equalizes when all joints, valve seats and stuffing boxes are tight, the leaking or seeping of the dividing walls in cylinder or valves may be the cause of the trouble. To test out the main valves and cylinders, the passages must be blocked and water pressure applied.

PROPER RESETTING OF THE VALVES

To cast adrift the cutoff and main valves is a real job, and to return them to their original position, trams should be made. These trams are not furnished with the machines, but unless the valves are reset just as they were, it will take some time to run tests to properly reset them.

If the passages show spongy in their walls and therefore bypass the air, they can be rusted with salammoniac, and this will answer for a time.

The best way, however, is to use melted sulphur and to do this in the cylinders they have to be removed from the bed to tilt them so the sulphur will run where it is wanted. Before trying to run the sulphur, the metal must be heated as much as possible or the material will not enter the pores of the metal and only a surface joint will result; but if the metal is sound and hot, the joint will be permanent.

The copper cooling coil in the cooler becomes corroded after a while, but when this occurs the pressures run down so quickly that an observer will almost at once surmise the cause. When the trouble is located, there is nothing to do but replace the coil with a new one or patch up the old one temporarily by soldering.

In the design of this machine the placing of the cylinder of the steam engine between the two other cylinders is, in my opinion, a mistake from the economy standpoint, but it makes a compact machine. It is clear that a hot steam cylinder should not be put close to the cold expander cylinder, though it is heavily lagged; nor should heat be transmitted to a compressor cylinder. Again, the use of a system of slide valves in the compressor is ill-advised, and self-acting valves as tested by me clearly show that the great trouble with the cutting of the compressor slide valves would be done away with.

Steam-Heated Fuel-Oil Pipe Line in Underground Conduit

When P. Ballantine & Sons, of Newark, N. J., decided to construct a new boiler plant, the question of fuel came to the fore. This was during the period when soft coal was hard to obtain and of poor quality at that, and it was decided not only to equip the new boilers with mechanical stokers, but to provide for burning fuel oil as well. The new boiler house contains four 500-hp. water-tube boilers and space has been provided for the future installation of two more, making a total of 3,000 horsepower.

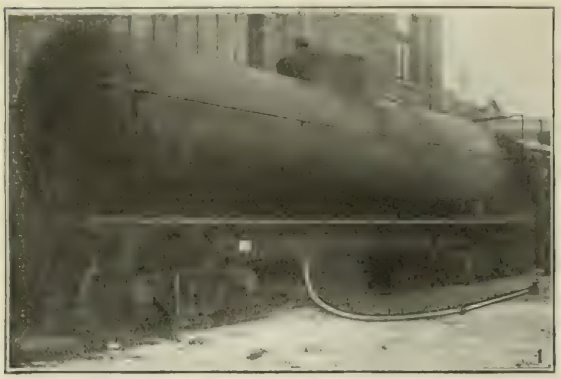


FIG. 1. TANK CARS BEING UNLOADED

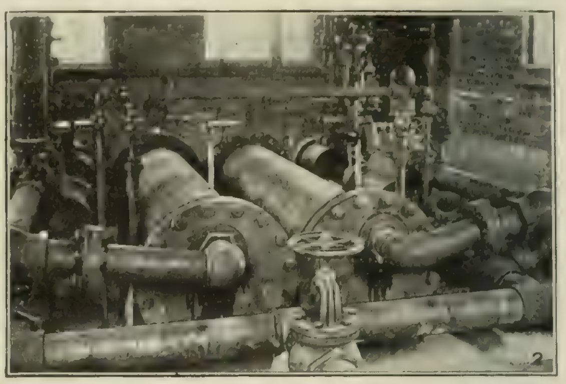
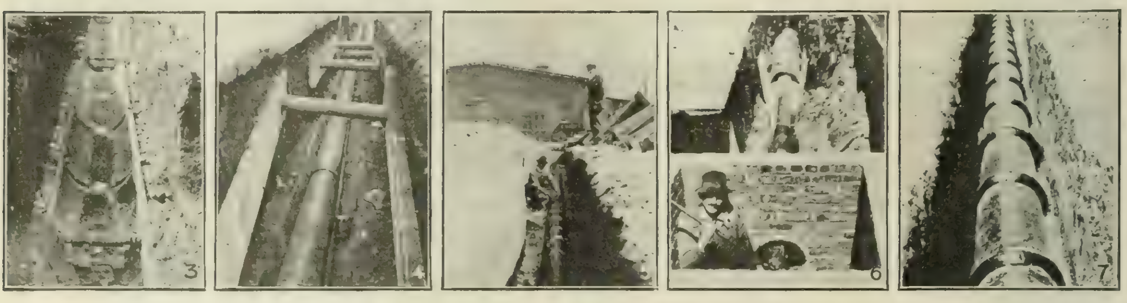


FIG. 2. FUEL-OIL PUMPS AND OIL HEATERS



FIGS. 3 TO 7. DETAILS OF PIPE CONDUIT LINE

Fig. 3—Bottom half of conduit and roll frame ready for piping. Fig. 4—Oil and steam pipe line on roll frame. Fig. 5—Applying sheet-metal jacket around oil and steam lines to act as a heating chamber. Fig. 6—Top of conduit being applied and conduit felting placed around the heating chamber. Fig. 7—Finished job showing cemented waterproofed bell joints.

In installing the proposed fuel-oil system, a 3,000,000-gal. storage tank was built close by a railroad siding and buried in the ground. The tank is made with four compartments, each 22 ft. 6 in. by 30 ft., and 15 ft. deep to the overflow; each compartment holds 77,269 gal. At one side of the tank is a pumphouse containing two duplex oil pumps, Fig. 2, so piped that one can pump from a tank car, Fig. 1, to the reservoir while the other is pumping from the reservoir to a small storage tank at the boiler house, or both can be used to pump from the tank cars, there being room for three cars to be placed for unloading at once.

In the new boiler house there are two similar pumps which pump from the small storage tank buried in the ground, just outside of the boiler house, to the oil burners. Each pump is supplied with an oil-heating tank containing coils through which the oil is forced in pumping, steam being admitted to the tanks to the outside of the coils. This heats the oil and makes it more convenient to handle through the pipe line and to the burners.

An interesting pipe-line installation between the main storage tank and the one at the boiler house has been made, consisting of the oil line and a steam line, Fig. 3, running together through a conduit, the two pipes being surrounded by a sheet-metal jacket, Fig. 5, to act as a heating chamber. Both pipes are placed in a J. M. conduit, and asbestos sponge fillings are placed around the heating chamber, which is between the sheet-metal jacket, as shown by Fig. 6, and the tile waterproofing covering, Fig. 7.

Expansion and contraction are taken care of by supporting the pipes on roll frames placed on 12-ft. centers, Fig. 3. These frames carry the pipes independently of the tile, and the insulation is the only weight resting on the tile.

So far as known this installation is the first of its kind; that is, it is the first time conduit has been put in use as a fuel-oil carrier. The pipe line is constructed under the sidewalk and manholes are provided at intervals.

Power Plants of the Morris & Essex Canal

By Hugh G. Boutell

To anyone interested in the historical side of engineering and similar work, some of the towns of northern New Jersey, situated only a short distance from New York City, contain many objects worthy of investigation. During a recent visit in that neighborhood I was particularly impressed with the elaborate works connected with the old Morris & Essex Canal. Much of this construction is naturally of the greatest interest to the civil engineer, but some of it will appeal to the mechanical man as well.

This canal was built during the period between 1824 and 1835, and connects tidewater at Jersey City with the Delaware River at Easton, Pa., about 102 miles away. The primary object of its construction was to furnish a cheap means of transportation from the Lehigh Valley region to New York City. The route selected gives to the canal a total rise and fall of 1,674 ft., since the summit level is 914 ft. above Jersey City and 760 ft. above Easton. To overcome this grade 23 inclined planes and 23 locks have been provided.

The locks present no features of particular interest, but the planes, to me at least, appear to be unique. Both single and double planes are used, depending on the location and, I suppose, the density of traffic, though this latter point is now hardly worth considering. The planes consist of a single or double line of rails, so arranged as to pass over the summit and dip into the water at the high level of the canal and into the low level at the bottom. On this track run two cars or cradles, constructed of heavy timbers. The cars are permanently coupled together and rest on a large number of small flanged wheels. The track is laid with rails of a long-ago obsolete cross-section, to a gage of about twelve feet. Each rail is carried by a heavy wooden stringer made fast to the roadbed. The cars are raised and lowered on the plane by a wire rope, about 2½ in. in diameter, supported by sheaves in the middle of the track.

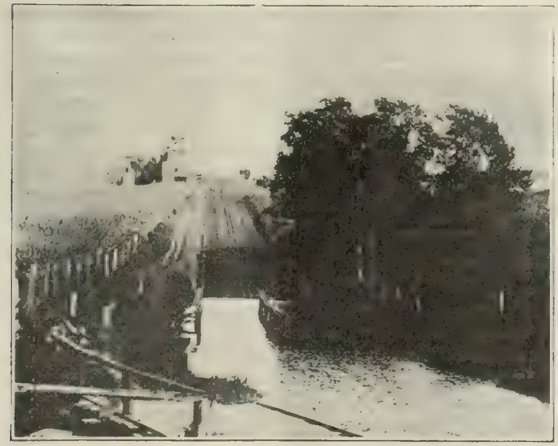


FIG. 1. VIEW LOOKING UP ONE OF THE DOUBLE PLANES

The cars on the left-hand track are in the water at the low level.

The "power plants" used for operating this hauling rope are most interesting. They are all more or less similar in construction and each one consists of a large drum, 12 ft. in diameter, over which the rope is wound, and which is driven by a vertical, low-head water turbine. This turbine runs, of course, always in one direction, but by means of a clutch controlled by the operator the motion of the winding drum may be reversed. Water for the turbine is conducted from the upper level of the canal by means of a rectangular wooden flume to a circular, vertical wooden pipe near the wheelhouse, where it drops to the pit in which the turbine is placed. After operating the turbine, the waste water flows into the lower level of the canal. Most of the machinery in connection with these planes, while not that originally used, was constructed prior to 1860, but it appears to be in good operative condition.

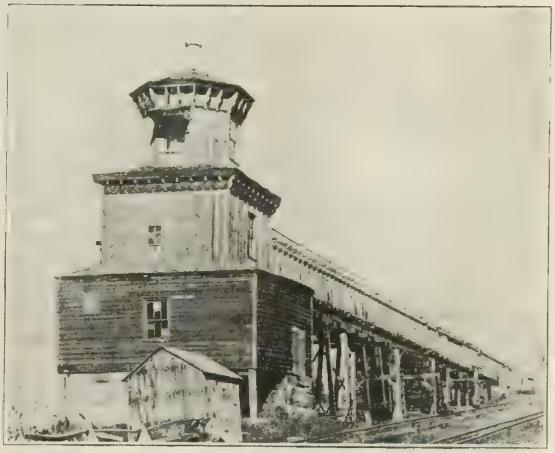


FIG. 2. VIEW OF PLANE, SHOWING WHEELHOUSE AND FLUME

The cars are controlled from the upper room.

The illustrations give a good idea of the appearance of one of these plants and the plane which it operates, near Easton, Pa. The long horizontal flume, the quaint old wheelhouse and the plane itself are all distinctly shown. The wheelhouses that I have seen were all built with at least two stories above ground; from the upper one the motion of the drum was controlled, thus giving the operator an unobstructed view of the plane.

When it is desired to pass a canal boat up or down the plane, the boat is floated onto the cars, made fast by ropes to cleats placed along the sides of the latter and either raised or lowered on the plane till the boat again floats at the new level. The system appears to possess advantages over the ordinary locks, for while the boat is being raised or lowered it is also going forward at about the same rate of speed as is maintained on the level portions of the canal. Thus less time is required to make the passage, and I imagine the water consumption of the turbines is less than would be the case with locks.

While the canal is still maintained in running condition, it is seldom used, having been unable to satisfactorily compete with the railroads. The planes are grass-covered, and spiders have endeavored with their tiny threads to prevent the motion of the cars upon the old rails, but even in their present condition the works are impressive and stand as a monument to early American skill and ingenuity.

Treatment of Direct-Current Motors for Mining Conditions

Motor Troubles Inherent to Mining Conditions Combating Moisture Troubles by Making Windings Moisture-Proof Dipping Tank Made from 50-Gal. Oil Drum Bake Oven Constructed from Gas Scrubber Dipping and Baking Process Described in Detail

By T. H. ARNOLD
Electrical Engineer, Mining Department, Arizona Copper Company, Limited

IN MINES where 250-volt trolley haulage is used the trolley wires and direct-current feeders are well distributed over the property, both on the surface and underground. Power may be conveniently obtained by tapping the feeders or trolley for the motors which operate small pumps, ventilating fans, small hoists, concrete mixers and for the numerous other small-power uses to be found around such applications. For the large hoists and pumps and for the heavy and more important drives special feeders must be run, and it is usually more economical to install alternating-current motors of somewhat higher voltage.

MOISTURE, DIRT AND NEGLECT THE PRINCIPAL CAUSES OF TROUBLE

Direct-current motors, especially the older types, have many troubles which are common to mining conditions. The main troubles encountered are due to moisture, dust and neglect. Motor equipment of a mine is much more scattered than is usual in other industries, and unless considerable supervision is exercised it is likely to be neglected. When a man has to climb a hundred or two feet of ladders to inspect a motor, he is prone to make his inspection by proxy. Dust causes trouble in bearing lubrication, heating and commutator trouble. The last may be due to abrasive dust cutting the commutator or to brushes wedging in the holders. Cleaning the motors frequently with compressed air and washing out the bearings is the only remedy.

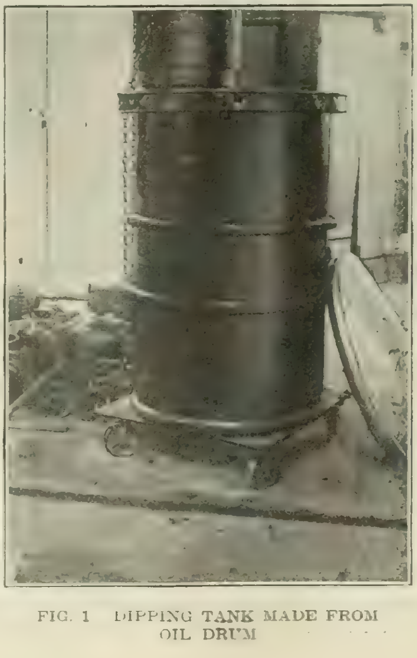


FIG. 1 DIPPING TANK MADE FROM OIL DRUM

Moisture trouble is more serious—it causes a partial or general failure of the insulation, resulting in burned-out coils or grounded commutator. It may be due to absorption of moisture from the atmosphere, to drip from the roof or to total immersion from flooding. If a motor is installed in a humid atmosphere, it should be operated sufficiently to keep it dried out. Temperature changes from changing air currents may cause the motors to sweat. An endeavor should be made whenever possible to locate the motors in places known to be dry. This, however, is frequently difficult; the damp portions of a mine will often shift with the progress of the ore removal.

The most practical place for combating troubles due to moisure is in the shop. All parts of the motor should be made as nearly moistureproof as possible by a thorough dipping in insulating compound and baking of the current-carrying parts. This method of treatment has several distinct advantages. A thorough dipping, followed by suitable baking, will fill the pores and openings and render the coils and commutator ends impervious to moisture, thus preventing insulation breakdowns. It prevents loosening and movement of the coils and band wires by swelling and subsequent drying out of the insulation. By filling the air pockets it enables the heat to be dissipated more readily. Cementing the wires together will prevent movement and chafing of the insulation. The coil leads will be stiffened and will not crystallize so readily at the commutator necks. The insulation in general will withstand damage from mechanical injury much better, as the coil will be practically a solid mass.

DIPPING AND BAKING ARMATURES AND FIELD COILS

The street railways and traction companies have realized for some time the savings resulting from regular and systematic dipping and baking of armature and fields coils. A complete equipment for this purpose is considered a necessary part of the shop outfit. The general custom is to remove, dip and bake armatures and field coils about once a year. At such times a general overhauling of the motor is made, worn or damaged parts are replaced or repaired and everything is thoroughly cleaned. Treatment of this nature will largely prevent breakdown at inconvenient times and will greatly benefit continuity of service.

Very few mining companies have equipment of this nature, and a brief description of a rather inexpensive outfit installed under the direction of the writer may be of benefit. It will handle direct-current armatures up to 25 hp., and larger ones may be manipulated by dipping one end at a time. Second-hand material was used largely, thus the cost was low, being principally for labor. It can be readily duplicated at almost any mining property.

The dipping tank, Fig. 1, was constructed from a 50-gal. oil drum. One head was cut out completely to give the maximum diameter of opening. In order to reduce the total amount of varnish necessary to completely cover the armature a piece of 4-in. pipe 14 in. long was placed in the center of the drum, at the bottom, for the shaft. The space between the pipe and the drum was then filled with concrete. This extra weight also prevents the tank from being readily upset. To prevent the evaporation of the volatile ingredients of the varnish a 2 x 2-in. sheet-iron trough was placed around the top of the drum. A sheet-iron cover fits over the top and rests in the trough. The trough is filled with water, thus sealing the joint of the cover. In order to move the tank more readily it was mounted on a truck made by bolting 4-in. malleable casters under each corner of a piece of ⅜-in. steel plate. The tank is run under the crane when dipping and draining an armature and stored in an out-of-the-way place when not in use. As usual with electrical repair shops, floor space is at a premium.

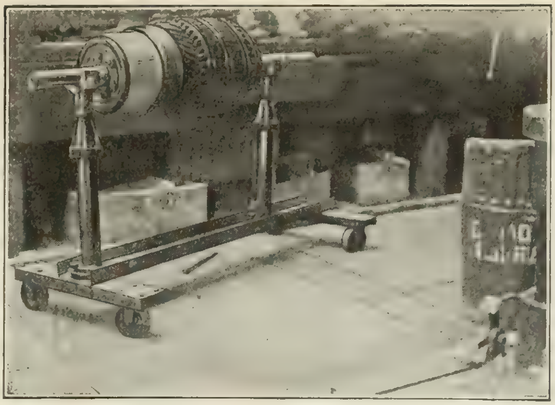


FIG. 2. ADJUSTABLE STAND FOR ARMATURES

HOW THE BAKING OVEN WAS MADE

The baking oven was made from a gas scrubber taken from an abandoned gas plant. It was of ample size to accommodate several armatures and happened to fit in a particular space in the shop which could be spared. It is constructed of ¼-in. sheet iron, and no attempt was made to insulate the sides. The door is held in place by bars which drop into wedging catches, the weight of the door forcing it into contact with the face of the oven. Heat is produced by open coils of No. 14 Nichrome wire supported on No. 4 porcelain knobs. To maintain a temperature of 90 deg. C. a current of 25 amperes at 250 volts is required. While lagging the oven would reduce the amount of power required somewhat, this was left for the future. Ventilation is secured by openings in the sides and top, and also by leakage around the door. The gases from the insulating compound are highly inflammable and considerable ventilation is advisable to insure safety from fire. Suitable supports are riveted to the sides and top for supporting coils and small armatures. Large armatures are rolled in on the armature stand and baked on the latter.

THE ARMATURE STAND

The armature stand, Fig. 2, was constructed from channel iron and pipe fittings. It is adjustable in height and length to cover a wide range. As it is mounted on casters it is readily moved about the shop. This enables an armature to be placed on it under the crane and then run into the winding room. Much heavy lifting is avoided in this manner, and one crane serves several purposes. When movement of the stand would be objectionable it can be bolted to thimbles set in the floor. The V-blocks are swiveled on the heads of the screws, thus enabling them to be adjusted to height with an armature in place. To remove a commutator from a large armature, the armature is blocked for height and the screw lowered out of the way. When the work is completed the screw is raised and the blocking removed. This apparatus is designed to be operated as much as possible by one man. After an armature or field coil has been rewound, repaired or thoroughly cleaned, as the case may be, it is heated to 90 deg. C. for two hours or longer to dry it out thoroughly. This heating also enables better penetration of the dipping varnish. The armature is then placed, commutator end down, in the dipping tank with the coils submerged and allowed to soak in the varnish till all evidence of bubbling has disappeared. It is then raised out of the tank and allowed to drain till all excess varnish has dripped back into the tank, and is then placed in the oven and baked. Small armatures are placed in the oven with the shaft vertical to prevent the varnish settling to one side during baking. Large armatures are placed with the shafts horizontal and are turned from time to time. The baking time is usually about eight hours, but is sometimes increased for large armatures. Oven temperature is maintained at 90 deg. C. While higher temperatures and longer periods are sometimes recommended we have found these to give good results for our conditions. After removal from the oven the armature is allowed to cool, excess varnish is cleaned from the shaft and commutator; the latter is then turned down and the mica undercut. The armature may now be put back into service or be stored until such time as it is required to replace one that has failed.

NICELY FINISHED APPARATUS USUALLY WELL CARED FOR

Field coils are removed from the machine, dipped and baked in a similar manner. While this process is going on the rest of the motor is given a general overhauling and the frame is painted with an engine enamel. The latter has a purpose other than the protection it affords. A well-painted motor is easier to keep clean. It is also a psychological fact that the average man will pay more attention to keeping a nicely finished piece of apparatus in good condition than one which externally looks as though it was ready for the scrap heap.

A satisfactory varnish for the purpose is a linseed-oil base of rather thin consistency. This varnish is selected as it does not dry out hard, but will retain its flexibility after exposure to considerable heat. It is also not affected by oils or water, which is one of the most important considerations around a mine.

Motors given this treatment will withstand a surprising amount of abuse and rough treatment. It appears to be inherent in mining to expect a machine to stand up and run satisfactorily under conditions that would be considered beyond all reason in other industries. It therefore behooves the electrical department to make the electrical equipment as nearly indestructible as possible, and it has been my experience that the treatment described in the foregoing helps materially.

The Steinbecker Oil Engine

The attention that has been given to the solid-injection oil engine is due to the design eliminating the employment of the injection air compressor. This reduces the cost of the engine, which in all other respects is fully as expensive as the Diesel, by at least 20 per cent. An engine that makes use of the solid-injection principle, but with important modifications, is the Steinbecker four-stroke-cycle oil engine recently introduced in Germany, and described in *Gas Engine*.

In Fig. 1 appears an outline of the fuel pump and combustion retort of this engine. The retort *A* is in communication with the engine cylinder through the passage *B*. On the compression stroke air is forced through *B* into the cavity *A*. Just before top dead center the fuel pump forces a small amount of oil into the passage *B*. This fuel is picked up by the air passing into the retort. The mixture of air and oil particles explodes, increasing the pressure existing in *A*. The direction of the air currents along the passage *B* is reversed, and the charge of burnt gases starts to flow from *A* into the engine cylinder. The fuel pump continues to force a stream of oil into the passage; this oil is picked up and atomized by the currents of burnt gases. The fuel is carried into the engine cylinder, and combustion occurs.

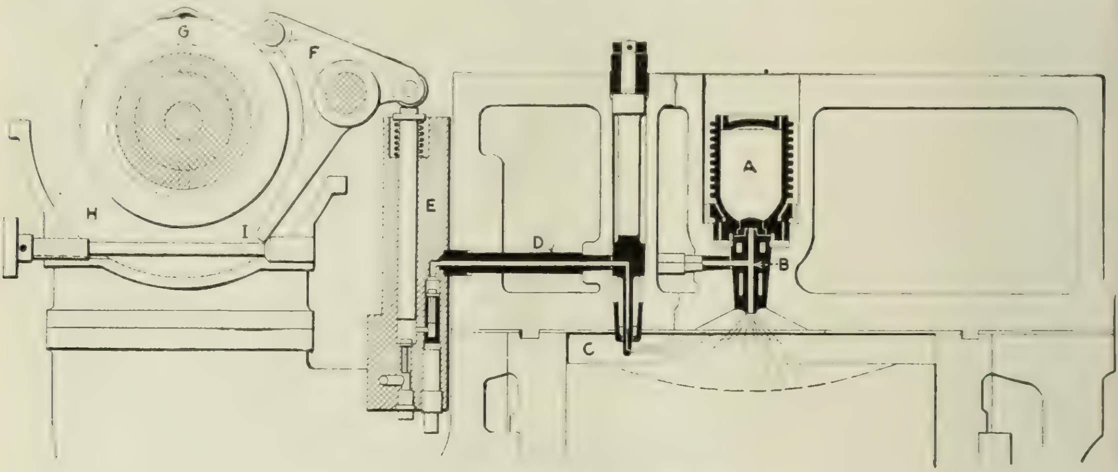


FIG. 1. STEINBECKER OIL ENGINE

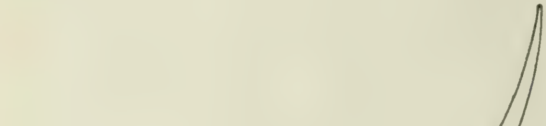


FIG. 2. NO-LOAD INDICATOR DIAGRAM

In the later developments of the engine a secondary fuel nozzle is placed at *C*. The fuel entering the cylinder from the passage *B* then provides the initial ignition, while the main charge enters at *C*. To provide against pre-ignition of the charge in *A*, the retort is water-cooled and provided with radiating fins. Indicator cards showing no-load and full-load conditions are shown in Figs. 2 and 3. It would appear that any variation in the characteristics of the fuel would seriously affect the timing of the explosion in the retort *A*. Unless some method is provided for the thorough scavenging of the retort after combustion takes place, there would probably be a tendency toward misfires under low-load conditions. The design is in many respects a development of the Hvid or Brons principle with the addition of a timing of the fuel introduction.

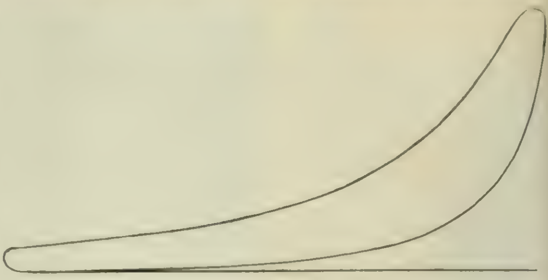


FIG. 3. FULL-LOAD INDICATOR DIAGRAM

The heaviest circuit breakers ever designed for 13,200-volt service will be installed by the United Electric Light and Power Co., New York, in its Hellgate Station. There will be 120 of these solenoid-operated type 04 Westinghouse circuit breakers having an interrupting ability of 58,000 amperes at the arc (1,500,000 kva.). The disconnecting switches are gang-operated, and their operating mechanisms are interlocked with the oil-breaker mechanism so that the disconnects cannot be moved unless the breaker is not in the operating position, thus assuring safety to operators. These oil breakers are unique in that the phase elements will be in separate rooms approximately thirty feet apart.

Improved Operating Conditions Save $13,585 in Fuel per Year

BY OLLISON CRAIG, M.E.*

An investigation of the operating conditions of the Buhl, Minn., power plant revealed that a number of factors were responsible for the waste of fuel, such as leakage of air past the dampers of stand-by boilers; contracted breeching area with soot and ash; damper not used, inattention to draft control; holes in fuel bed; open furnace doors; soot on boiler heating surface; low combustion rate; too many boilers in operation and improper management. All of these conditions were easily remedied, resulting in the saving of $13,585, based on the price paid for coal.

IN AUGUST, 1919, the village of Buhl, Minn., requested the Charles L. Pillsbury Co., consulting engineers, of Minneapolis, to make an investigation of the Buhl municipal power plant and to report on the conditions found and the things that should be done to secure economy of coal consumption. The plant had burned, the previous year, 8,100 tons of coal, costing about $8 a ton. After investigation an arrangement was entered into whereby a monthly inspection was made of the plant and a check kept on the operating records, to insure that the recommended changes were put into practice and to determine the results of these changes.

The principal equipment of the plant consists of one 18 x 24-in. non-releasing Corliss engine, 200 r.p.m., direct-connected to a 250-kw. 2,400-volt 60-cycle three phase a.-c. generator; one 13 x 24-in. four-valve engine, 275 r.p.m., direct-connected to a 75-kw. 2,400-volt 60-cycle three-phase a.-c. generator; one 14 and 16 by 10 and 16-in. tandem steam-driven air compressor; three 150-hp. return-tubular boilers, equipped with stokers; one 350-hp. horizontal water-tube boiler, equipped with a stoker; one 350-hp. cross-drum, vertical water-tube boiler, equipped with a stoker, and one feed-water heater and V-notch meter, having a capacity of 45,000 lb. of water per hour.

A concrete stack, 60 in. inside diameter by 185 ft. above the line of the grates, serves all the boilers. Coal is weighed in cars of about one-ton capacity each, which cars are elevated to a light track running over the stoker hoppers. From this track the coal is dumped and distributed to the various hoppers.

The plant supplies heat, light, power and water to the village. The bulk of the steam produced during the year, however, is used for heating, as all the homes, business buildings and public buildings in the village are supplied with steam from the municipal plant for heating. There was not, so far as could be learned, an individual heating plant in the town. During the summer exhaust is turned into the mains, supplying customers with steam for use in hot-water tanks. The electric power generated is used principally for internal lighting, street lighting and cooking, the street lighting producing a peak electrical load for a few hours in the evening. The air compressor is used for lifting water from a deep well into a reservoir at ground level, from which it is elevated into a steel tank by electrically driven centrifugal pumps.

The investigation was made to determine those conditions of equipment and of operation which were wrong and to collect data on which to base recommendations for corrective measures.

RESULTS OF THE INVESTIGATION

It was found that the boilers were being operated far below rating, the load varying from 30 per cent to 140 per cent of rating. The average for the previous year was 75 per cent. To show the effect of operation below rating, two evaporative tests were made. At the time of the investigation two 150-hp. boilers were being operated. The first test was made with these two boilers in operation, and the second with only one 150-hp. boiler in operation. The first test showed a steam production of 56.7 per cent of rating and an evaporation of 6 lb. of water per pound of coal; the second showed a steam production of 126 per cent of rating and an evaporation of 8.25 lb. of water. The CO_2 in the flue gases in the two cases was, respectively, 4.4 and 13.7 per cent. In the first case the amount of grate surface in use was so large that for the greater part of the time it was practically impossible to keep it covered with fuel. This accounts for the low CO_2, and the low CO_2 in turn indicated a large loss of the heat generated up the stack.

Certain other errors of operation were found which entered into the results of the tests. The firemen made no use of the dampers. If the steam demand dropped and the safety valves blew, they opened the furnace doors. During the second test, when such a condition occurred, the damper was throttled. The amount of air passing through the furnace was thereby reduced instead of increased, and consequently the amount of heat carried out the stack was reduced. Attention was also given, during the second test, to the bed of fuel, to prevent the formation of holes; and the damper was regulated by the use of a draft gage to control the supply of air in accordance with the demand.

The dampers of all boilers were found to be stuck in place; that is, in open positions. The breeching was faultily designed, there being one sharp bend around which one-third of the available stack draft was lost. The breeching was found to be badly filled with soot and fly ash. These things tended to reduce the amount of draft available in the furnaces, and in turn the amount of air supply and the amount of coal the furnaces could burn. The sharp turn consumed a large amount of draft pressure by causing eddy currents. The clogging of the breeching by soot and fly ash increased the friction loss by increasing the velocity of the gases. The dampers being open in stand-by boilers reduced the stack draft by diluting the stack gasses with cold air and reducing the stack temperature, which was found to be as low as 200 deg. F.

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*Chief Engineer for the McLaughlin Coal Reduction Co., Decatur, Ill. Formerly Mechanical Engineer with the Charles L. Pillsbury Co., Consulting Engineers, of Minneapolis, Minn.

The setting of the boilers was found to be quite good, the brickwork having been covered with a plastic coating to prevent the infiltration of air. The water side of the boiler tubes was in good condition, the boilers being washed with fair regularity and boiler compound having been used effectively. The fire side of the boiler tubes, however, was badly caked with soot. The only tube-blowing equipment was a hand lance, and blowing was not done effectively or with sufficient frequency.

At the time of the investigation the power-plant operators thought that the load could not be carried with one boiler, since the air compressor was quite often in operation during the evening hours while the peak electrical load was on. It was their opinion that this caused a demand for steam that was too great for one boiler to supply. The air compressor was in operation about 14 hours of each 24 hours, for pumping water into the reservoir. The peak boiler load resulting from the operation of this compressor during the peak electrical load existed only from two to three hours each evening. It was obviously possible so to control the periods of operation of this compressor, while still keeping sufficient water in the reservoir, that its operation during the period of peak electrical load could be stopped, thus avoiding the extreme peak of steam demand which required the operation of two boilers.

The principal factors in the waste of fuel in the plant were: Leakage of air past dampers in stand-by boilers; contraction of breeching area by soot and fly ash; sharp bend in breeching; dampers not used; attention not given to draft; holes in fuel bed; open furnace doors; soot on boiler heating surface; low combustion rate; too many boilers in operation and improper management.

RECOMMENDATIONS SUBMITTED

A report was submitted covering the causes of fuel loss and containing recommendations for corrective measures. The report contained curves showing the records of plant operation in graphic form for the preceding year. Curves were included showing the boiler horsepower in operation, the percentage of rating developed, the evaporation per pound of coal, and the relation between the rating developed and the evaporation per pound of coal. The latter curves indicated quite distinctly that better evaporative results had been secured in the past with heavily loaded boilers, than with lightly loaded boilers. The results of the two tests were also cited to add emphasis to the comparison of operating conditions and to the recommendations.

The recommendations which were particularly emphasized were as follows:

The rate of combustion per square foot of grate surface should be increased. An average of 20 to 25 lb. of coal should be burned per square foot of grate surface per hour instead of the actual average of 13 lb. To effect this, fewer boilers should be operated. The horsepower developed should be 130 per cent of rating instead of the actual average of 75 per cent developed.

Dampers in all boiler uptakes should be put in operating condition. Dampers on stand-by boilers should be kept closed. Draft gages should be installed, and dampers on the boilers in operation should be regulated by the use of the draft gages to control the supply of air according to the requirements for combustion.

Strict attention should be given to the fuel bed to keep it even and free from holes.

The practice of opening furnace doors to reduce the rate of steam production, when the safety valve blows, should be discontinued. The dampers should be throttled instead.

The breeching and gas passages should be kept free of soot accumulations. Flues and tubes should be effectively blown at least once each eight-hour shift, and preferably with permanently installed tube blowers, rather than with a hand lance.

The equipment in the plant, so far as possible, should be operated to make the boiler load as even as possible. This applies particularly to the operation of the air compressor.

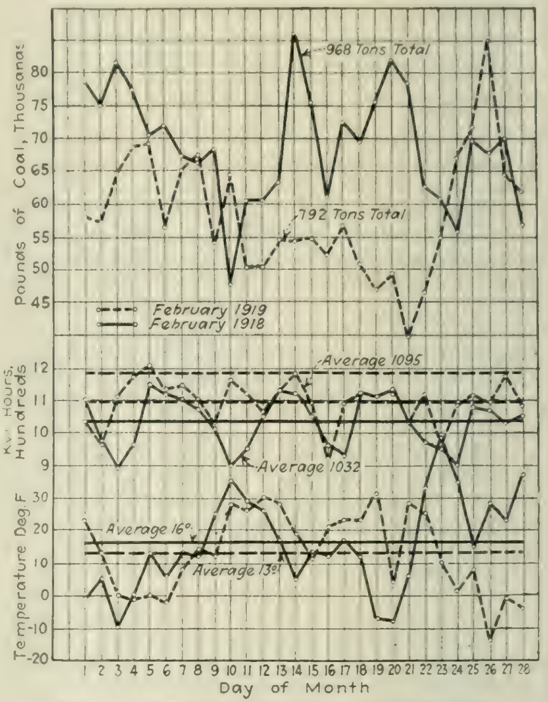


FIG. 1. OPERATING CURVES COMPARED FOR FEBRUARY, 1918-1919

Flue-gas analyzing equipment should be used with sufficient frequency to determine the variation of CO_2 in the flue gases and to determine whether the coal is being burned efficiently or inefficiently.

MONTHLY INSPECTIONS WERE MADE

After the report was submitted, an inspection was made of the plant each month. Particular attention was given to operating conditions at the times of inspection. Each month the operating data were plotted into curves and curves for the same month of the previous year were superimposed for comparison. Fig. 1 shows the curves for February, 1919, in dotted lines; the curves for February, 1918, being superimposed in solid lines. For this month the total coal consumed was 792 tons in 1919, as compared with 968 tons in 1918. The kilowatt-hours produced were 33,200 in 1919, as compared with 2,900 in 1918, and the outside temperature averaged 13 deg. F. in 1919, as compared with 16 deg. in 1918.

These curves, together with an analysis of the operating data for the month and a comparison of the operation with the same month of the previous year, were incorporated into a monthly inspection report. This report also included the result of the plant inspection.

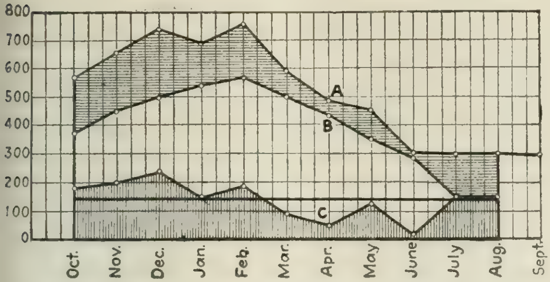


FIG. 2. AVERAGE RATED BOILER HORSEPOWER MONTHLY CURVE, YEARS 1917, 1918 AND 1919

The inspections and reports served to keep a check on the plant and to keep the Village Water and Light Board informed as to its operating and physical conditions. The monthly inspections also made it possible to get put into effect recommendations that might otherwise have been neglected and to keep the plant operatives interested in fuel saving.

Fig. 2 shows the average rated boiler horsepower in operation each month, curve *A* being for 1917-18 and curve *B* for 1918-19; curve *C* indicates the difference, or reduction. The average reduction was 146.3 hp., or practically equivalent to cutting out one of the 150-hp. boilers.

Fig. 3 shows the total coal consumption per month, the saving in coal, the average kilowatt-hours generated per day for each month and the average outside temperature for each month. In this figure curve *A* shows the actual coal consumption per month for 1918-19; curve *B* the consumption for 1917-18 and curve *C* the consumption for 1917-18 corrected for operating conditions, or service performed, during 1918-19. Curve *D* shows the percentage of saving in coal, or the per cent difference between curves *A* and *C*.

In order to make a comparison of coal consumption, it was necessary to make corrections for the service performed. Fig. 4 shows a curve with average monthly outside temperatures and total monthly coal consumption as co-ordinates. After making corrections in the coal consumption for February, 1919, for the number of days in the month, and for March, 1919, for gross inefficiency due to fallen furnace arches, the points fall quite close to a straight line. The slope of the line gives the change in coal consumption per month for a change of one degree in outside temperature. The amount indicated by the curve is 14,000 lb. Each month during the heating season, then, the coal consumption for the same month in the preceding year was increased or decreased by the product of the difference in temperature between the two months and 14,000, according to whether the temperature was lower or higher. This correction was possible, since during the heating season practically the entire steam production, including both the live steam and the exhaust, was used for heating purposes. A correction was also made for increased radiation. During the non-heating season a correction was made, based only on the per cent difference in electrical output, on the assumption that the variation in plant service was represented by this difference. Curve $C + 193$, then, represents the amount of coal that would have been consumed in 1917-18 if the service delivered had been the same as in 1918-19. The difference between curves *A* and *C* represents the true saving in coal as nearly as it was possible to determine.

The net results were: A reduction of one 150-hp. boiler in the boilers operated; an actual reduction of 1,270 tons of coal with an increased service output; a net saving of 1,842 tons of coal on the basis of the same service output; a net saving of 21.2 per cent of coal consumed during the year of inspection, on the basis of the same service output and a net saving of $13,585, based on the price paid for coal.

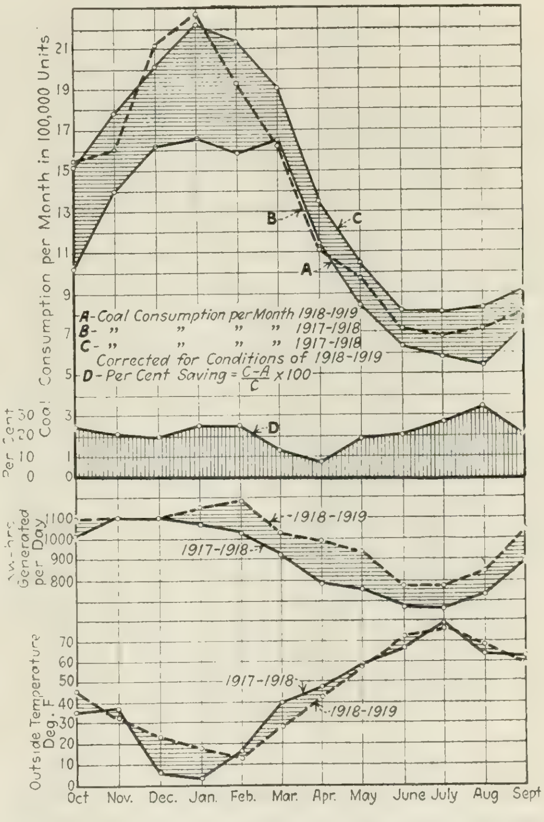


FIG. 3. CURVES SHOWING COAL CONSUMPTION PER MONTH, AVERAGE KILOWATT-HOUR GENERATED PER DAY, PER MONTH AND AVERAGE OUTSIDE MONTHLY TEMPERATURE

The Buhl plant is typical of a large number of plants. Some or all of the conditions that existed could be found in most plants, and most plants could make a decided reduction in coal consumption as easily as was done at Buhl.

Weighing the coal fired and the water fed will give an average indication of the over-all efficiency of a boiler plant, but if the ratio of water to coal is low, other means must be taken to locate the cause of the inefficiency. In most cases some one or more of the conditions enumerated will be found as the cause of high coal consumption, and these conditions should be searched for in detail.

In the operation of any boiler the big loss of fuel is through the loss of heat up the stack. This loss, in general, may be divided into two parts—excess of air and inefficient heat transmission. If more air is passed through the setting than necessary for combustion of the fuel, this excess air performs no function other than to carry away heat that would otherwise be available for making steam. If the transmission of heat is inefficient, the gases of combustion will pass the heating surfaces without transferring all the heat available for transmission.

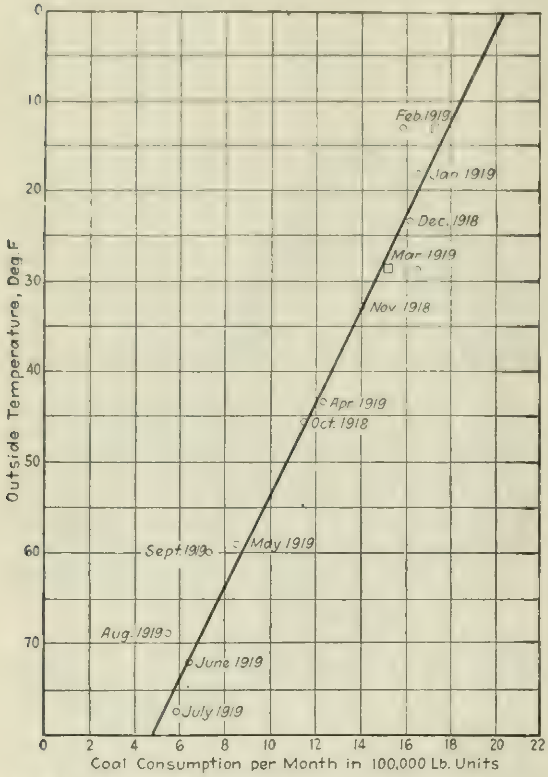


FIG. 4. AVERAGE MONTHLY OUTSIDE TEMPERATURE AND TOTAL MONTHLY COAL CONSUMPTION AS CO-ORDINATE

The excess air may be detected by determination of the CO_2 in the flue gases. Roughly, the flue-gas will contain from 19 to 20 per cent of CO_2 when burning bituminous coal and containing no excess air. If the CO_2 should be 10 per cent, there would be, roughly, 100 per cent of excess air, and if the CO_2 should be 5 per cent, there would be approximately 300 per cent of excess air. About 12 lb. of air is required to burn 1 lb. of bituminous coal. If the CO_2 should be 5 per cent, about 36 lb. of excess air would be passing through the setting and carrying away heat. If the flue gases were 500 deg. higher in temperature than the entering air, the heat lost would be, roughly, 36 × 500 × 0.25 or 4,500 B.t.u. for each pound of coal burned. The actual stack loss would be one-third greater, or 6,000 B.t.u., the 4,500 B.t.u. being the heat carried away by the excess air alone.

Practically, some excess air is necessary in order to secure proper combustion, but 15 per cent CO_2 should be set as an approximate standard. Most plants are getting the 5 per cent.

If the flue gases are passing out at a temperature 600 deg. above that of the entering air and the temperature can be reduced 100 deg., 17 per cent of the stack loss can be saved. This would represent a saving in coal of 4 or 5 per cent if the CO_2 was 10 per cent.

A flue-gas analyzer will tell when there is an excess of air, and a flue thermometer will tell when the temperature of the gases is too high. If the CO_2 is low, the cause may be holes in the fuel bed, improper damper regulation, leaky setting or too light a fire. If the boiler is heavily loaded, there is less possibility of a light fire or of holes in the fuel bed than if lightly loaded. This is one reason for operating boilers above rating. If air leaks or contractions or impediments in the breeching reduce the draft in the furnace, sufficient coal cannot be burned to operate the boiler at economical capacity. Frequent analyses should be made of the flue gases, and if the CO_2 is low, the possible causes should be checked and the necessary corrections made. For the purpose of firing operations a CO_2 recorder is preferable to a hand instrument. If the use of a flue thermometer shows a high temperature of flue gases, the heating surfaces are not clean, assuming that the boiler is of proper design. Care should be taken to keep soot and ash accumulations from one side and scale from the other.

There are a large number of possible losses that this discussion has not considered, but if use is made of a flue analyzer and a flue-gas thermometer, the CO_2 kept between 10 and 15 per cent, and the stack temperature kept down to 500 or 550 deg., the bulk of the losses experienced in the average plant will be recovered.

Suggestions for the Semi-Diesel Engineer

If the crankcase is not kept drained of lubricating oil, the engine may run away when the load is thrown off. The oil will be carried into the cylinder by the scavenging air.

When a heavy fuel oil is used, a considerable residue will drip down into the crankcase of vertical engines. If this tarry substance is not removed, it will work into the crankpin oiling device. Many crank brasses are ruined because of this carelessness.

On two-cycle engines the piston-pin brasses wear as rapidly as do the crankpin bearings. The former should be adjusted as frequently as the latter.

The piston-pin setscrews often work loose. If the pin is allowed to shift sideways, the cylinder walls will be scored.

In some engines a brass scraper is placed in the end of the piston pin. The scraper picks up the lubricating oil from the cylinder wall and forces it through a passage onto the piston pin. This scraper often becomes choked with tar. It should be cleaned very frequently.

EDITORIALS

Is the Purveyance of Coal a Concededly Private Industry?

LAST July the legislature of Indiana awoke to the fact that a sure and plentiful supply of food and fuel is one of the first requirements of contentment, security and well being, the assurance of which is a proper and legitimate activity for a people in its collective capacity, and appointed a Coal and Food Commission.

This commission was given the power, among other things, to regulate and fix the price at which all coal moving in intrastate commerce in the State of Indiana shall be sold to jobbers, wholesale and retail dealers and to the general public, just as a public utilities commission fixes the price at which gas, water, electricity and transportation shall be sold.

The day when regulation of public utilities was proposed is not so long ago that the storm of protest against such interference with "private industry" will be forgotten. The lucubrations of journalistic champions of those interests against the great proposer of these progressive policies are blots upon their editorial pages that the subsequent vindication of Roosevelt and government regulation have made odious. The utilities themselves now admit the justice and desirability of intelligent regulation which will insure the stability of their properties, a fair return upon the investment in them and service to the public at cost plus a fair profit.

Is the mining and distribution of the fuel resources of the country any less a matter of public concern than furnishing its light, power, water and transportation?

Is the administration of the fuel supply, upon which all these utilities as well as most of the basic industries of the country and the health and comfort of the people depend, "a concededly private industry"?

An injunction suit was filed in August last against the Commission in the United States District Court at Indianapolis by which it was sought to test the power of the State of Indiana to regulate its coal industry in the manner contemplated by the legislature. In discussing the court's dismissal of the application for injunction, Rush C. Butler, general counsel of the National Coal Association, says in a recent issue of the *Coal Review*, the organ of the Association:

> The interesting and at the same time the alarming feature of the opinion of the court is that while no state in the United States has heretofore attempted any such regulation of a *concededly private industry*, it is apparent that the exercise of price-fixing and other regulatory powers by the Federal Government during the war has made such an impression as to lead the court seriously to consider whether the exercise of those powers by the several sovereign states during times of peace may not be nothing more than the exercise of the portion of the police power not delegated by the states to the Federal Government.
>
> Perhaps I should not have used the word "alarming" in speaking of this opinion, for, after all, the laws which govern us, whether municipal, state or Federal, merely reflect the mind and will of the people and the courts' duty is merely to interpret and apply these laws.
>
> Accordingly, if it is the will of the people that such laws be enacted, it is clearly within their power, by constitutional amendments if not otherwise, to authorize the enactment of statutes similar to the one referred to. However, the opinion of the court may well give alarm to the coal industry if for no other reason than that that industry and no other is singled out for price-fixing and regulation in this particular piece of legislation.
>
> It is understood that the case will be carried directly to the Supreme Court of the United States and that the power of the state to enact such legislation will be vigorously contested.

Electrical Maintenance and Continuity of Service

CONTINUITY of electrical service first became a factor in the operation of large power systems, but has gradually spread into every branch of power distribution and utilization. As industrial processes become more highly developed and more dependent upon the application of power, the necessity of reliable power service in every department of the manufacturing process has become, in many cases, almost imperative. Failure of motors is almost as serious as failure of the main generating units.

By careful study of industrial needs manufacturers have done a great deal in the development of reliable electrical equipment in almost every branch of industry. However, this is only one-half of the story—what is of equal importance is the installation and maintenance of the equipment. If electrical machinery is to obtain the proper care, it is essential that it be installed where it can be given attention by the maintenance men. To install a motor in some location where the attendants must run the risk of injury every time they inspect or make adjustments, is one of the surest ways to have it neglected, with the resulting poor service. In this issue is an article, "Treatment of Direct-Current Motors for Mining Conditions," by T. H. Arnold, in which he says, "When a man has to climb a hundred or two feet of ladder, he may make the inspection by proxy." This statement is also true wherever a motor and controller are installed in a place that is difficult to get at.

The treatment for motors in mines recommended in Mr. Arnold's article can be applied advantageously to these machines in any industry where they are subjected to moisture, metallic dust, etc. It is not as generally appreciated as it should be that no matter how rigid the construction of a motor may be or how thoroughly it may be insulated, there is always a certain movement of the coils due to the magnetic forces set up about the conductors by the current. This movement will eventually crack the insulation and allow the penetration of moisture, dust, etc., which will cause breakdowns. These failures can, as has been proved by numerous experiences, be practically eliminated by a periodic cleaning and baking of the current-carrying parts and then impregnating them in an insulating compound. Such treatment must necessarily be given in the shop, which means in most cases that spare parts or motors must be available, unless there are regular periods when the plant is down for making changes. The cost of such parts, when looked at from the price only, is not infrequently a stumbling block in the way of securing them, but when the increase in production that will result in a continuous service from the motors is considered, the investment in spare parts will generally take another aspect, and it will be seen that they will pay a substantial dividend on the investment.

An important chord in the maintenance of equipment has been struck by Mr. Arnold in his statement that "It is a psychological fact that the average man will pay more attention to keeping a nicely finished piece of apparatus in good condition than one that looks externally as though it was ready for the scrap heap"; and since the author has found that a motor can be kept in good condition around a mine, it evidently can be accomplished under almost any condition. The idea that a motor should be allowed to run until failure occurs without any attempt to anticipate and avoid trouble, is fast passing into the realm of wrong ideas, and a new order is gradually being introduced; namely, that by proper application, installation, inspection and maintenance electric-motor equipment can be made as reliable as power-generating equipment. Mr. Arnold has given one of the ways of doing this.

Ash Disposal from City Plants

THE problem of ash disposal is becoming one of considerable importance at power plants in many cities. This is due to several factors. The increase in the ash content of coal in recent years has been quite noticeable and may be greater in the future as leaner seams are worked. The increase in the size of plants and of power loads in many cases causes the production of more ash than can be used in local undertakings. There are few available dumps adjacent to most of the large power plants. Finally, there is the direct loss of combustible in the form of coke and fine coal particles. In some cases this loss has run as high as fifty per cent of the total ash, although fifteen per cent is considered good practice in the best plants.

If too much emphasis is placed on low carbon in the ash there is danger of the fireman admitting too much air into the furnace in an endeavor to reduce the percentage of wasted coke. Several attempts have been made to treat the ash in a modified washer, and while this is said to be practically possible, it was not an economic success because the cost of the process and the high water content of the recovered material offset any saving effected.

Where waste land is available, especially if adjacent to the plant, ash can be used as fill. In New York City most of the ashes are loaded on barges, hauled to sea and dumped. Unless these are taken to deep water some portions wash up on shore to the detriment of the beaches. In cities like Chicago, where there are neither low mud flats nor deep sea for dumping, the problem is quite a serious one. For a while railroads used all surplus ash for embankments, fills, etc., but in some cases they are now unable to handle the large amount available, owing partly to car shortage and partly to the temporary stoppage of railroad extensions. Several companies and even some of the smaller business concerns are finding the disposal of ash an expensive burden.

Engineers of this country must find some economical means of disposing of this waste material. In several stations in England the ashes are screened and graded and used for concrete and various other forms of construction. Possibly a similar use might be found here. Cinder concrete is highly resistant to fire, is lighter than ordinary concrete, and hence forms a desirable material for building construction. If ash can be properly sized and screened, there may be a field for it in this use as well as for sidewalks, road bases, etc.

The costs of this preparation are not known. However, there should be some means of utilizing this waste material as a byproduct of the plant by finding an industrial use for it. There may be other ways than those indicated in the foregoing that some engineers have found satisfactory. If we are to avoid huge ash piles resembling culm banks around our power plants in certain cities, some use must be found for the ashes, and this must be done quickly.

The Semi-Diesel Engine Association

IN GENERAL contradiction to the policies followed by European manufacturers of oil engines, the American builders have heretofore maintained a marked disinclination to make public any information as to experiments conducted or difficulties encountered and overcome. This attitude, while it allows each manufacturer to be the sole beneficiary of his experimental work, is actually antagonistic toward the popularizing of the oil engine. No other influence has had such weight in the discouraging of sales as this too prevalent factor of secretiveness.

The manufacturers of semi-Diesel engines are to be congratulated that they have abandoned this attitude and have organized an association to promote the popularity of the semi-Diesel engine. To accomplish this, two courses of action will be followed. A freer interchange of information on design and manufacture will be put into effect. Furthermore, the association intends to give a considerable amount of publicity to their product. To attain the latter feature, the association will find that more results can be secured by closer co-operation with the magazines that cover the field of intercombustion engineering. *Power's* columns are open at all times to a free discussion of all forms of oil engines.

Apprehending that the Northwest may suffer again this winter from a coal famine, J. F. McGee, former State Fuel Administrator for Minnesota, has addressed a letter to President Wilson, asking that the wartime control of coal be restored and prices fixed by the Government. The communication is said to contain some serious charges of profiteering and diversion of shipments. No one is particularly anxious to see the United States Fuel Administration revived and least of all the coal men, but if such a step becomes necessary, the responsibility will be theirs.

The United States Shipping Board, acting through the Department of Justice, has instituted suit against a coal contractor for alleged failure to conform to contract. Perhaps we shall find out why the Shipping Board was compelled to pay eighteen and twenty dollars a ton for coal which the dealers claim that they were selling for export for $7.29.

CORRESPONDENCE

Does a License Law Help?

The discussion that has been going on in the correspondence columns of *Power* for some time in regard to engineers' licenses seems to be one-sided and not getting anyone anywhere. I am not opposed to the license laws, either local, state or Federal, but I fail to see where they are going to help the operating engineer in the least, either by an increase in pay or by enlarging his knowledge of the proper operation of a steam plant.

We have here in the South a vast number of engineers who carry licenses of many different forms and varieties, from the United States marine license of unlimited horsepower down the line to that of some small Northern city that happens to have a local license law on its statute books. This does not necessarily mean that the present holders of these licenses are the original applicants; in fact, I heard that one of the present holders had boasted that he had stolen a license from an engine room in Chicago and was working under the original owner's name.

I know an engineer in Alabama who could not pass a written examination for the reason that he could not add a column of figures or multiply two times two and get the correct result; yet this man's 2,500-hp. cross-compound engine and the 2,000-kva. turbine cannot be beaten for maintenance, operation and efficiency anywhere in the country. I further know that his employer would not let him go, license or no license.

I could cite many instances in which I have been called in to do repair work where the licensed engineer has been at fault, also where the unlicensed man has been to blame, but of the two cases the licensed engineer has been the most to be criticized, as the most was to be expected of him, for he was supposed to have passed an examination and proved his ability.

Where, may I ask, would a license help in the case cited by R. G. Summers in the Sept. 14 issue? If the operator of that particular plant had all the licenses that were ever issued they would not have prevented the overloading nor have shortened the period of ten months' cleaning, as those are things strictly up to the operator himself. If he were the man he ought to be to operate a steam plant, he should have been able to show his employer where he was wasting money by overloading the boiler to the amount stated.

If the engineers of the country want a license law why don't they get it? The engineers of Massachusetts got one back in 1895, and got it through their own untiring efforts. I consider it a pretty good law at that, yet it is not all that a license law should be, by any means.

The holder of a license may be no better as an engineer than one who does not hold one, and the license does not make a man any more capable of approaching his employer with a suggestion than if he did not have one. I do not believe that an employer thinks any more of a man with a license than he does of one without. The only thing that a license might do would be to certify that the holder was a competent man to operate a plant, in the eyes of the examining board, and that could be very easily found out as soon as the man began work, if his employer knew anything at all.

I cannot see that the engineers of the country would be any better off with a license law than they are at the present time. Of course, if it is necessary to pass a law to make an engineer study and fit himself for a license, why all right, but I would call it a compulsory-education law rather than a license law.

In conclusion I will say that I hold a Massachusetts first-class license and have had it for nearly 25 years.

Gordon, Ga. CHARLES N. SHAW.

Another Veteran Engine

I have a 14 x 36-in. Putnam engine that has an honorable record. It was installed in 1894 and for nineteen years the repair bill on it was less than five dollars.

The cylinder was then rebored, and new packing rings were added to the piston. A new governor was put on and the speed increased from 75 to 100 r.p.m. The piston rod was in almost its original condition, the variation in size being only 0.01 in. A cut of $\frac{1}{64}$-in. was taken to make it true.

This engine has been in service for 26 years and has always been packed with one kind of fibrous packing. But one brand of cylinder oil has ever been used to lubricate the valves and piston. The main and outboard bearings, also the crankpin boxes, have never been repaired and are in excellent condition now.

New Haven, Conn. W. H. WAKEMAN.

Commutator Made from Copper Block

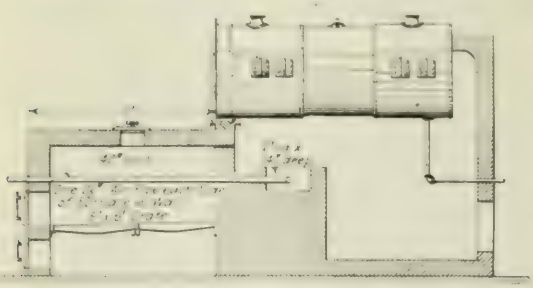
Referring to *Power* of Sept. 21, page 458, the article by Vernon Pearson on "Commutator Made From Copper Block," I wish to inform you that this method has been used for several years. A patent was taken out in August, 1916, by Edward F. Smith, of Cincinnati, Ohio. This patent (No. 1,195,861) was assigned to the Neil & Smith Electric Tool Co., and is still in force. Anyone using this method is liable for damages. H. E. WEIGHTMAN.

Chicago, Ill.

Had Trouble Burning Hog Fuel

When I came to my present plant, they were cutting out oil burning and putting in wood-burning furnaces, which were a miserable failure. We used slab wood direct from the mills. After about six months of this, a change to hog fuel was made, using furnaces designed as shown. These furnaces started off as though they would amount to little more than when slab wood was used, but study, good firemen and hard work have enabled us to get sufficient steam with but four of the six boilers in use.

The principal trouble with this hog fuel is that it is anything from large-sized slivers to all sawdust of the finest sort; our ashpits at first had to be cleaned twice a day, and the expense of handling so much charred fuel was a chronic complaint. We tried changing to another design of grate, but obtained no better results. The grates would clog so badly that we had to clean them during a day's run and the screens on top of the stacks would so fill with soot as practically to stop the draft, which nearly put out the fires and covered the town with particles of burnt fuel as well.



DESIGN OF FURNACE FOR BURNING HOG FUEL

This condition was overcome by the use of a long pipe poker flanged at one end and used to tamp the fuel tight so as to close all holes in the pile, thus compelling the air supply to come in from the front of the pile. If a fireman allows the fuel to get too low or if it is not properly tamped, the stack screens will soot up; the same condition prevails if the ashpits get too dry and hot.

I do not understand the clinkers. On some days there will be none to speak of, and the next day with the same treatment and conditions, as far as I can see, there will be nearly a wheelbarrow load from each furnace. These clinkers are not all thin and porous, but some of them are from one to nearly four inches in thickness.

Kent, Wash. C. W. **Fields**.

Repair of Semi-Diesel Fuel Pump

In a Texas power plant there are two 85-hp. oil engines. Texas crude oil is used. This oil carries a fairly high amount of sulphur. The fuel-pump plungers became roughened by the sulphur eating the surface. The rough part of the plunger destroyed the pump packing so that it was almost impossible to keep the packing oiltight. If the gland was tightened enough to stop the oil drip, the packing wedged against the rough pump plunger, preventing the pump spring from forcing the plunger back on the suction stroke.

To remedy this the operator turned up a plunger from a bronze piston rod out of an old steam pump. The eccentric rod did not strike the plunger, but a steel cap which was easily fitted to the bronze rod. Irregularity in the action of an engine fuel pump is often the result of a corroded plunger.

New York City. E. E. **Snow**.

Transformer Would Not Parallel

Recently I was called upon, as trouble shooter, to determine the reason why two banks of transformers, one of three 75-kva. units and the other of three 200-kva. units, would not operate in parallel, although designed to do so. They were connected in closed delta, as in Fig. 2, and were supplied with current at 25,000-volts three-phase, stepping this down to 2,300. The transformers in one bank were of a different manufacture from those in the other, but had been built to the same specifications. Therefore, the operating characteristics would be the same, and, it could not be understood why, when an attempt was made to parallel the two banks, the switches would trip and the fuses on the primary side blow.

Either bank would operate perfectly by itself, and the voltage of the two banks was exactly the same. I checked over the wiring and found the connections were correct, therefore immediately suspected that it was a question of reversed polarity. I reversed the two secondary leads on one 75-kva. transformer and connected directly onto the terminals of the corresponding 200-kva. unit, as in Fig. 1, protecting the windings with a two-ampere fuse wire, after which the primary switch was closed, and as the fuse did not blow it showed my diagnosis was correct. It was then only a matter of reversing the secondary leads on the inside of the case of the 75-kva. transformers. Upon paralleling the two banks after the leads were reversed, they went together perfectly and have operated that way ever since. The difficulty was due to one manufacturer having used the positive polarity scheme of connections and the other the negative. M. A. **Anderson**.

Pittsburgh, Pa.

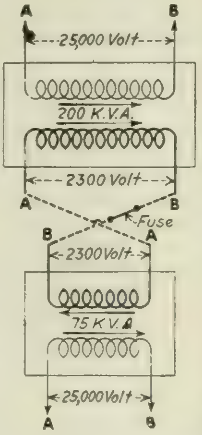


FIG. 1. TESTING TRANSFORMER'S POLARITY

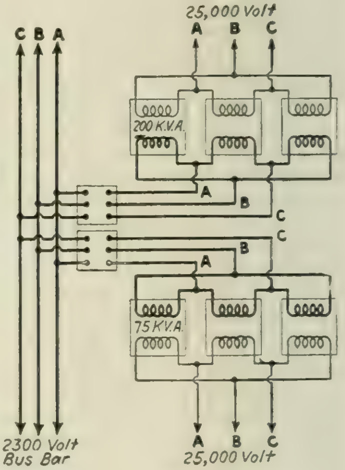


FIG. 2. CONNECTIONS OF TWO TRANSFORMER BANKS FOR PARALLEL OPERATION

Smoke-Observation Sight Hole

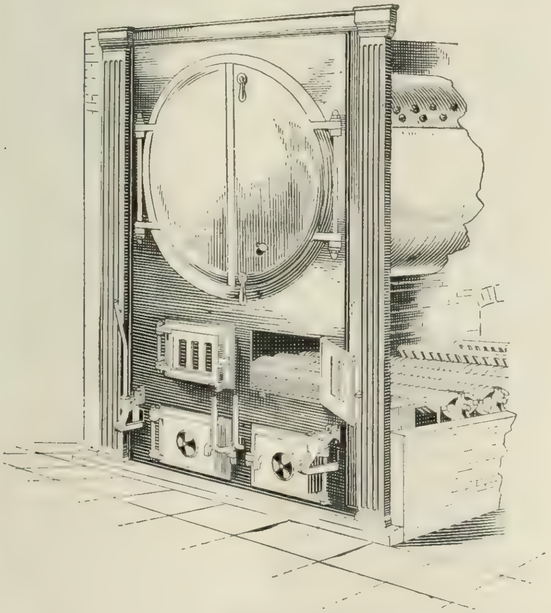
Referring to *Power*, Aug. 24, 1920, page 290, "How a Smoke Cloud Forms," by Osborn Monnett, darkness, both physical and mental, seems to hover over Salt Lake City, far too dense for penetration by those who are supposed to aid in clearing the atmospheric conditions in the beclouded city.

Primarily, the foundation for smoke clouds is laid in the installation of unscientific coal-burning devices. Firemen cannot be taught to do the impossible, hence they fail to prevent the nuisance, but by following standard methods (periscopes) may improve it some.

As an aid to the firemen through daylight or darkness, without or within the boiler room, I call to your attention the accompanying illustration designed by me, with the little sight hole in the uptake door which enables the fireman to know all about the smoke conditions at the top of the chimney.

If the furnace is properly fired, immediately thereafter the view through the boiler tube will be clear and unobstructed by smoke and the wall behind the boiler will be plainly visible. If there is smoke, the fireman will know that his furnace conditions are not right, and by the aid of the sliding dampers in the firing doors he will correct them so that the product of combustion will be CO_2.

In a few hours after taking charge of such a furnace, the fireman will learn that just enough air over the fire to burn the hydrogen gas is needed, and no more, and will adapt himself and the furnace to work together whether he fires light or heavy, and he will close the feed-door dampers when the hydrogen is consumed. His instructor is the visible condition as revealed through the sight hole, and it is unerring and unmistakable. Of course it is assumed that a proper depth of fuel is carried upon the grate and that the chimney draft is approximately correct.

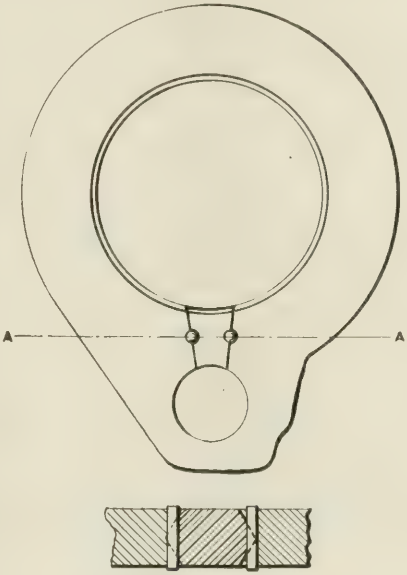


SIGHT HOLE FOR OBSERVING SMOKE CONDITIONS

Buffalo, N. Y. T. E. MARTIN.

Diesel Cylinder-Head Repair

The welding of fractured Diesel cylinder heads is not an unqualified success. It requires an experienced welder, and if extreme care is not exercised the weld will show fractures on cooling. To claim that 50 per cent of the repairs fail to hold is not overstating the case. Especially is this true when applied to the head of the type A Busch-Sulzer engine, which, owing to its shape around the exhaust opening, always shows a fracture. In most cases the initial crack does no damage, but in the course of two or three years of operation at least one head on the engine must be welded or repaired. The welding distorts the lower surface of the exhaust bridge, and no amount of grinding will keep it in line with the rest of the flange surface.



Cross-Section of Wedge at A–A

DIESEL CYLINDER-HEAD REPAIR

Instead of welding, on one particular job a machine process was undertaken. A portion of the metal along the fracture was removed by a shaper and the edges made wedge-shape as shown in the illustration. The surfaces were hand-scraped as was also the steel wedge which was to be inserted in the cavity. The wedge had a 1 to 24 slope and was sledged into place. Two dowel holes were then drilled and pins inserted. The two ends of the wedge were cut off to conform with the adjoining surface. At one end the exhaust valve seats on the wedge, and although the latter was steel, no leaking occurred at the seat.

It will be noticed that the inner, or wide, end of the wedge rests against the male portion of the joint when the head is placed on the cylinder. Even if the dowel pins failed to hold, the male joint would prevent any movement of the wedge. The angular shape of the sides of the wedge effectively prevent any vertical motion. In operation the wedge is absolutely tight and shows no signs of fracture. The stress that exists in a welded bridge is not present. The head is, in fact, better than a new one. The cost of repairing this totaled $48, which is about one-half the cost of welding. E. E. LONG.

New York City.

Multipliers for Use with Portable Voltmeters and Wattmeters

The article on "Multipliers for Use With Portable Voltmeters and Wattmeters," in *Power* of Sept. 7, 1920, neglects one very important detail regarding wattmeter connections. Multipliers should be connected to wattmeters in such a manner that the electrostatic stresses between the potential and current coils of the instrument do not exceed those for which the instrument is designed. Where the current coils of the wattmeter must carry the line current, the multiplier should be connected between the meter and the opposite side of the line from that which goes through the series coils of the instrument. This keeps the potential difference between coils within the range for which the instrument was designed, and the connection is shown in Fig. 1.

If the wattmeter is connected as in Fig. 2, the potential between the coils of the wattmeter is equal to that across the line itself. This will result in distorted readings, and in probable damage to the meter if it is used on a relatively high voltage, as for instance, 2,000 volts.

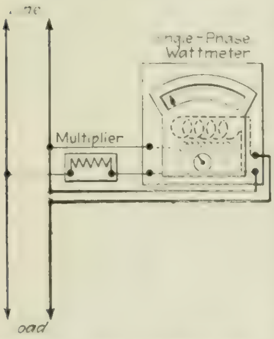


FIG. 1. WATTMETER CORRECTLY CONNECTED

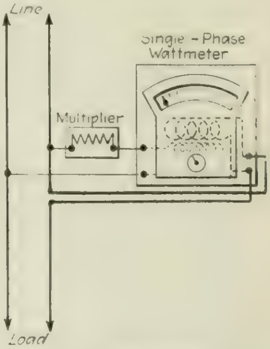


FIG. 2. WATTMETER INCORRECTLY CONNECTED

It is a matter of common experience that wattmeters often burn out under apparently unexplainable circumstances. This usually happens where the meter is at first connected up with due care for the relative potentials as marked on the terminals, and, if the meter gives a negative reading, the operator interchanges the potential wires. On meters having an internal multiplier an effect similar to that given for Fig. 2 is produced. Crossing the potential leads is something of a temptation where the current leads may happen to be heavy and clumsy. Persons using wattmeters have to be careful in connecting the instrument as indicated by the manufacturers, especially as regards the relative polarity of wires.

Eddyville, Iowa. HENRY H. BRUNNER.

The article by H. C. Yeaton on "Multipliers for Use with Portable Voltmeters and Wattmeters," in the Sept. 7 issue, is both interesting and instructive, but a little stress should be laid on the limitations of the formulas and methods described, since under certain conditions their use would give exceedingly misleading results. No doubt the use of multipliers is satisfactory for practically all direct-current potential circuits, but on alternating-current meters the methods described may be used only when the potential circuit is ohmic resistance alone and the inductance is negligible; for instance, in the dynamometer-type voltmeter and wattmeter.

When there is appreciable inductance, as, for instance, in the induction-type or the moving-iron-vane type, the current in the potential coil is no longer dependent on ohmic resistance alone, but on the impedance of the circuit; consequently, instead of figuring out a multiplier with resistance equal to the ohmic resistance of the meter, say for a 2 to 1 multiplier, we must figure out one whose ohmic resistance is equal to the ohms impedance of the meter.

Take a Westinghouse portable induction-type voltmeter, for instance, with 150 volts full scale range. The total ohmic resistance is 1,210 ohms, while a milliammeter in series shows that the meter is taking only 106 milliamperes, so that the impedance is 1,415 ohms, and a multiplier must have this value to give a correct 2 to 1 ratio. Even if the frequency is changed from 25 to 60 cycles and the meter reads correctly on both frequencies, the same multiplier cannot be used on both as the impedance varies with the frequency.

If the inductance, in henrys, of the potential circuit be known, then the calculation of multipliers becomes similar to the method described, but for the value of R the following quantity for impedance must be substituted:

$$\textit{Impedance} = \sqrt{R^2 + (2\pi NL)^2}$$

in which R = ohmic resistance, $\pi = 3.1416$, N = frequency in cycles per second and L = inductance in henrys.

In the case of induction-type wattmeters and watthour meters the use of multipliers is absolutely taboo, since the multiplier creates a large phase-displacement angle, making any readings almost impossible of calculation even in case of extreme necessity. Induction-type meters have been supplied with resistor-reactor multipliers in rare cases, which not only function as a multiplier, but also give the correct phase and approximately correct indication. However, their use is neither practical nor necessary as small portable potential transformers are just as convenient and can be used interchangeably on a number of different instruments and any commercial frequency whenever it is found desirable.

Another case causing much confusion is the attempt to use a multiplier on single-phase power-factor meters or single-phase synchronoscopes. In this case, as before, a multiplier will change the phase relations in the meter so that its indications are worthless and cannot be even approximated. The transformer is also the solution of this problem. E. A. REINMANN.

East Orange, N. J.

Formerly attorney for the Kansas United Mine Workers, Jake (J. I.) Sheppard, of Fort Scott, is in full sympathy with them. "The fact is," says Sheppard, "the miners have been averaging this summer only two days a week in the Kansas fields." "Why then," asked an impertinent questioner, "if that is the case, did they refuse to work on Saturdays?" Sheppard had some sort of an answer ready: "Isn't a man who works as hard as the miners entitled to some sort of a holiday?"—*Coal Age.*

INQUIRIES OF GENERAL INTEREST

Slip of Link—In operation of a link-motion reversing valve gear, what is meant by the slip of the link? L. B.

In operation the link and link block vibrate around different centers. Consequently, for each revolution of the crank of the engine the link slips back and forth a certain distance on its block, and this slippage of one on the other is called the slip of the link.

Cracked Parts of "Dry Type" Semi-Diesel Engine—What would be the cause of cracked bridges of the air and exhaust ports and piston of a "dry type" semi-Diesel oil engine? M. G.

Cracking of the parts mentioned could be caused by excessively high exhaust temperatures as a result of lime scaling of the water jacket, or a leaking atomizer, or from overloading the engine.

Submergence for Air Lift—What should be the amount of submergence of air pipe for an air lift of a well 275 ft. deep, having water 22 ft. from the surface? W. G. S.

Most efficient operation of air lifts usually is obtained with an air-pipe submergence (when the pump is in operation) that will be about 60 per cent of the total air lift, measured from the foot of the air pipe to the level at which the water is discharged, which is equivalent to a submergence 1½ times the height of the point of discharge above the working level of water in the well.

Explosions in Diesel-Engine Air Lines—In a Diesel engine the safety plugs on the injection air lines blow out repeatedly. What causes this? R. N.

It is apparent that explosions occur in the air line. These explosions can be caused in two ways. If the fuel valve spring is very weak, the explosion pressure in the cylinder will force the valve open, allowing the flame to blow through the air line, igniting any deposits of lubrication oil in the line. Also, if the injection air leaves the compressor very hot, it may ignite any lubrication oil deposited in the air pipes.

Determining Lap and Lead of D Slide Valve—How can the lap and lead of a D slide valve be determined without removing the cover of the steam chest? W. R.

Turn the engine over slowly and make marks on the valve stem against the end of the stuffing-box gland when the valve rod is farthest in and farthest out of the stuffing box. Make a mark on the valve stem midway between these two marks and turn the engine over until this middle mark is even with the end of the stuffing-box gland. The valve then will be in the middle of its travel, and the lap on either end will be the distance the valve has to be moved before it begins to uncover the port. Open the cylinder drain cocks and try what position the wheel or crosshead will be in when the valve begins to admit steam to the cylinder and for that position mark the valve rod at the end of the stuffing box. Then the distance from this mark to the mark previously made for indicating when the valve would be at mid-travel will be the lap for the corresponding end of the valve; and the lead will be the greater distance the valve rod would be moved in or out of its stuffing box by placing the crank on dead center.

Height of Closing-in Side Walls of H. R. T. Boiler Setting—At what height should the side walls of a horizontal return-tubular boiler setting be closed in against the sides of the boiler? A. T.

The furnace sides of the walls should be closed in no higher than the highest row of tubes, and for durability of the setting it is preferable to close in not higher than the center of the boiler. Any heating surface obtained of the shell above the center of the boiler receives little benefit of circulation of the heated gases and soon becomes valueless on account of deposits of soot and ashes.

Advantages of Eccentric—When and why is an eccentric used in preference to a crank? J. D.

An eccentric is, in fact, a crankpin that is so large as to envelop the shaft. For imparting a smooth reciprocating motion, the eccentric form of a crank is preferable, because the necessary bearing surface takes up less length along the shaft, the crank motion is obtained without cutting away or reducing the strength of the shaft, and may be made adjustable lengthwise on the shaft and also in angular position with respect to the main crank or other parts carried on the shaft.

Larger Safety Valve for Relieving Lower Boiler Pressure—Can the same safety valve be used if the safe working pressure of a boiler is changed from 100 to 25 lb. per sq.in.? R. H.

If the safety valve is no larger than was necessary for carrying 100 lb. pressure, then with all other conditions the same it would be too small for 25 lb. pressure. Steam at the higher pressure is denser, contains more heat per pound and would be discharged at higher velocity through a given valve aperture, and for equivalent relief of heat a larger safety valve is needed with the lower pressure.

Advantages of Compound Engines—What are the advantages of compound engines over simple engines? J. R. M.

Saturated steam cannot be expanded more than four or five times in one cylinder without so great a range of temperature that the losses from cylinder condensation overcome the advantages of using the steam expansively. If steam of high pressure and temperature is introduced into a small cylinder, and then carried at lower pressure into the main cylinder and there expanded to the desired terminal pressure, the temperature range will not be excessive in either cylinder and, at the same time, the expansive force of the steam is fully realized. In addition the hotter steam thus comes in contact with the smaller areas of the high-pressure cylinders and there is less surface for condensation. Another advantage of compounding is that a simple engine with early cutoff and large ratio between the initial and terminal pressures is subjected to great fluctuations of stresses, requiring a stronger frame and running parts and heavier flywheel, while in a compound engine there may be the same ratio of expansion with much less fluctuation of energy of expansion causing less fluctuation of energy in the cylinders; and where the cross-compound type of engine is employed, with the cranks set 90 deg. apart, the turning effort is more uniform and the engine runs more steadily than with a single-crank engine.

Making Steam Electrically in Switzerland

By E. J. CONSTAM-GULL,
Chief Engineer, S. A. Escher Wyss Engineering Works, Zurich, Switzerland

The author describes and gives performance data on electrically fired steam boilers in Switzerland. It is not likely that electricity will be used to any appreciable extent for this purpose in North America. But in Switzerland, where water power abounds and fuel is scarce and very expensive, electric heating is more and more practiced. Time may show that at some parts of the day in sections of the American Pacific Northwest, where water-power resources are tremendous, electrical heating, even for boilers, would be desirable.

THE adoption of the electrically heated steam generator has been greatly advanced by the scarcity of fuel, and more so by the exorbitant prices charged for it. Many Swiss industries are forced to spend nearly ten times the yearly amount spent for the same quantities in pre-war times. The fuel now obtainable is not only much more expensive than it used to be, but it is less suitable for firing. Some actual cases given here may prove of interest:

1. A small cotton spinning mill requires for its planing department about 2,000 kg. (4,400 lb.) of low-pressure steam per day. With the existing ordinary boiler beechwood is the fuel burned. The price of this fuel is 40 Swiss francs[1] ($7.73) per cubic meter (35.31 cu.ft.), approximately $3.50 per cord foot, delivered. This price includes cutting. The coefficient of evaporation is three; the yearly consumption is 440 cu.m. (971 cord feet), representing a total expenditure for fuel of 17,600 Swiss francs ($3,400). In addition to this must be reckoned the yearly wage of the firemen, amounting to 23,100 Swiss francs ($4,620) per year—this only for fuel for the purpose of producing the steam for the planing.

2. A cotton spinning mill of medium size consumes for its smoothing department about 5,000 kilos (11,000 lb.) of steam per day. The boilers are fired with beechwood and other waste wood, consuming about 3.6 cu.m. (6.62 to 7.94 cords) of wood per day, or 1,090 cu.m. (2,405.9 cords) yearly, which means a yearly expenditure for fuel at the rate of 41 francs per cu.m., equal to 1,090 × 41 = 44,700 Swiss francs ($8,630) plus 6,500 francs ($1,254) for salary for the fireman; in total therefore 51,200 Swiss francs ($9,884) for working expenses only for steam used for this particular branch of the business.

3. A worsted-yarn spinning mill requires daily for the purpose of washing the wool, etc., 12,000 kg. (26,400 lb.) of steam. The existing boiler plant is operated with American and Belgian coal, French "*tout venant*" (run-of-mine), Dutch turf (peat) and firwood chips (waste). Considering a coefficient of evaporation 5½, 2.2 tons daily or 660 tons of coal yearly is consumed, amounting to a yearly expenditure of 660 × 280 = 185,000 Swiss francs ($35,714). Adding 8,400 francs ($1,621) for salary for the fireman, a total expenditure of 193,400 Swiss francs ($37,335) results, and this only for fuel and operation of the boilers for this particular branch of industry.

4. A chemical works requires for one of its branches 48,000 kg. (105,600 lb.) of steam per 24 hours working (day and night shifts). With a factor of evaporation of 6½, 7.4 tons of coal daily or about 2,000 tons yearly must be fired. At the rate of 280 francs ($55) per ton the yearly cost for the fuel is 560,000 Swiss francs ($108,108). Adding 8,200 francs ($1,583) for salaries for the firemen makes a total cost per year of 568,200 francs ($109,691) for steam production only for this particular branch of manufacture.

These few examples will sufficiently illustrate the present high cost of steam in Switzerland. These costs must now be compared with those for producing electrical energy, the price of which, however, extends over a wide range, depending on various factors. There is no standard rate stated, referring in this instance only to the various Swiss

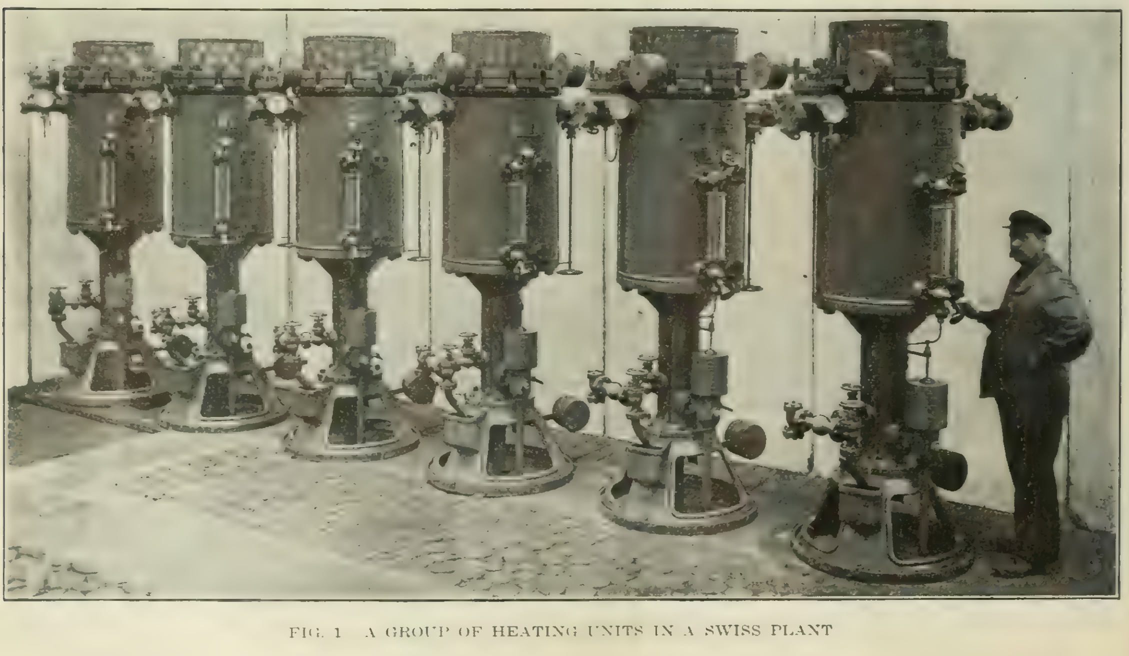


FIG. 1 A GROUP OF HEATING UNITS IN A SWISS PLANT

works that possess their own hydro-electric power plants where they obtain superfluous hydro-electric power at least during the summer season and also during the night hours. These works are no doubt in an advantageous position, but likewise buyers of electrical energy are frequently in a position by the introduction of electrical heating to reduce their working expenses to a considerable extent. It is a well-known feature of the Swiss electrical industry that, in general, there is a surplus of electrical energy during the summer months and at night compared with other times of the year and day. Considering the electrothermic economy of electrical heating apparatus, the problem of converting electrical energy into heat does not now involve particular difficulties. For instance, the electrical steam generator, Fig. 1, of the "Revel" system distinguishes itself by its compact construction, which accounts for its trifling losses of heat due to radiation. This generator has an over-all diameter of 620 mm. (24.2 in.) and a total height of 2.5 meters (approx. 8 ft.). This boiler produces 550 kg. (1,210 lb.) of steam per hour with a voltage of 500 at the terminals, and a gage pressure of 15 atmospheres (220 lb.). The same boiler produces 250 to 300 kg. (550 to 660 lb.) of steam per hour at a tension of 200 to 250 volts.

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[1] According to normal rates of exchange the American gold dollar equals 5.28 francs; at present rates the dollar equals 6.21 francs.

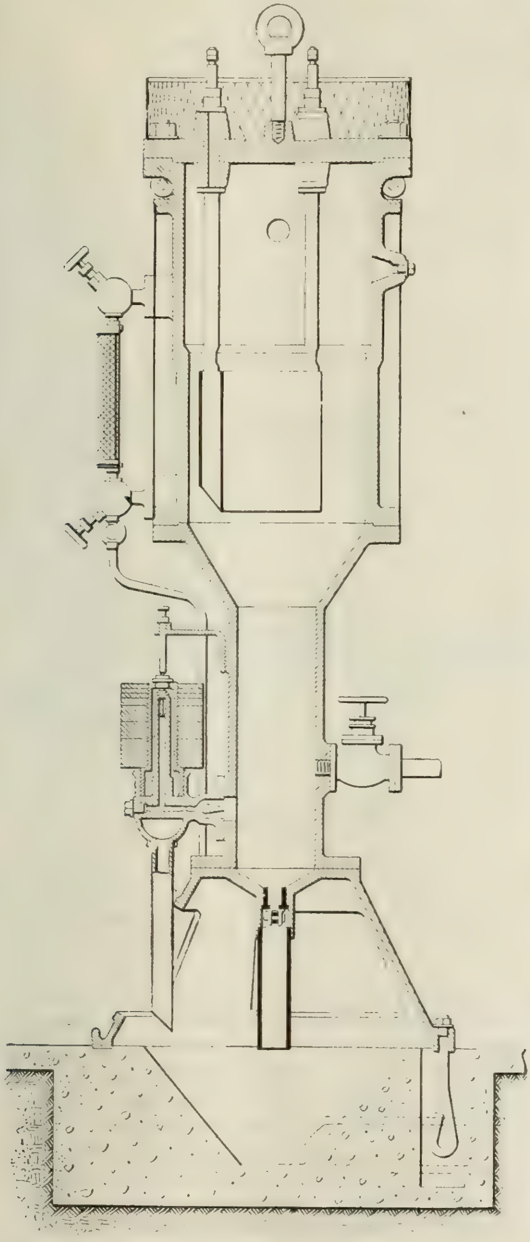

FIG. 2. SECTIONAL VIEW OF ELECTRICAL WATER HEATER

FIG. 3. VIEW OF TOP OF WATER STORAGE TANKS

Fig. 1 shows a battery of 6-hp. "Revel" boilers designed for 15 atmospheres (220 lb.). Figs. 2, 3, 4 and 5 show other views of the boiler and its application. These boilers have an external diameter of 700 mm. (27.3 in.), and a height of 2.7 meters (8 ft. ¾ in.). Their steam production per hour amounts to 800 kg. (1,760 lb.) with the voltage 3,000.

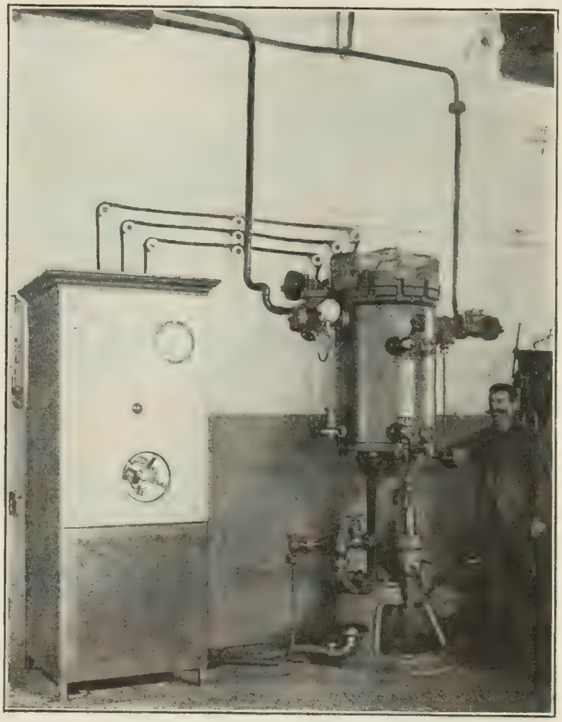

FIG. 4. RESISTANCE BOX AND HEATER

The Swiss Association of Boiler Proprietors have conducted experiments on such a Revel boiler; an extract of the results is given here. The performance corresponds to an evaporation of 1.3 kg. (2.86 lb.) of so-called standard steam per kilowatt-hour. ("Standard steam" here means steam evaporated from and at 212 deg. F.) This steam contained but 3 per cent moisture, compared with 5 to 10 per cent for the steam produced by ordinary boilers. The evaporation and heating of steam in the "Revel" generator is accomplished at the water surface.

As 1 kw.-hr. converted 1.284 kg. (2.82 lb.) of water from 0 deg. C. (50 deg. F.) into steam of 100 deg. C. (212 deg. F.), the actual efficiency of evaporation amounts to 95 per cent. It must be borne in mind that the electrical energy used was only 146.7 kw. per hour, while the boiler was designed for a capacity of 200 kw. The variation in steam pressure was inappreciable during the period of the tests.

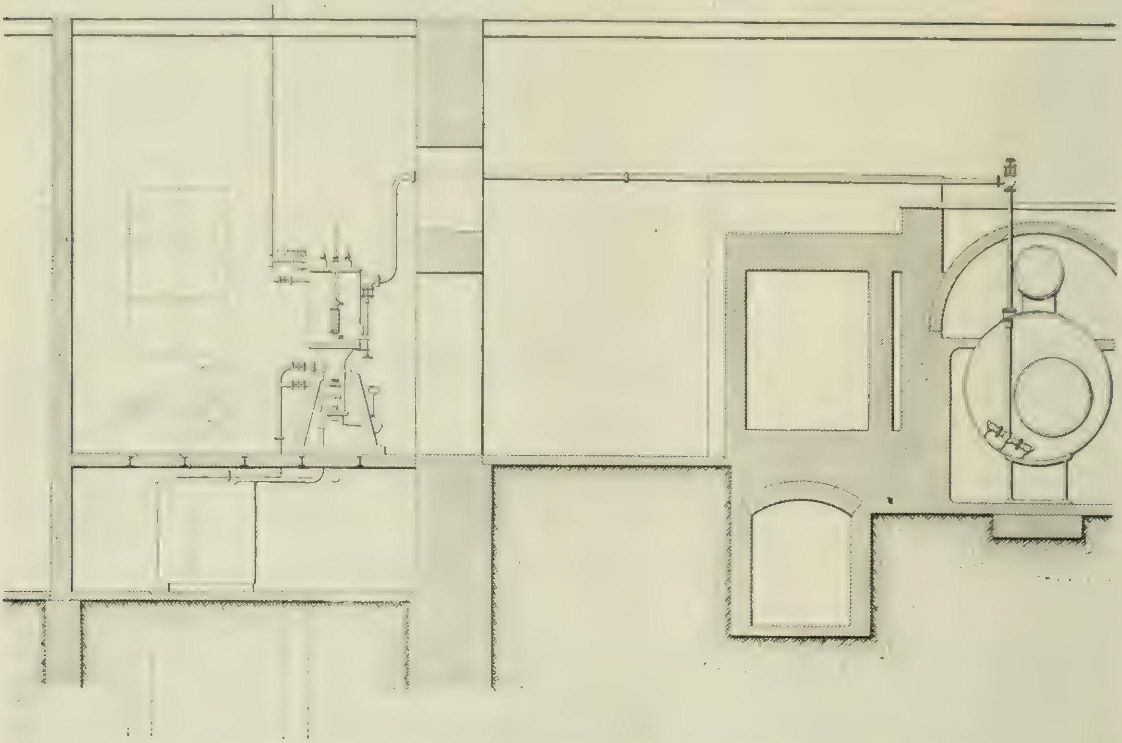

FIG. 5. SECTIONAL VIEW OF PLANT USING ELECTRICAL APPARATUS FOR STEAM MAKING

The main features of this type of boiler are the stationary electrodes which penetrate the cover of the apparatus. The intake of electrical energy into the boiler is regulated according to the quantity of steam required, and is easily arrived at by simply raising or lowering the water level in the boiler.

MAIN RESULTS OF AN EVAPORATION TEST

Electrical readings:		
Mean electrical potential (rectified)	219	volts
Ammeter readings	384	amp.
Mean electrical energy readings (rectified)	367	kilowatts
Mean electrical energy per hour	146.7	kw.-hr.
Evaporation:		
Mean steam pressure (gage) in the boiler	6.42	atm. (94.3 lb.)
Mean steam temperature of feed water, deg. C.	10	(50 F.)
Mean temperature of the waste water before check valve, deg. C. ..	14	(57.2 F.)
Initial heat per kg. of steam	652.6	cal./kg. (2,584 B.t.u. per lb.)
Total evaporation (gross)	461	kg. (1,014 lb.)
Total evaporation per kg. (gross)	182.2	kg. (405 lb.)
Steam produced per kw.-hr. (gross)	1.256	kg. (2.76 lb.)
Water of 10 deg. C. (50 deg. F.) inlet temp. converted into steam of 100 deg. C. (212 deg. F.)	1.284	kg. per kw.-hr. (2.824 lb
Percentage of moisture in steam....	2.93	

Even a low water level in the boiler does not involve any danger, as this is actually the case with ordinary fixed boilers.

Westinghouse Company Receives Large Turbine Orders

The Westinghouse Electric and Manufacturing Co. announces that it has received within the past three months orders from electric power companies for over a half million horsepower of turbine-generators, which represents the largest volume of power business ever given to a manufacturer by private interests. These orders form one of the most effective steps that have so far been taken toward the improvement of the general economic situation. The country as a whole is short of power, and in consequence industry of every kind has been hampered.

Among the orders received by the Westinghouse Company are the following: Cheswick Power Co., Pittsburgh, Pa., one compound unit of 60,000 kw. (80,000 hp.), which will be one of the largest engines ever built; Narragansett (Rhode Island) Electric Light Co., one compound unit of 45,000 kw. (60,000 hp.); United Electric Light and Power Co., New York, two compound units of 35,000 kw. (48,000 hp.) each; Brooklyn (N. Y.) Edison Co., two single units of 25,000 kw. (33,000 hp.) each; United Electric Co., Springfield, Mass., a single unit of 25,000 kw. (33,000 hp.); Commonwealth Edison Co., Chicago, one compound unit of 35,000 kw. (48,000 hp.); Havana (Cuba) Electric Railway Co., two single units of 25,000 kw. (approximately 33,000 horsepower each.

Commenting on this large sale of steam turbines, E. H. Sniffin, manager of the power department, Westinghouse Electric and Manufacturing Co., pointed out that the business in large turbine units was about equally divided, as to number, between units of over 30,000 kw. and units of under 30,000 kw. rating.

From the present knowledge of design it appears that this will continue to be the case for some time to come, but of course definite prediction cannot be made on account of the rapid development in the industry.

Economies in Pumping-Station Operation at St. Louis*

A Review of Coal-Saving Efforts and Results in the Past Five Years—Boiler Efficiencies Increased by Changes in Grate Settings and Baffles—Pump Duties Raised by Using Superheated Steam

OWING to the rapid increase in the cost of coal it became imperative on the part of the mechanical engineers of the St. Louis Water Department to make a thorough investigation of the heat losses existing in our respective pumping plants with a view to reducing the losses to the lowest possible minimum. Coal makes up probably 40 per cent of the total pumping cost. The object of this paper is to present an account of the pumping-station economies effected at St. Louis during the last five years.

According to our experience, the chain-grate type of stoker is best suited for burning the low-grade clinkering coals, such as are found in the Illinois coal fields within a radius of 25 miles from St. Louis. This type of stoker is capable of meeting any peak load up to 100 per cent above normal boiler rating. Its first cost is about half of that of the forced-draft underfeed type. A ratio of 1 sq.ft. of grate surface to 45 sq.ft. of boiler-heating surface has given the best results, considering our loads and coals. The coal is 2-in. Southern Illinois screenings having an average heat value of 10,300 B.t.u., with from 20 to 25 per cent ash.

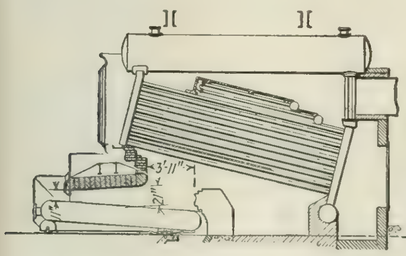

FIG. 1. OLD SETTING AT CHAIN OF ROCKS

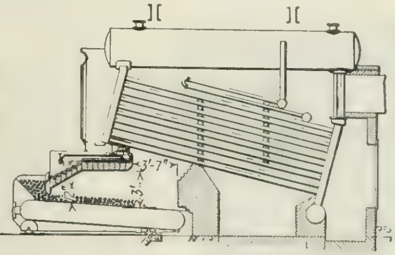

FIG. 2. NEW SETTING AT CHAIN OF ROCKS

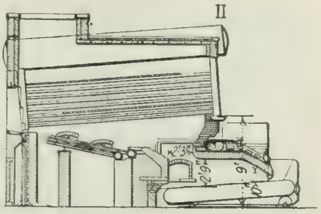

FIG. 3. NEW BOILERS AT BADEN STATION

The first chain-grate stokers we installed were at the Chain of Rocks plant in 1914. They were placed under six National water-tube boilers, each of 360 hp., and two O'Brien water-tube boilers, each of 250 hp. capacity. The boilers were set 7 ft. from the floor, and the arches were set 11 in. from the grate at the front and 22 in. from the grate at the rear, the arch being 6 ft. 5 in. long. The original arch was set according to the design of the stoker contractor. The boilers were arranged with horizontal baffles, the lower baffle being placed on the second row of tubes. The average boiler efficiency under operating conditions with this setting was approximately 58 per cent, and it was difficult to obtain an overload of 25 per cent.

By referring to Fig. 1, which shows the original arch, it will be apparent that from the standpoint of obtaining a large liberating volume under the arch and an efficient shape of the roof so as to obtain the maximum benefits of heat reflection coming from the bridge wall, this arch did not function properly. It did not permit a concentration of heat at a point where a maximum concentration is desired; namely, at the point of ignition. These objectionable features have been overcome by the new design of arch shown by Fig. 2.

In this setting the distance from the floor to the front water leg remains 7 ft., being determined by the original setting of the boiler. The arches are set 12 in. from the grate at the front end, rise rapidly to a hip, and are 36 in. high at the rear. The length of the arch is 6½ ft. This arch has a better concentration of heat rays near the feed gate, the rays being reflected from the bridge wall, than the one shown by Fig. 1, due to obtaining a contour which approximates the curve of a parabola, in which curve all reflected heat rays would concentrate at the focus.

Comparative tests made before and after the change in the arch shape showed: With the old type of arch, on a capacity test run by the stoker contractor, an evaporation of 15,770 lb. of steam per hour was maintained for ten hours. With the new style arch an evaporation of 17,140 lb. of steam per hour was generated for five hours. The former represents an overload of 38 per cent, while the latter represents an overload of 60 per cent. At the same time the average boiler efficiency was increased from 58 to 63 per cent, or a gain in efficiency of approximately 9 per cent. After all the boilers have been equipped with the new arch, it is estimated that the saving in annual coal cost will amount to about $5,000 at this station.

A similar improvement in capacity and efficiency was made at the Bissell's Point Station. The boilers here are set with the front water leg 6½ ft. above the floor line. The original arches were sprung transversely across the grate, 9 in. above the grate at the hip, rising to 18 in. above the grate at the center. Longitudinally, the arch was parallel to the grate. This type of arch (that is, in respect to the low height above the grate) was the common practice among chain-grate stoker builders up to within but a few years past. The arch was removed and replaced with a new type of flat arch, which is 12 to 13 in. above the grate at the feed gate and rises straight, without a hip, to 30 in. above the grate at the rear end. The length is 7 ft. Because of the limitation of the low setting, it was not possible to construct a hipped arch at this station. However, a good saving was effected for the reason that, prior to the change in arch design, it was only possible to burn crushed egg or lump coal at this station, owing to the low arches, which did not effect a proper ignition with the lower grades of screenings. With the new arch the lower grades of screenings are burned successfully, and the same evaporation is obtained per pound of coal with screenings as with the crushed egg or lump coals, thereby resulting in a saving in the price of coal of about 18 per cent. When applied to our last year's coal cost at this station, this amounts to an annual saving of about $10,000. After all the boilers at this station were equipped with the new type arch, the average over all rating of the boiler room rose from 90 per cent to 115 per cent, even with the use of lower grade coal.

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*Abstract of a paper by L. A. Day, Engineer-in-charge Operating Section, Water Division, St. Louis, Mo. Read before the American Water Works Association, June, 1920.

The experiences outlined led us to adopt, in the installation of new boilers at the Baden plant, a setting in which is embodied a construction which we believe eliminates all objectionable features found by previous experience (Fig. 3). In this setting the arch is similar to that of the new arch for the Chain of Rocks Station, the distance at the feed gate above the grate is 10 in., rising rapidly to a hip, and is 34 in. above the grate at the rear. The length of the arch is 7 ft. The height of the front water leg above the floor is 9 ft., this height providing a larger combustion chamber than in the previous settings, thereby obtaining a more thorough mixing of the gases and oxygen and providing a relatively longer gas travel, all of which is necessary for the efficient burning of coal at high rates of combustion. The evaporation at this station averages 6¾ lb. of water per pound of coal at a boiler efficiency of 66 per cent, and comparing this performance with that of the other stations, when the old type of settings prevailed, shows a saving of about 13.8 per cent in coal.

As has been previously stated, the over-all boiler efficiency of the other two stations is 63 per cent with the improved arches, while that at the Baden station, with practically the same style arch as was adopted at the other stations, shows an over-all boiler efficiency of 66 per cent. This increase of 3 per cent in efficiency, or a gain of 4.8 per cent, may be attributed to the higher boiler setting; namely, 9 ft. instead of 7 ft. which prevails at the other two stations. In other words, by setting the boilers two feet higher at the Baden station, we show a gain of 4.8 per cent in over-all boiler efficiency, and this gain when computed on the annual cost of coal at this station, amounts to $3,000 annually.

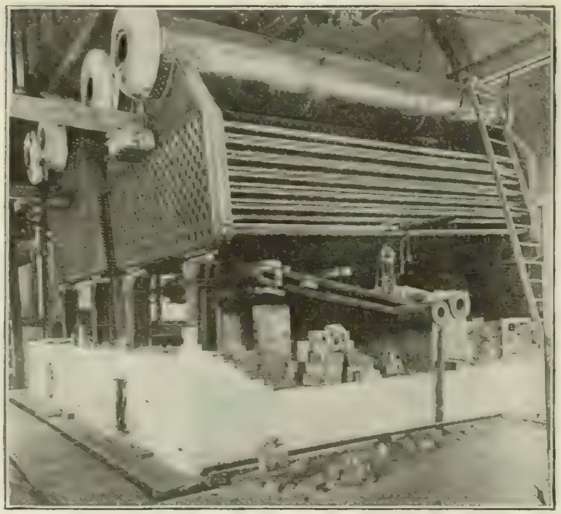


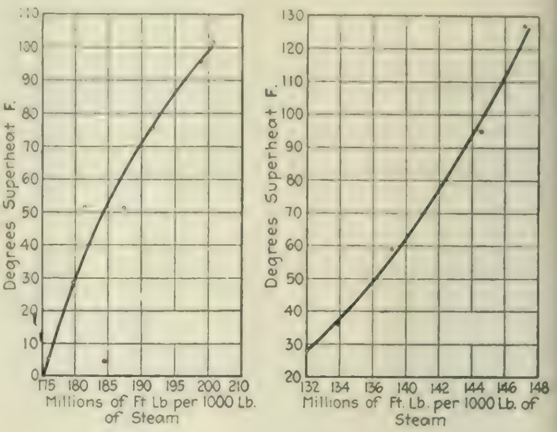
FIG. 4. VIEW OF SETTING OF BOILERS AT BADEN STATION, SHOWING SUPERHEATERS IN COMBUSTION CHAMBER

The gains mentioned are principally due to the improvement in furnace design, but part of the saving in coal must be credited to improvements made in boiler baffling.

Boiler baffling should be so placed as to force the gases into contact with all parts of the tube bank. In the older Heine type of settings at our plants, the lower baffle was made up of box tile on the lower row of tubes, and the upper baffle was 13 tubes above on the top row of tubes. The opening in the lower baffle was in some cases as much as 60 in. from the rear water leg. The path of the gases in this type of boiler was diagonally upward through the tubes, leaving the rear water leg and the tube ends near it untouched by the hottest gases.

By eliminating the box tile on the lower row of tubes and placing a specially designed tile on the third row of tubes, and also reducing the opening in the lower baffle from 60 to 42 in., we reduced the flue temperature from an average of 650 deg. F. to 550 deg.

The use of superheated steam at all of our plants has proved to be one of the greatest factors in increasing the efficiency of the engine rooms. The Water Division has made tests on the effects of superheated steam on triple expansion and on compound pumping engines. The triple-expansion engines, which pump against 85 to 125 lb. pressure and whose capacities vary from 15 to 20 m.g.d., showed a saving for various degrees of superheat as represented by the curve, Fig. 5. The steam saving for 100 deg. superheat amounted to 12.1 per cent, while the saving in coal amounted to 7.5 per cent. The low-service compound pumping engines, which pump against a maximum head of 65 ft., or about 28 lb. pressure, and whose nominal capacity is 30 m.g.d., showed a saving for various degrees of superheat as represented by Fig 6. The steam saving for 100 deg. superheat amounted to 17.3 per cent, while the saving in coal amounted to 13.2 per cent.



FIGS. 5 AND 6. PUMP DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT AT ST. LOUIS

The saving in coal due to the introduction of superheated steam at the Chain of Rocks station has been sufficient to pay for the superheaters in about 3½ years. The life of a superheater, when the elements are not exposed to the direct flame, should be equal to the life of the boilers.

When the compound pumping engine was originally installed 25 years ago, it developed a duty of 118,000,000 ft.-lb. per 1,000 lb. of saturated steam, no superheat being used. The pumping engines at this station were all bought on the bonus and forfeiture basis, which naturally led the contractor to make every effort toward obtaining the highest duty possible. The Water Department, however, in running the duty tests with variable degrees of superheat, made no attempt whatever to increase the economy of the pumping unit before the test was run—by increasing the vacuum, repacking the plungers, renewing pump valves, inspecting valves and pistons, etc. In other words, the test was made on a pump running under every-day plant conditions, and even with a superheat of only 28 deg., which is the lowest obtainable, the pump developed a duty of 132,000,000 ft.-lb. per pound of steam, which is a saving of 11.9 per cent in steam consumption over that of the original duty test with saturated steam, where the duty obtained was 118,000,000 ft.-lb. per 1,000 lb. of steam. This is a very creditable showing for a pump that has been in service for 25 years.

There seems to be, to the writer's knowledge, a prevailing impression in a great many water-works plants, that the use of superheated steam, with its consequent economies, is offset by difficulties with lubrication. This contention is not borne out by our experience.

Our turbine-driven pumps are installed in the same station with the low-service compound pumping engines previously referred to. Two of these are of the single-stage centrifugal type, each of a nominal daily capacity of 35,000,000 gal. They were installed in 1913 and have been in active service ever since. The test duties of these pumps at a head of 65 ft. was 100,000,000 ft.-lb. per 1,000 lb. of saturated steam. A recent test run under the same pumping conditions, but with 124 deg. of superheat instead of saturated steam, showed a duty of 115,000,000 ft.-lb. per 1,000 lb. of steam, an increase in duty of 15 per cent. The physical condition of the pump may be said to have been the same during the two tests, for the reason that the unit had just been overhauled.

On the same turbine-driven centrifugal pump comparative tests were made to determine the difference in duty, with the same superheat and vacuum, before and after the pump was overhauled, as just described. The duty before overhauling was 93,500,000 ft.-lb. per 1,000 lb. of steam and after overhauling was 106,000,000, showing a saving of 13.3 per cent, due entirely to overhauling.

It might be well to mention that the pumps at our low-service station are subject to abnormal wear due to their pumping raw river water containing a large amount of sand in suspension.

Standard Specification for Steam Hose

The American Society for Testing Materials has adopted the following standard specification for steam hose:

. These specifications cover wrapped steam hose, suitable for steam-heat connections when the steam pressure does not exceed 125 lb. per sq.in.

1. Manufacture

2. The hose shall consist of: (a) An inner rubber tube; (b) cotton-duck reinforcement; (c) an outer rubber cover.

3. The rubber tube shall be smooth, uniform in quality and thickness, and free from injurious defects.

4. The reinforcement shall consist of cotton duck woven with not less than 16 nor more than 22 strands per inch of width in both warp and filler, each strand having 5 threads of long-fiber cotton. The duck shall be cut and applied on a bias of from 42 to 46 deg. with edges lapped at least 0.5 in. and with both sides well frictioned with a rubber compound suitable for the required service.

5. The rubber cover shall be uniform in quality and thickness, and free from injurious defects.

2. Physical Properties and Tests

6. Where applicable, references are made below to the Standard Methods for Testing of Cotton Rubber-Lined Hose (Serial Designation: D 15) of the American Society for Testing Materials.

7. The temperature of the testing room and samples shall be as defined in Section 19 of Standard Methods D 15.

8. A portion 18 in. long shall be cut from each length of hose, except in the case of 22- 24- or 30-in. lengths, when one length from each 200 ft. or less shall be taken for test. A portion 2½ in. long shall be cut from the test specimen and subjected to the tests specified in Section 9. The remaining portion of the test specimen shall then have the exposed ends coated with a covering of rubber cement and be subjected to the digester test as specified in Section 12, after which another 2½-in. portion shall be cut from the test specimen and subjected to the tests specified in Section 10.

9. The quality of the rubber friction binding the plies together shall be determined by suspending a 20-lb. weight from the separated end of the duck of a 1-in. test ring cut from the 2½-in. sample described in Section 8, the force being applied radially. The rate of separation of the plies shall be not greater than 1 in. per minute. The test shall extend for 10 minutes when the size of the hose permits.

10. The quality of the rubber friction after steaming shall be determined, as described in Section 9, on a 1-in. test ring cut from the sample after it has been subjected to the digester test, except that a 15-lb. weight shall be used in place of the 20-lb. weight specified in Section 9.

11. (a) The tests of tube and cover shall be conducted in accordance with Sections 18, 20, 21, 22, 23, 24 and 25 of Standard Methods D 15. (b) Test specimens shall be cut longitudinally from the hose. (c) The friction between the inner tube and cotton duck shall be the same as that between the plies. (d) The tensile strength before steaming shall be not less than 600 lb. per sq.in. (e) The tensile strength after steaming shall be not less than 450 lb. per sq.in. (f) The elongation at the breaking load for both the tube and cover shall be such that the original 2-in. gage length of the test specimens shall stretch to not less than 6 nor more than 10 in. before steaming, and to not less than 4 nor more than 8 in. after steaming.

12. The digester shall consist of a closed cylinder containing dry saturated steam at a pressure of 45 lb. sq.in. The test specimen specified in Section 8 shall be placed in the digester and shall remain there for 48 hours continuously. An examination of the specimen after being subjected to the heat of the steam should be made immediately after removal from the digester and should disclose no blistering of the inner tube or loosening of the tube from the fabric. Tests after steaming prescribed in the specifications shall be made as soon as possible after the specimen has cooled for 24 hours.

3. Sizes and Dimensions

13. (a) Steam hose shall be in accordance with the sizes and dimensions specified by the purchaser. (b) The thickness of tube shall be not less than ⅛ in.

4. Workmanship

14. The hose shall conform to the dimensions specified and shall be finished in a workmanlike manner. The tube and cover shall be free from injurious defects.

5. Marking

15. (a) Each 50-ft. length of hose shall have inlaid in rubber in three places, namely, midway between the ends and within 10 ft. of each end, a brand showing the name of the manufacturer, the month and year of manufacture, the trade name of the hose, and the legend "A. S. T. M. Specifications." Shorter lengths than 50 ft. shall have one brand similar to the above inlaid in rubber. (b) Serial numbers of rejected hose shall not be applied to any other hose during the same calendar year.

6. Inspection and Rejection

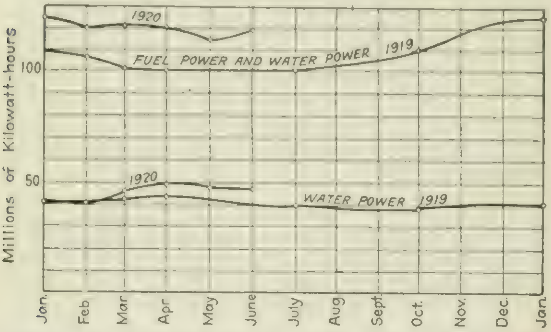
16. (a) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the hose to permit of arrangement for inspection. (b) The manufacturer shall afford the inspector representing the purchaser, without charge, all reasonable facilities to satisfy him that the hose is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works. (c) The purchaser may make the tests to govern the acceptance or rejection of the hose in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser. 17. Samples of rejected hose shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests the manufacturer may make claim for a rehearing within that time.

At a recent meeting of engineers from Louisville and Cincinnati in the Engineers' and Architects' Club a committee of three was appointed to investigate the feasibility of "harnessing" the falls at Louisville. Government engineers have seriously considered the project and after an investigation declared it feasible. W. H. McAlpine, U. S. Engineer, Frank H. Miller, engineer Louisville Electric Co., and Louis E. Strong, of the Louisville Gas and Electric Co., were asked to make an exhaustive investigation as to the feasibility of the falls as power development.

Production of Electricity by Public-Utility Plants

Figures given out by the United States Geological Survey indicate an annual production of electricity during 1919 by water power of 14,740,000,000 kw. hr., equal to 37.9 per cent of the entire production of electricity; 24,160,000,000 kw.-hr., or 62.1 per cent of electricity was produced by fuel power, making an annual total of 38,900,000,000 kw-hr. The total fuel consumption during 1919 for production of electricity was as follows: Coal, 35,000,000 short tons; oil, 11,050,000 bbl.; gas, 21,700,000 M. cu.ft.

The accompanying chart, showing the average daily production of electricity by public-utility plants in the United States by water power and fuel power from January, 1919, until May, 1920, indicates that 110,000,000 kw.-hr. of electricity was produced in the early part of January. This figure dropped steadily, however, until the beginning of March, when it totalled 100,000,000 kw.-hr. Electrical production remained stationary until July, when a steady increase was noted, which reached the high figure of 134,700,000 kw.-hr. in January, 1920. During May the production had dropped to 114,600,000 kw.-hr. with a rise in June to 120,000,000.



AVERAGE DAILY PRODUCTION OF ELECTRICITY BY PUBLIC UTILITY PLANTS IN UNITED STATES BY WATER POWER AND FUEL POWER, 1919 AND 1920

A separate curve on the same chart shows the number of kilowatt-hours produced by water power. From January, 1919, until January, 1920, the production, with slight fluctuations, remained the same, showing an average of 40,000,000 kw.-hr. From February until June an increase was noted which reached its highest point in April with a total of 50,000,000 kw.-hr.

The proportion of each monthly total produced by water power beginning January, 1920, is 33, 38, 41 and 42 per cent respectively, an increase in the amount of kilowatt-hours produced by water power in May of about 27 per cent over January and February. This increase is due largely to the increase in stream flow.

The mean daily output for the first five months in 1919 was 102,680,000 kw.-hr., and the mean daily output for the corresponding period of 1920 was 119,860,000, an increase of 16.7 per cent.

In comparing the 1920 and 1919 curves of mean daily production of electricity, it should be noted that the 1919 curve from April to July is drawn as a straight line as the production for May and June, 1919, was not determined. If figures for these months were available, the 1919 curve might show the same tendency for May as the 1920 curve.

Figures indicating the number of kilowatt-hours produced by water power in various states show California by far the largest producer. Montana ranks second with less than half the production of California. In electrical power produced by fuels, however, California ranks fourth. Illinois is first, Massachusetts second and Michigan third.

It is estimated by the Geological Survey that Pennsylvania used more coal for the production of electrical power than any other state in the Union; New York second and Ohio third. Texas leads in the use of petroleum and derivatives for production of electric energy, and Oklahoma is second. In the use of natural gas for fuel by public utilities, Oklahoma is first, West Virginia is second and Ohio third.

Coal Shortage in Northwest

Important hearings behind closed doors are being held by the Interstate Commerce Commission in an effort to insure the transportation of the Northwest coal and at the same time permit a larger volume of coal to move to Midwestern destinations. All interests concerned are being given an opportunity to be heard. Despite every effort, the railroads have found it impossible to meet the Lake program. With the advent of cool weather the Midwestern States have refused to wait longer for their coal.

A minimum of two thousand additional cars would be required daily if anything like the general distribution of coal is to be secured in Ohio, Indiana, Illinois, and Michigan. The railroads are positive that they cannot take care of this additional movement under present conditions. The commission has given no intimation as to what measures it will take. It may restrict the use of open-top cars to coal movement until the close of navigation. Color was given in this solution by the fact that the commission has called on representatives of the steel and sand and gravel industries, the largest shippers of open-top cars. Another possibility is that the priorities being enjoyed by public utilities may be suspended.

New Publications

GAS AND FUEL ANALYSIS. By Alfred H. White, Professor Chemical Engineering, University of Michigan. Published by McGraw-Hill Book Co., Inc., New York City. 290 pages; 57 illustrations. Price, $3.

A number of volumes dealing with fuel analysis have been published the past few years. Unfortunately, the majority have been of a character that failed to meet the needs of the power-plant engineer. Other volumes written especially for the operating force have been entirely too elementary. While the volume under discussion was written primarily for classroom use, it should meet a ready reception from the practical engineer. The method and apparatus required in fuel testing and gas analysis are fully covered.

ADVERTISING THE TECHNICAL PRODUCT. By Clifford Alexander Sloan and James David Mooney. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Cloth. 6 x 9 in.; 365 pages.

In this book the more important factors of the advertising problem that are peculiar to advertising the technical product are discussed. The work was compiled with the assistanc and co-operation of a number of business men. The efforts of these men. who have all been successful in various phases of the work discussed in the book, have resulted in impregnating it with the substance of practical experience. The book is made up of five parts: The general problem and its economic elements; the instruments available for advertising the technical product; technical advertisements; advertising organizations; and appendix.

FUEL OIL IN INDUSTRY. By S. O. Andros. Published by Shaw Publishing Co., Chicago, Ill. 240 pages; 107 illustrations.

The author of this volume has endeavored to cover the use of oil as fuel in the various industries. The work as a whole is quite good; the first chapters, dealing with the physical and chemical characteristics of oil, are especially worthy of comment. Suitable space has been given over to a discussion of colloidal fuel. A number of chapters are devoted to oil storage, heating, pumping and similar questions concerning the handling of oil. In the remainder of the volume the author has given entirely too much space to descriptions of industrial processes, much of the material having but little bearing on the use of oil as fuel. More pages should have been devoted to methods of installation and proper operating procedure. To those who desire to secure a general understanding of the employment of oil as fuel in industrial processes this work will prove a welcome find

Obituary

Augustus C. Buzby, president and founder of the Keystone Lubricating Co., of Philadelphia, died Sept. 21, at the age of sixty-six years. Mr. Buzby came of an old Quaker family, which settled in Burlington County, N. J., in 1640. He attended the Philadelphia College of Pharmacy, and after his graduation devoted himself to chemistry; later, he organized a wholesale drug-supply business. He was best known, however, as the founder and president of the Keystone Lubricating Co., which he built up into a large and successful organization. He left a wife, Florence Buzby, and four sons, in whose hands the direction of the Keystone company now rests. These men are: Harold A. Buzby, vice president and general manager; Warren F. Buzby, second vice president and treasurer; Norman F. Buzby, secretary and export manager; and Kenneth K. Buzby, assistant treasurer. Mr. Buzby was a prominent Mason, and was a member of the Manufacturers' Club of Philadelphia, the Philadelphia County, Pen and Pencil, Friendly Sons of St. Patrick, Terrapin Club and other organizations. He was also a vestryman of the Episcopal Church of the Savior. He leaves a host of friends who mourn the loss of a square-dealing and honorable man.

Personals

Herbert Hoover has been appointed a member of the advisory Board for the Eastern Industrial Region, Superpower Survey, now being conducted by the Geological Survey.

J. R. Lowe, sales engineer for the Midwest Engine Co., has been transferred from the New Orleans office of the company to the Hill Pump Works Division, at Anderson, Ind.

T. Walter McGrath, for eight years with the Electric Storage Battery Co., is now with the M. J. Dougherty Co., power piping contractors, fabricators and erectors, Philadelphia, Pa.

W. G. C. Thompson, formerly mechanical engineer, D. G. Dery, Inc., Allentown, Pa., has been appointed assistant professor of mechanical engineerng at the Pennsylvania State College, State College, Pa.

Carl C. Thomas has been appointed Western representtive of the Dwight P. Robinson & Co., Inc., engineers. Mr. Thomas will be located in the Electric Equipment Building, South Hope St., Los Angeles, Cal.

Paul J. Keifer, formerly assisant professor of steam engineering, University of Illinois, is now associate professor of mechanical and marine engineering, Postgraduate Dept., U. S. Naval Academy, Annapolis, Md.

A. G. Christie, formerly associate professor of mechanical engineering, Johns Hopkins University, Baltimore, Md., has been appointed professor of mechanical engineering of the Night Technical Schools of Johns Hopkins University.

J. H. Klinck has been discharged from the army as Major, Q. M. C., Construction Service, and has returned to the Westinghouse Electric and Manufacturing Co. He will be located in the general sales department of the East Pittsburgh Works.

Francis Irman has become publicity manager of the Quigley Furnace Specialties Corp., of 26 Cortlandt St., New York City. Mr. Irman has had long experience in the advertising field and is a trained engineer, having received his engineering degree from Kings College, London, England.

H. J. Marks, formerly sales engineer and district sales manager, of New York, for the Badenhausen Co., manufacturers of boilers and American ball engines, is now established at 90 West St. as H. J. Marks & Co., Inc., Sales Engineers, and will act as New York agents for the Badenhausen Boilers, etc.

Ragnar Garlstedt arrived in America on the steamer "Imperator" Oct. 2. He was formerly connected with the Swedish General Electric Co. and is the inventor of many electrical and mechanical devices used in gas plants, pulp and paper mills and power plants. While in this country his address will be Grand Central Palace, New York City.

Society Affairs

The American Association of Engineers will meet at the Engineers' Club of Philadelphia, Oct. 13.

The American Society of Heating and Ventilating Engineers will meet on Oct. 14 at the Engineers' Club of Philadelphia. Dr. John R. Allen will read a paper on "Résumé to the Work of the Research Bureau."

The American Institute of Electrical Engineers will meet at a luncheon at the Engineers' Club of Philadelphia, Oct. 12. Dr. George K. Burgess will address the members on "Bureau of Standards and Its Engineering Contacts."

Members of the Illuminating Engineering Society will meet at a luncheon, Oct. 19, at the Engineers' Club of Philadelphia. "The Inspiring Outlook for American Engineering" will be the subject of an address by Morris L. Cook.

The Detroit Engineering Society will hold its regular meeting Oct. 15. Frank J. Raymond, of the Inter-Racial Council, New York City, will read a paper on "The Relationship of Foreign Labor to Its Employees."

The Detroit Engineering Society will meet on Nov. 5. E. J. Mehren, editor of *Engineering News-Record*, who has just returned from an extensive trip through Europe, will read a paper entitled "Conditions in Europe from a Political, Social and Engineering Standpoint." On Nov. 19 another meeting will be held at which Major Theodore A. Leisen will read a paper on "The New Water Filtration Plant for Detroit."

The National Association of Practical Refrigerating Engineers will hold its eleventh annual convention at the Auditorium Hotel, in Chicago on Dec. 8 and 11, 1920. This is the first meeting of this association to be held in Chicago, and the arrangements that are being made for it indicate that it will be one of the largest ever held by the association. The program has been selected because of its importance as relating to modern, practical refrigeration engineering.

The Glasgow Corporation is making preparations for the engineering, shipbuilding and electrical exhibition that is to be held in the Kelvin Hall, Glasgow, from Nov. 8 to Dec. 4. This hall has an area of over 200,000 sq.ft., and is well adapted for such an exhibition, and will contain, when the show is open, three miles of passageway with stands on both sides. A cinematograph hall is being planned in connection with the exhibition to show films devoted to the engineering, shipbuilding and electrical industries. The exhibitors are to include most of the well-known British engineering firms. It is reported that over 15,000 personal invitations have been dispatched to foreign visitors, for whose benefit, during their stay in Glasgow, advisory bureaus are to be set up by the corporation at the principal Glasgow stations.

Business Items

The Wasioto (Ky.) Light and Power Co. was organized by E. M. Bell and others with a capital of $30,000 for the purpose of installing a plant. The work will be launched at once.

The Hart Co., of Williamsport, Pa., announces its incorporation, under the laws of the State of Pennsylvania with a capital of $100,000. The concern will manufacture a complete line of valves, faucets, basin cocks, etc. The incorporators are Walter Hart, Harry A. Miller, LeRoy W. Gleason, Edgar R. Munson and Harry S. Kolb, all of Williamsport.

Trade Catalogs

The McAlear Manufacturing Co., manufacturers of specialties for steam heating and power plants, have ready for distribution two booklets, 'A" and "B," entitled respectively, "Vacuum System of Heating" and "Vapor Heat." The booklets contain illustrations and text illustrative of vacuum and vapor heating specialties. Copies will be sent on request.

The A. & F. Brown Co., engineers, founders and machinists, of New York City, have ready for distribution a new 130-page catalog entitled "Power Transmission Machinery." The catalog contains numerous photographs and line drawings descriptive of the text. The volume includes descriptions of glass, shafting, couplings, bushings, pulleys, and various other apparatus pertaining to power transmission. A copy will be sent on request.

The Link Belt Co., of Chicago, has ready for distribution a revised edition of catalog No. 380. The booklet which contains 96 pages covers the Link Belt line of standardized monorail electric hoists as well as overhead traveling cranes in capacities of ½ to 3 tons. It completely describes these machines, giving tables of weights, clearance dimensions and speeds, and contains illustrations. Copies can be had by applying to the Link Belt Co., 910 So. Michigan Ave., Chicago.

"Reciprocating Engines and Steam Turbines" is the title of a new 135-page booklet just issued by the Travelers Indemnity Co., Hartford, Conn. Principles of safe and economical operation of reciprocating and steam turbines is the subjected treated in the booklet. The first main division deals chiefly with plant conditions, accident causes, safeguards, etc. The second division takes up the discussion of certain theoretical points that should be of interest to the thoughtful engineer. Particular attention has been paid to the explanation of the principles of reversibility. A copy of this booklet will be sent to anyone interested.

New Construction

PROPOSED WORK

Mass., Danvers—The Comn. of Mental Diseases, 36 State House, Boston, will receive bids until October 14 for installing a 1 story power plant at the State Hospital here. About $250,000. Noted July 20.

Mass., Wrentham—The Commonwealth of Massachusetts, c/o Kendall, Taylor & Co., 93 Federal St., Boston, has rejected all bids for a 1 story, 50 x 70 ft. cold storage building and a 40 x 90 ft. industrial building at the Wrentham State School, here; plans will be revised and new bids will be called. About $100,000. Noted April 27.

R. I., Providence—The City, Public Bldg. Dept., will soon award the contract for a 3 story school, including a steam heating system on Kenyon Ave. About $700,000.

N. Y., Buffalo—The National Lamp Co., c/o F. S. Terry, Nela Park, East Cleveland, O., plans to build a power plant here. About $200,000. George H. Johnson, Nela Park, East Cleveland, O., Archt.

N. Y., Buffalo — The State Hospital Comn., Capitol, Albany, received bids for an addition to the central heating plant at the Buffalo State Hospital here, from Moran & Gibbs, 608 Niagara Life Bldg., $162,300; J. W. Danforth Co., 70 Ellicott St., $168,710; Geo. H. Drake, 218 Lexington Ave., $174,375. Noted August 31.

N. Y., Green Island (Troy P. O.)—The Ford Motor Co., Boulevard and Woodward St., Detroit, Mich., plans to build a power plant here, to develop 6,000 hp. About $2,000,000. Stone & Webster, 120 B'way, New York City, Engrs.

N. Y., Jamestown—The Dahlstrom Metallic Door Co. plans to install a 300 hp. synchronous motor generator set and make changes in the heating system. J. A. Westman is general manager.

N. Y., New York—The Bronx Co., 177th St. and Bronx River, plans to install steam turbines in generating plant.

N. Y., New York—The Dept. of Water Supply, Gas and Electricity received bids for furnishing, delivering and installing additional discharge lines at the 179th St. pumping station from the Melrose Constr. Co., 103 East 125th St., $14,000; John A. Greggory, $14,753; Henry E. Fox, 81 East 125th St., $15,700.

N. J., Pennington—The Peerless Insulated Wire & Cable Company is in the market for shafting, pulleys and hangers, to be used in connection with its new plant. Chas. E. Miller, Supt.

N. J., Ventnor City (Atlantic City P. O.)—The Common Council will receive bids until Oct. 25 for additions and alterations to waterworks including new building, boiler, pressure tanks, etc. W. I. Risley, Guarantee Trust Bldg., Atlantic City, Civil Engr.

Md., Baltimore — The Chizuk Amuno Congregation, c/o W. Levy, 2352 Eutaw Place, will soon award the contract for a 1 and 2 story, 85 x 115 ft. synagogue including a steam heating system at Eutaw Place and Chauncey Ave. About $400,000. J. E. Sherry, 409 Calvert Bldg., Archt.

Md., Baltimore—The Johns Hopkins Hospital will soon award the contract for a 7 story, 70 x 185 ft. hospital building addition at Wolfe and Monument Sts. A steam heating system will be installed in same. J. E. Sherry, 409 Calvert Bldg., Archt. and Engr.

Md., Baltimore—The United States Fidelity & Guaranty Co., Calvert and Redwood Sts., will receive bids until Oct. 21 for a 3 story, 40 x 113 ft. office building including steam heating system on Calvert and Mercer Sts. About $300,000. Wyatt & Nolting, 1012 Keyser Bldg., Archt., H. F. Doeleman, 507 North Charles St., Engr.

D. C., Washington—The Washington Ice Mfg. Co., 3117 K St., N. W., plans to build an ice plant on 32d and M Sts., N. W. About $100,000.

D. C., Washington—Bureau of Yards and Docks, Navy Dept., will receive bids until Oct. 15, for a 69 x 81 ft. power house at the Naval and Experimental Research Laboratory at Bellevue.

Fla., Jacksonville—The Secy. of the City Comn., Room 13, City Hall, will receive bids until October 15 for furnishing and delivering one 333 kva. oil cooled transformer 6,600 13,200 volts primary, 2,300 volts secondary, 60 cycles, 7,200 alternations, provided with four 2½ per cent full capacity taps in the 13,200 volt winding, or two 5 per cent taps in the 6,600 volt winding. Bidders are requested also to state allowance that will be made for three burned out 300 kva. General Electric water-cooled transformers, 60 cycles, 6,600 volts primary, 2,200 volts secondary.

Ga., Trion—The Trion Co., Inc., is planning to build a 1 story addition to its power plant. Jackson & Moreland, 387 Washington St., Boston, Mass., Engrs.

Ky., Covington—The City plans an election to vote on $250,000 bonds for the installation of a 10,000,000 gal. electric triple expansion pump for the municipal waterworks. J. M. Louk, Supt. Pub. Wks.

O., Cleveland—The Allen Theater Enterprises, Richmond E St., Toronto, Ontario, plans to build a power plant for a new theater and commercial building at Euclid Ave. and East 14th St., here.

O., Cleveland—The Broadway Savings & Trust Co., O. M. Stafford, Pres., East 55th St. and B'way, is having plans prepared for an 8 story, 80 x 150 ft. bank and office building, including a steam heating system. About $400,000. Walker & Weeks, 1900 Euclid Ave., Archt.

O., Cleveland—The Citizens' Savings & Trust Co., c/o Alvord Smith, East 9th St. and Euclid Ave., will soon award the contract for a 10 story bank and office building including steam heating system at East 101st St. and Euclid Ave. About 1,000,000. Walker & Weeks, 1900 Euclid Ave., Archt.

Ind., Marion—Hoggson Bros., Archts. and Engrs., 485 5th Ave., New York City, are preparing preliminary plans for a 1 story bank building including a steam heating system, here, for the First Natonal Bank About $300,000.

Ill., Chicago—The Chas. G. Stevens Co., 33 South Jefferson St., will soon award the contract for a warehouse, garage and power house on Western Ave. and 45th Place. About $75,000.

Wis., Camp Douglas—The Wisconsin National Guard is having plans prepared for a 45 x 50 ft. power and engine house and is in the market for boilers and engines. Henry Hengels, 425 East Water St., Milwaukee, Archt. and Engr.

Wis., Milwaukee—Backer & Pfaller, Archts., 216 West Water St., will soon award the contract for a 1 story, 90 x 150 ft. factory including motors, etc., on State St. for the Shope Brick Co., 216 West Water St.

Wis., Milwaukee—The Sewerage Comn. plans to build a boiler house on Jones Island. Six 500-600 hp. boilers will be installed. T. C. Hatton, City Hall, Engr.

Iowa., Fort Dodge—The Bd. Educ., c/o Paul Gustafson, Secy., will receive bids until Oct. 27 for a 3 story 190 x 260 ft. high school including steam heating system. About $650,000. Wm. B. Ittner, Bd. of Trade Bldg., Archt.

Kan., Burlingame—The City is having plans prepared for a power plant. About $70,000. Black & Veatch, 701 Mutual Bldg., Kansas City, Mo., Engrs.

Kan., Wellington—The City is having plans prepared for electrical improvements to the light and water plant including installation of boiler, generator and turbine. About $60,000. Johnson & Benham, Kansas City, Mo., Engrs. Noted March 9.

Neb., Sidney—I. G. Graybill, Mayor, will receive bids until October 15, for remodeling present power plant and installing two 250-hp. boilers, engine, generator, etc. Noted March 9.

N. D., Mayville—Arthur Devor, Archt., 486 Endicott Bldg., St. Paul, Minn., plans to build a 1 story, 64 x 84 ft. power house. About $20,000. Owner's name withheld.

Mo., Webb City—The Rock Hill Pant & Cloth Co. is having plans prepared for a pant factory to consist of a 2 story 61 x 150 ft. and a 3 story, 16 x 30 ft. building, and is in the market for a 250 hp. oil engine. About $150,000. Bucy, Niller Engr. Co., Joplin, Engr.

Tex., Austin—The University of Texas, Board of Regents, is having plans prepared for a 3 story, 70 x 200 ft. addition for the biology department, including additions to the present heating and power units. About $300,000. Geo. A. Endress, Littlefield Bldg., Archt.

Col., Denver—The Rocky Mountain Consistory No. 2, 16th and Grant Streets, is having plans prepared for a 6 story, 116 x 171 Masonic temple including steam heating and forced ventilation system. Estimated cost $650,000 to $800,000. Gardner & Parry, 209 Guardian Trust Bldg., Engrs.

Ore., Burns—Louis C. Kelsey, Consult. Engr., Portland, has submitted estimates to the City Council, for the installation of the proposed municipal light and water plant. About $300,000. Noted June 22.

Ont., Queenston—The City plans to install five generators of 55,000 hp. each and other equipment in the proposed 160 x 600 ft. hydro-electric power house here. About $4,000,000.

Man., Winnipeg—The Government plans to expend $1,000,000 on hydro-electric developments in rural Manitoba. J. M. Leamy, Provincial Power Comnr.

CONTRACTS AWARDED

Mass., Boston—The City has awarded the contract for furnishing and erecting two pumping plants, one to be located at Lincoln power station of the Boston Electric Ry. Co., Commercial St., and the other at Station 38, property of the Electric Illuminating Co., Atlantic Ave., to the Westinghouse Electric & Mfg. Co., 10 High St., at $174,469.

Mass., Wakefield—The Heywood Bros. & Wakefield Co., Gardner, have awarded the contract for a 1 story, 40 x 50 ft. boiler house. Cost, between $25,000 and $30,000. Noted Oct. 5.

N. Y., Brooklyn—The New York State Hospital Comn. has awarded the contract for a 2 story, 50 x 70 ft. addition to the laundry building at the Brooklyn State Hospital to the White Johnson Co., 1133 B'way, New York City, at $150,000.

N. Y., New York—The A Z A Realty Co., 31 East 27th St., will build a 12 story, 25 x 15 ft. office and showroom building including a steam heating system at 115 Lexington Ave. About $600,000. Work will be done by day labor.

N. Y., New York—The Church of Christ Scientist, c/o B. E. Miller, Archt., 477 5th Ave., will build a 75 x 95 ft. church including a steam heating system on Anthony Ave. About $300,000. Work will be done by day labor.

N. Y., New York—The Plaza Hotel, 58th St., has awarded the contract for alterations and addition to hotel including a steam heating system to Geo. A. Fuller, 175 5th Ave. About $250,000.

N. Y., New York—The Union Indemnity Co., New Orleans, La., has awarded the contract for an 8 story office building including a steam heating system at 96 Maiden Lane, here, to A. C. Voight, Grand Central Terminal Bldg., New York City. About $350,000.

N. J., New Brunswick—W. Reade, 112 West 34th St., New York City, has awarded the contract for a 1 story, 100 x 235 ft. theater building on Livingston Ave., to C. Brown, Campbell Ave., Long Branch, N. J., at $500,000. A steam heating system will be installed in same.

Pa., Philadelphia—The Reyburn Mfg. Co., 23rd and Allegheny Sts., has awarded the contract for a warehouse, power house, etc., to Wm. Steele & Sons Co., 16th and Arch Sts.

La., Bogalusa—The Great Southern Lumber Co. has awarded the contract for an addition to paper mill plant including a steam heating system, to Stone & Webster, 120 B'way, New York City, at $250,000.

La., New Orleans—The New Orleans Gas Light Co., Baronne and Common Sts., has awarded the contract for two new generators to the Western Gas Constr. Co., Buchanan, Holt and Winter Streets, Fort Wayne, Ind.

La., New Orleans—The Supervising Archt., Treasury Dept., Washington, D. C., has awarded the contract for a refrigerating machine to be installed in the marine hospital here, to the Wm. Leibe Refrigerator Mfg. Co., New Orleans, La., at $1,990.50.

Ill., Chicago—The Chicago & Alton R.R., 608 South Dearborn St., has awarded the contract for a warehouse including a steam heating system to Dwight P. Robinson, 125 East 46th St., New York City, at $1,000,000.

Wis., Oconomowoc—The Oconomowoc Fuel Co. has awarded the contract for furnishing coal conveying and handling machinery to be used in connection with new coal storage sheds, etc., to the Northern Conveyor & Mfg. Co., 3027 Walnut St., Milwaukee. Est. cost $25,000.

Tex., El Paso—The Home Mission Board, Southern Baptist Conference, Atlanta, Ga., has awarded the contract for 2 ward buildings, power house, etc., here, to the C. W. Hedrick Constr. Co., Southwestern Life Bldg., Dallas, at $300,000.

Ore., Portland—The Public Dock Comn. has awarded the contract for ten 100 hp. motors and compensators for the new 15,000 ton drydock, to the Westinghouse Electric Manufacturing Co., Union Bank Bldg., Pittsburgh, Pa., at $29,040.

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POWER

Volume 52 New York, October 19, 1920 *Number* 16

Automatics

By RUFUS T. STROHM

There are scads of strange devices in our power plants today,
Made to put an end to trouble and to keep the jinx away,
While a lot of them are fashioned with the pleasing end in view
Of avoiding heavy labor that would fall to me and you;
But although they're almost human in the way they do their share,
They require close inspection and they need continued care;
So some accidents will happen and some trials will remain,
For we haven't found the fellow with an automatic brain.

You can use a warning whistle of the kind that starts to blow
When the water in the boiler gets too high or falls too low,
But your hair will turn to silver while you wait to hear it wail,
If the water-column piping isn't free from sludge and scale;
And unless the water tender is alive and on the jump,
It will never halt disaster though it blare like Gabriel's trump;
For a boiler can't forevermore withstand an overstrain,
And we haven't found the fellow with an automatic brain.

You may furnish every engine with a form of safety stop,
With the object of protecting all the workers in the shop,
But you've got to clean and oil it, or its joints will rust and grip,
And you'll find it out of order when you're praying it will trip.
So, you see the risks you're running and the chances that you take
If the chief and his assistants aren't keen and wide awake;
Troubles thrive where men are careless, foolish, ignorant or vain,
Since we haven't found the fellow with an automatic brain.

Thus with stokers, lubricators, non-return valves and the like—
They are mighty clever helpers, but they're sure to go on strike
If, when you have made them part of your equipment, you proceed
To forget you ever bought them and ignore the care they need.
You will find that they'll protect you, and your drudgery will shrink,
But they're only brass and iron, and they weren't made to think;
So you needn't look for absolute security to reign
Till the race brings forth the fellow with an automatic brain.

Central-Station Operation in Tropical America

By L. E. GOWLING
Mechanical Engineer, Havana Electric Railway, Light and Power Company

Operating a power plant in the tropics is accomplished under more difficult conditions than those obtaining in colder climates. Three factors affect the general boiler operation—fuel condition, distribution of load and the general condition of the cooling water for the condensers. The condenser problem is the greatest daily factor that has to be contended with, as the temperature of the injection water averages 81.37 degrees. The article deals with some of the operating conditions.

EARLY in 1913 a consolidation of the street railway, lighting and power interests in the City of Havana, Cuba, was carried out, the new organization being known as the Havana Electric Railway, Light and Power Co. To take care of the ever-increasing demand for electric energy and also to reduce the cost of producing power, the new consolidated power plant was designed and built in 1913-14,[1] this plant (see Fig. 1), taking the place of three old and inadequate power stations. The general equipment of this station consisted of three 12,500-kw. Westinghouse turbine-generators, complete with surface condensers and air, condensate, circulating and boiler-feed pumps, all of centrifugal type and steam-turbine driven (see Fig. 2). The boiler equipment consisted of twenty-four 600-hp. B. & W. horizontal water-tube boilers with superheaters; sixteen of these boilers were equipped with stokers but the other eight, not being immediately needed, were left without furnaces. These are now being equipped with furnaces for oil burning. A complete mechanical equipment was also installed to receive coal from ships or lighters at the private wharf of the plant, deliver it to the furnaces, remove the ashes and load them into railroad cars, all without hand labor. Since the beginning of operation of the consolidated power plant in 1914, the increase in production per year has been continuous and rapid; beginning with the

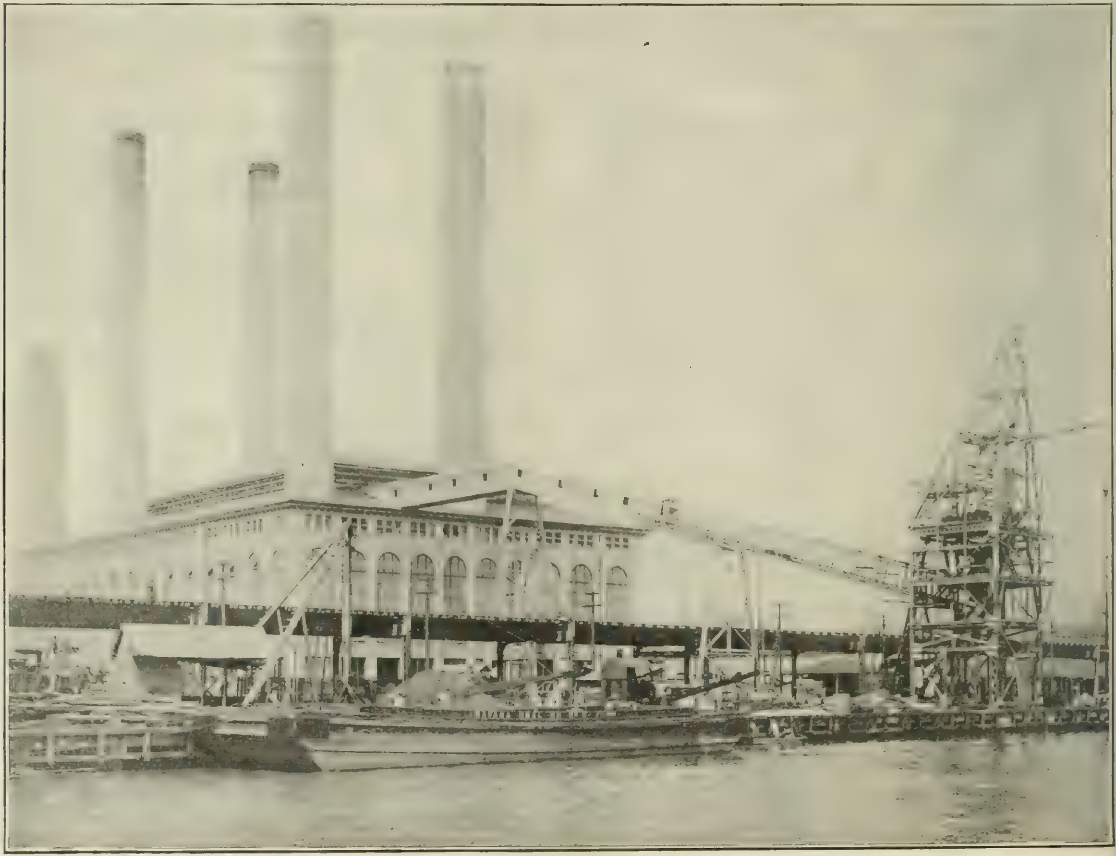

FIG. 1. OUTSIDE VIEW OF THE POWER PLANT OF THE HAVANA ELECTRIC LIGHT AND POWER COMPANY

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[1] Described in *Power*, Aug. 17, 1915, and Aug. 24, 1915.

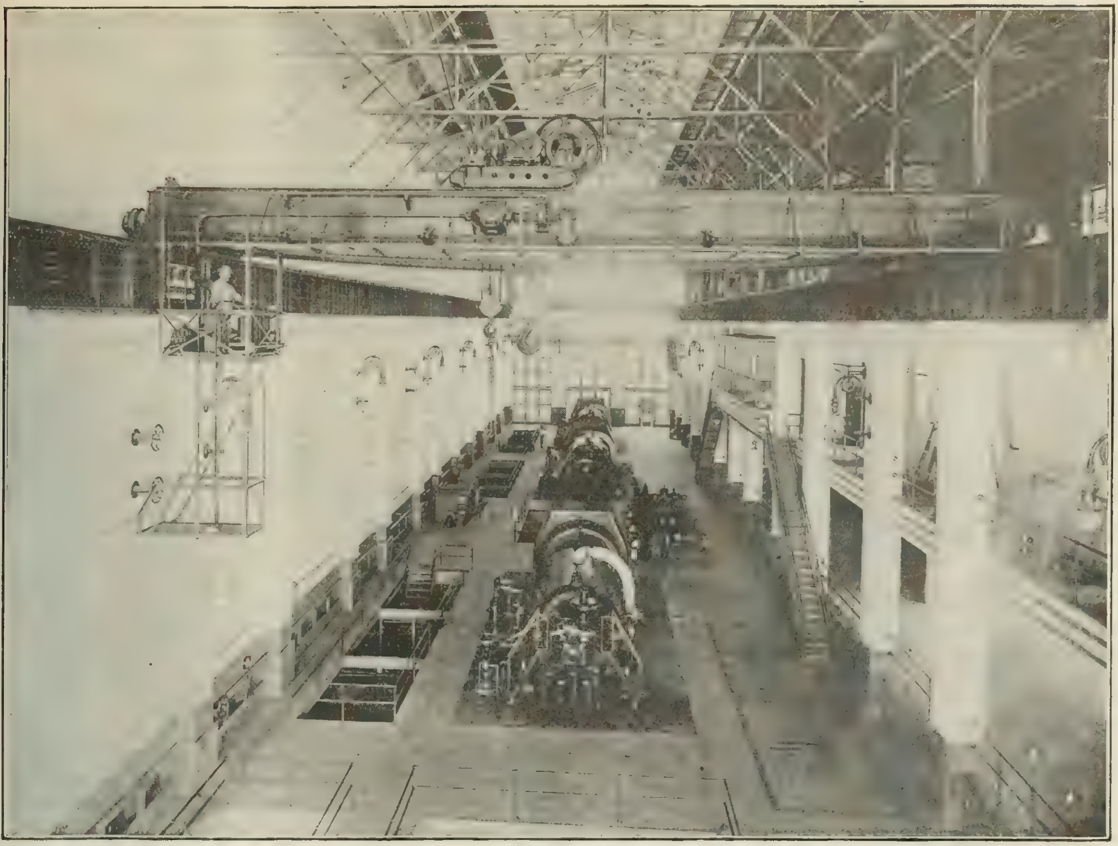


FIG. 2. GENERAL VIEW OF TURBINE ROOM, HAVANA ELECTRIC LIGHT AND POWER COMPANY

current year, however, the increase has far outstripped all previous records. The percentage of increase each year has been as follows: 1915, 6.3 per cent; 1916, 11.2 per cent; 1917, 13.1 per cent; 1918, 7.8 per cent; 1919, 13 per cent; 1919, first six months, 8.5 per cent; 1920, first six months, 23.1 per cent. The curves Figs. 3, 4 and 5 show very clearly the growth of load over the various years.

In operating a central power station in the Tropics, on account of the climatic and living conditions, a somewhat larger labor force is necessary to handle the same amount of equipment; it is necessary that much larger stocks of materials and replacement parts be kept on hand because of delays in shipment and transport; and the cost of all materials is enormously increased. All this tends to increase the cost of energy per kilowatt-hour at the switchboard and to the consumer.

Because of the high importation charges it has been the policy of the company to purchase only the best obtainable grade of coal, but during the late war and up to the present time, it has been very difficult to get selected fuel. The semi-bituminous coal that is being used at present contains about 13,000 B.t.u. per pound, and represents 81 per cent of the total cost of manufacture per kilowatt-hour generated.

Every effort has been made to maintain a high standard of operation in the plant, and the operating efficiencies obtained since the equipment was placed in service have varied but slightly. The cost of energy generated, however, has risen, owing to large increases in fuel, material and labor charges.

The plant supplies current for the operation of the electric railway and the electric light and power service of the City of Havana. The generators operate at 2,300 volts three-phase 60-cycles, at which a portion of the output is distributed to both services. A part of the light and power distribution (underground) is at 6,000 volts, and energy for all the railway substations but one and part of the light and power distribution is transmitted at 13,200 volts.

The three factors having the greatest effect on the general boiler operation in this plant are conditions of fuel, distribution of load and general condition of cooling water for the condensers. The average rating of the operating boilers, based on active hours, is 161.25 per cent with feed water at 214 deg. F.; three boilers only are used on the midnight to morning load, six to handle the day load, and ten to carry the peak, which is very steady. Practically none of the commercial power load extends beyond the daylight hours, and the resultant daily load factor is kept down in consequence. The condition of the circulating water, the effect of which will be described more fully, makes it necessary to maintain at all times a large percentage of banked boilers ready for service, even during the peak hours. About 5.2 per cent of the total coal consumed daily is utilized solely for this insurance of service.

Some general figures given for the average operation of the plant for the first four months of the present year are as follows:

During a series of check runs on the average daily operation last fall, a boiler and furnace efficiency of

79.5 per cent was obtained, with a corresponding coal rate of 1.55 lb. per kw.-hr. generated, the flue gas averaging at the same time about 13 to 13.5 per cent CO_2. This check covered an eight-hour period including the peak.

The condenser problem is the greatest factor in the daily operation that has to be contended with in Havana. The average temperature of injection water for January to May, 1920, was 76.77 deg. F., and the average vacuum obtainable was 27.96 in. referred to 30-in. barometer. In the year 1919 the maximum temperature was 86.40 deg. F., the minimum 72.02 deg. and the average 81.37 deg. The circulating water is obtained from an arm of the local harbor and is a mixture of salt water, a small amount of fresh water from streams and stormwater from drains emptying into the harbor.

Average hourly production, kw.-hr.	8,440
Average daily maximum hourly production, kw.-hr.	17,515
Load factor (daily), per cent	48.19
Based on $\frac{\text{Average production kw.-hr.}}{\text{Average daily maximum production kw.-hr.}}$	
Plant factor, per cent	22.5
Based on $\frac{\text{Average production, kw.-hr.}}{\text{Installed station capacity for continuous rating}}$	
Boiler steam pressure, lb. gage	200
Average superheat, deg. F.	150
Net evaporation — actual	8.42 lb. per lb. coal
Evaporation (from and at 212 deg. F.)	9.52 lb. per lb. coal

Note: Evaporation is corrected for water blowdown and steam used in jets under the grates.

Coal rate	2.121 lb. per kw.-hr. generated
Coal rate	2.135 lb. per kw.-hr. distributed
Boiler and furnace efficiency	72.46 per cent., monthly maximum
Boiler and furnace efficiency	71.00 per cent., monthly average
Net plant efficiency	12.4 per cent

Note: Efficiencies based on assumed average calorific value of coal, 13,062 B.t.u.

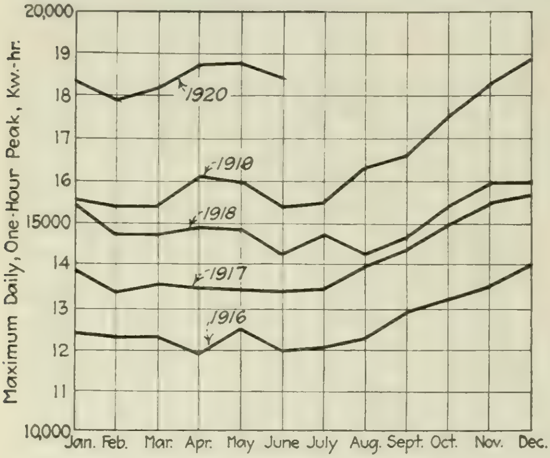


FIG. 3. MAXIMUM DAILY ONE HOUR PEAK IN KILOWATT-HOURS

It carries a considerable amount of salt, some sewage, abundant jellyfish and other animal matter. During the summer months especially, when the water temperature is high, a great deal of very sticky matter is carried in suspension. In fact, this coating on the condenser tubes reduces their heat-transmitting capacity quite seriously and makes it substantially impossible to maintain the cooling surface at high efficiency. This deposit is easily removed, however, by washing with a rotating brush and a stream of water. Most of the condenser fouling comes from the large amount of silt and animal life in the water, and condenser tubes are cleaned with compressed air and water at least every three days and sometimes oftener, in order to keep the vacuum as high as is necessary for good economy of the main turbine units.

Among the different organisms existing in the water are free-swimming barnacles small enough to pass through the screens; they deposit themselves on the walls of the canal in the plant and at certain times of the year break away in masses; this substance is swept into the condenser and stops up the tubes very quickly and sometimes makes it necessary to remove a turbine unit from service at once. The trouble is overcome to some extent by running all the circulating pumps at full speed, circulating a large amount of water in the canal and loosening up the large masses as much as possible. This is done during the period of light load about once a week.

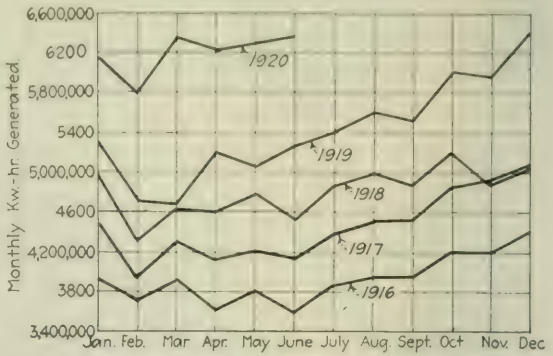


FIG. 4. MONTHLY KILOWATT-HOURS GENERATED

The corrosive action of the cooling water due to its high temperature and impurities is usually severe, and this company was one of the first to make use of the idea of tilting the condensers so that the tubes might drain empty when not in use. This idea was previously worked out in one of the old plants of the company, and the results obtained have fully justified its adoption.

Water for makeup and general plant service is taken from the city water system; it is scarce, high-priced and heavily charged with scale-forming matter. For this reason it is important that all condensate be saved, and the exhaust piping system has been so arranged that any steam not condensed in the heaters is passed to the low-pressure stages of the main turbines, through constant-pressure valves; thus it is made to do useful work and the condensate is saved for boiler feed. As the city supply is subject to variations of pressure and even occasional interruptions seriously threatening the constancy of service, a large fresh-water storage is of great importance and about a fifteen-day supply is kept on the plant property in the combined underground storage system.

A regular maintenance schedule is followed out as closely as is practicable with regard to the boilers, main units, auxiliaries and appurtenances about the plant. Regular and thorough inspections are made every year of each main unit, both the steam and electrical ends, and of all the auxiliaries pertaining to that unit; boilers are cleaned and inspected on regular schedule of working hours, and everything is done to keep the equipment, steam and electrical, in as good condition as possible. Only by this means has it been possible to maintain the plant economically.

It is an interesting fact that the plant was in its sixth year of operation before the first boiler tube was lost, and out of three condensers containing 6,700 tubes each, only 14 have been plugged to the present time, and these showed only slight pinhole corrosion.

Owing to the close proximity of the plant to the ocean and the general humidity and saltiness of the air, particular care has to be taken of the electrical equipment.

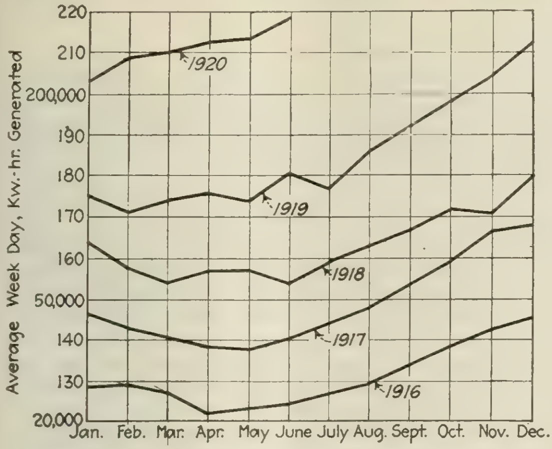


FIG. 5. AVERAGE WEEKDAY KILOWATT-HOURS GENERATED

It is very advisable to keep all electrical apparatus in operation as regularly as possible in order to prevent saturation of the coils; the dampness at night, especially at certain periods of the year, is intense, and at times of sudden changes in temperature the condensation on unused machinery is excessive. Much difficulty is experienced in maintaining switching and other contacts in perfect condition.

The following data on air conditions were obtained during daylight periods only:

Relative Humidity	Nov. 19-Dec. 12, 1919 Deg. F.	June 11-19, 1920, Deg. F.
Maximum	91 0	79 0
Minimum	53.0	58 0
Average	73 0	70 0
Dew Point		
Maximum	74.62	75 46
Minimum	56.75	65 88
Average	66 45	70 39

With the cost of coal mounting year by year, it was thought advisable to make a trial of oil fuel and at the present time the eight boilers which were left without stokers at the time of plant construction are being equipped with furnaces for oil burning. The high setting of these boilers with their front headers 12 ft. above the floor, which at the time of installation was much criticized, should be especially advantageous for burning the new fuel.

Provision is being made to receive oil (Mexican crude) by both water and rail, and storage is being provided on the plant property in underground concrete tanks of such capacity as to furnish fuel for the plant equal to the present coal-bunker supply. With oil as fuel even greater economies of operation and lower energy cost are expected, than obtained with coal.

In view of the future demand for energy an order has recently been placed for two 25,000-kw. three-phase 60-cycle 13,200-volt turbine-generator units with two 56,000-sq.ft. LeBlanc condensers. The new equipment will be installed in the present building with very few changes and in the same manner as previous apparatus was installed.

The condensers will be arranged with divided water boxes so that they can be cleaned while in service, as each condenser is served by two circulating pumps. The turbine will be nozzled to give the best economy between 20,000 and 25,000 kw., and with the new equipment considerable improvement in station efficiency is expected.

A High-Speed Internal-Combustion Engine

H. R. Ricardo, in a paper before the Gas Explosion Section of the British association, as reported in *Engineering*, gave the results of an extended series of tests on a high-speed engine with varying compressions.

A series of the tests dealt with the efficiencies at various loads and with different compression ratios. The results appear in the table. It will be observed that the efficiency at full load was higher with the higher compression ratio; of additional interest are the tests at partial loads, where the efficiencies at the higher compressions show a smaller drop than when using lower compressions.

RESULTS OF THE TESTS

Per Cent of Full Load	Indicated Thermal Efficiency	Brake Thermal Efficiency	Relative Efficiency
	Compression ratio 6 : 1		
Per Cent	Per Cent	Per Cent	Per Cent
100	34.9	30.7	68 2
80	33	27 5	64.5
60	31.0	25.6	60 6
50	30 0	23 9	58 6
40		21.5	
	Compression ratio 4 : 1		
100	27.5	23.4	64 6
80	25.8	21.7	60 6
60	23 5	19 0	55 3
50	22 3	17 4	52 4
40		15 2	

Experiments with different fuels proved, as might have been expected, that each fuel had a certain limiting and very defined compression, after which detonation occurred, followed by preignition and loss of power. In certain oils no detonation occurred; violent preignition and an excessive drop in speed were the first indications that the compression had been caried too high. In all the ordinary fuels preignition never occurred until the engine had passed through the detonation phase.

The general conclusions arrived at may be summed up as follows:

1. The limiting compression is controlled by the tendency to detonate, which in turn is governed by the normal rate of burning. If means are employed for slowing down the normal rate of burning, such as the addition of a small quantity of CO_2, much higher compression ratios can be employed. Preignition which controls and limits the compression ratio, is in nearly every case brought about by some local use of temperature due to persistent detonation.

2. For any given fuel the tendency to detonate depends, apart from the compression ratio, upon the form of combustion chamber, the number and position of the igniters, the inlet temperature of the mixture, the strength of the mixture and the degree of turbulence.

Operation of Synchronous Motor-Generator Frequency Changers

Uses and Applications—Synchronizing and Paralleling Methods—Explanation of Phase Displacement, Angular Lag and Load Division

By M. W. SMITH
Engineer, Westinghouse Electric and Manufacturing Company

IT IS often desirable to change the voltage, phase relation and frequency of power generated on one system for use in another system and for various other reasons. The change of voltage or phase relation may be effected by transformers, but the change of frequency must be accomplished by some form of rotating machinery such as the frequency changer, Fig. 1, or its equivalent. A frequency changer generally consists of two synchronous machines directly connected together, built to operate at the same speed but generating different frequencies; consequently they must have a different number of poles.

The frequency changer may be employed to supply power at a different frequency to subsidiary systems having no other source of power or to link together two independent systems each having its own generating plant. In the former case there are no complications introduced as to synchronizing on both ends, etc., since the set has to be synchronized on one end only. The sole requirement between the relation of the motor and generator is to have the correct ratio of field poles to give the desired change in frequency.

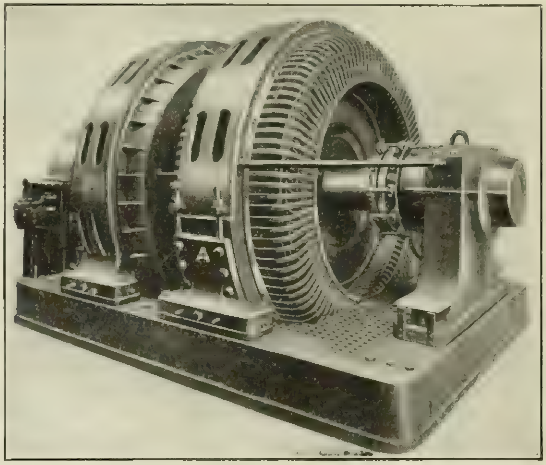


FIG. 1. FREQUENCY-CHANGER SET

There may be various reasons for linking together two independent systems. Where two stations generating power at different frequencies and having their peak loads at different times are close together, there is a mutual economical advantage to be gained in connecting the two systems together by frequency changers, and the efficiency of both plants is materially increased. The frequency changer set is also very valuable when a lighting system generating at 60 cycles is to supply a railway load operating at 25 cycles or in case a railway system is to supply a lighting system. With the increasing use of the single-phase railway motor the frequency changer has been employed as a phase converter as well as a frequency changer by using a three-phase motor and a single-phase generator. By this method the three-phase system is not unbalanced by the single-phase load.

In connection with the foregoing applications the frequency changer has the advantage that by means of a voltage regulator the voltage on the receiving side may be kept constant, within certain limits, regardless of the fluctuations on the motor side of the system. Furthermore, especially in the case of railway work, a load of low power factor on the receiving side has no effect on the power factor of the generating and transmission system.

It is hardly necessary to discuss very fully the methods of starting frequency changers. These have often been explained in connection with synchronous motors. Frequency changers may be started as induction motors by the application of low voltage, usually one-half voltage, on its terminals. This method has the advantage that it requires no synchronizing as the term is generally applied. When the set has reached nearly synchronous speed, the field may be applied and should be overexcited so that when the motor is thrown on full voltage the field will be strong enough to hold the line current down to a reasonably low value. In cases where the line current is excessively high on starting, especially in the case of large sets, or in installations where the generating plant is not very large as compared with the set, it may be necessary to use oil pressure in the bearings.

Where only one set is to be used between two systems, there is no required mechanical relation between the motor and generator, as explained later, and the set is simply synchronized as two machines in the usual way, the motor being synchronized first and then the generator. However, if several sets are to be operated in parallel between two systems, a different problem is encountered. When one set is brought up to speed and synchronized on the motor side with another set, the generator end may not be in phase with the generator bus. This condition is dependent upon the ratio of the number of poles on the motor to the number of poles on the generator. If an unloaded set is being paralleled with busses to which loaded machines are attached, the generator end of the unloaded set can never be in phase with the loaded bus after the motor ends have been thrown together on account of the phase displacement, due to the load.

For the present purpose consideration will be made of unloaded sets. In any case, where the ratio of the poles on the generator to those on the motor is a whole number, the motor and generator of the set must necessarily be in phase. In fact, every one of the north poles on the motor is directly in line with a north pole on the generator, as shown in Fig. 2, so that no matter at what point the motor is thrown in with respect to the motor of the other set, the relation of the generator will be corrected. But when the ratio of the poles on the generator to those on the motor is other than a whole number, the generator will not necessarily be in proper phase at the same time the motor is thrown in. For instance, consider sets connecting together a 25-cycle and a 60-cycle system, these being the standard frequencies in the United States. Suppose at present the motor is on the 25-cycle side, then the smallest number of poles that can be used to give the desired change in frequency is 10 on the motor and 24 on the generator. This gives a speed of 300 r.p.m., which is usually lower than desirable but as high as possible.

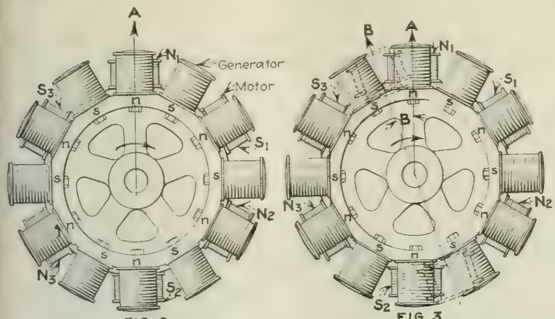


FIG 2

FIG 3

FIGS. 2 AND 3. A SIX-POLE AND A TWELVE-POLE ROTOR. RATIO BETWEEN MOTOR POLES AND GENERATOR POLES A WHOLE NUMBER

In Fig. 4 is shown the relation of the poles on the motor and generator of such a set. Referring to this figure, it will be seen that there are but two poles on the motor which are exactly in line with the poles on the generator; that is, there are only one-fifth of the poles on the motor in line with poles on the generator. Hence there is only one chance in five of the generator potential being in phase with the busbars when the motor is thrown on. In other words, each pole on the motor corresponds to 2.4 poles on the generator, which is equivalent to one complete cycle and 72 deg. additional, or one cycle on the motor is equivalent to 2.4 cycles on the generator. Therefore, five cycles will have to be made on the motor before an integral number of cycles are made on the generator, which is 5 × 2.4 cycles = 12 cycles. But 5 cycles on the motor, or 12 on the generator, is one revolution of the set. Hence there is only one chance in five of both the motor and generator having the correct phase relation.

Synchronoscopes, phasing lamps or voltmeters may be used to determine whether the generator has the correct phase relation after the motor has been thrown on. If correct, the generator switch is closed. If incorrect, two methods may be resorted to in order to secure the correct relation.

One method is to make use of a special synchronism indicator with two pointers appearing on the same dial, which is a combination of the 60-cycle and 25-cycle indicators. After the 25-cycle end is started and thrown on the line, there is, as stated before, one chance in five of the 60-cycle end being correct for connecting in parallel with the other sets. It is always best to start from the low-frequency side, as there is a better probability of both ends being correct for paralleling than when started from the high-frequency side. The position of the 60-cycle pointer on the indicator will show whether the phase relation is correct. When incorrect, the switch on the motor side is opened and the set begins to slow down. The two pointers on the synchronous indicator begin to revolve at different speeds, the 60-cycle pointer making 2.4 revolutions while the 25-cycle pointer makes one. There will be one instant when both hands will appear together at the top of the dial. However, in the case of an unloaded machine being paralleled with a loaded set, the pointers will not come together at the top of the dial but one will be shifted ahead, since the phase angle, due to the load on the other machines, holds them back in angular phase. Whenever these hands or pointers appear together as mentioned, both machines have the proper phase relation, and at this instant the switch on one machine may be closed and the other machine must necessarily have the correct phase relation, and as soon as its switch is closed the set is in parallel with the others.

In the second method of starting the motor is left connected to the line and a double-pole, double-throw reversing switch is used in the synchronous-motor field to step the motor back (by reversing the field) one pole at a time until the generator has the correct phase relation. Since it is purely a matter of chance and there is only one chance in five of obtaining correct relations, it may be necessary to reverse the field several times in succession; in the worst case it will be necessary to reverse the motor field four times.

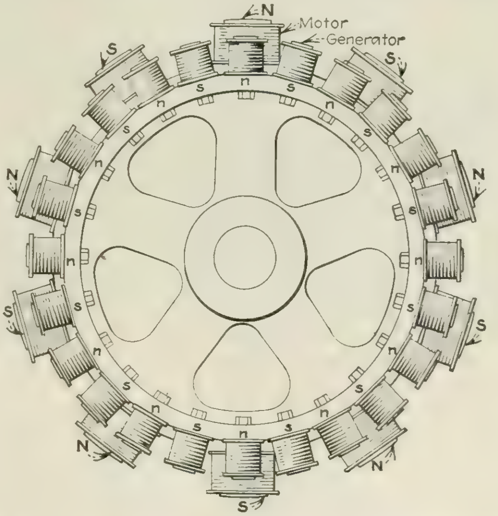


FIG. 4. A TEN-POLE AND A TWENTY-FOUR-POLE ROTOR. ONLY TWO POLES ON MOTOR ARE IN LINE WITH GENERATOR POLES

As mentioned previously, an unloaded set can never be in phase with a loaded set, owing to the phase displacement or angular lag caused by the load. This lag angle is due to both the motor and the generator. Since in a synchronous motor the mechanically revolving field must make the same number of revolutions per minute (although a lag angle may exist between them) as the revolving magnetic field, their relative positions may be examined by the use of a diagram at rest with the same accuracy as if the diagram were revolving at the given synchronous speed. In other words, the point of view will remain fixed with respect to the magnetic field. At no load (neglecting friction, etc.), the magnetic and mechanical fields are in phase. In Figs. 2 and 3 suppose *A* to be the point of view and remaining stationary, together with the magnetic field, and let N_1, S_1, N_2, S_2, etc., represent the motor poles and *n*, *s*, *n*, *s*, etc., represent the poles of the generator. Now when a load is thrown on, the mechanical field of the motor must fall back or lag a certain angle *B*, as shown in Fig. 3, by the poles drawn in dotted lines, so that it may be able to carry the load. The magnitude or number of degrees in this angle will depend on the load, field excitation and number of poles.

FACTORS INFLUENCING LAG ANGLE

Of course, the greater the load the greater must be the lag angle in order to draw larger current from the line to carry the increased load. Since the field excitation fixes the relation between the counter and applied voltages, it must also have some bearing on this angle. If the motor is coupled to a generator having twice the number of poles as itself, the generator will have a lag angle of twice as many electrical degrees as the motor, since the mechanical lag, so to speak, is the same. Take, for instance, the 6-pole motor and the 12-pole generator, as shown in Fig. 2, and, say, a lag angle of 5 deg. (mechanical), there will be a displacement of 15 electrical degrees on the motor and 30 on the generator. The electrical and mechanical design will, of course, also influence this angle, as mentioned later. However, the load is the controlling factor, and, roughly speaking, this angle may be said to be proportional to the load.

In addition to the aforementioned angle there is a further displacement in the angle between a loaded and an unloaded set due to the phase displacement between the induced emf. and terminal emf. of the generator. Every generator must have a certain amount of resistance and inductance in its windings, and when current flows through these windings of the generator, there must be a voltage drop due to this resistance and inductance. The inductive drop is the principal factor which causes the phase displacement. Since the inductance in a machine is practically constant, the inductive drop is proportional to the load, and hence the angular displacement between the induced and terminal voltage of the generator is roughly proportional to the load. A combination of these two actions of phase displacement gives a total displacement (which is roughly proportional to the load) between a loaded and unloaded machine which is equivalent to the sum of the two angles.

PARALLELING FREQUENCY-CHANGER SETS

Obviously, on account of this angular lag an unloaded set can never be exactly in phase with a loaded set, and they must, therefore, be thrown together with this angular displacement between them. Since the emf. of the unloaded set is, therefore, ahead of or in advance of that of the loaded set, it will tend to take the load when the sets are thrown together. However, when some of the load is transformed from the loaded to the unloaded, the lag angle will decrease on the loaded machine and increase on the unloaded machine and the two machines will settle to a stable position, each having the same angular displacement. In some cases where the throwing on of a machine in the manner mentioned causes too much disturbance on the line, the incoming machine may be loaded by water rheostat or other convenient means so as to give it a lag angle corresponding to that of the loaded set in service. A reactance may also be used in the circuit of the incoming machine to limit the initial rush of current. The reactance may be gradually cut out and load transferred to the incoming set.

The load division between sets evidently must depend on the phase angle in each. If any set has a terminal emf. ahead of another set, it will tend to take the load. Two identical sets each having the same field excitation will divide the load equally, but if either set has a motor or a generator with a better or closer regulation than that of the other set, it will take more than its share of the load because (at the same load) its terminal emf. is ahead of the other machines. This machine will continue to take increased load until the increased current in its windings causes its angular lag to equal that of the other machines. Some changes in load division may be effected by field excitation, but this method is not advisable since it must be done at a sacrifice of high power factor, which in many cases defeats one of the main advantages of a synchronous frequency-changer set.

STATOR SET IN CRADLE STRUCTURE

The foregoing discussion has been based on the assumption that the mechanical details were perfect; that is, that the motor and generator were lined up exactly. However, owing to the liability of errors in workmanship and machining, this is seldom if ever the case, and there may be an initial phase displacement even at no-load due to mechanical construction. A machine might easily have such a mechanical error of alignment that its action might be reversed at light loads. In view of the fact that such mechanical error is likely to exist even with the most careful construction, the stators of frequency changers which are to be operated in parallel with other sets are mounted in a cradle construction (shown at *A*, Fig. 1) bolted to the bedplate so that the stator of one machine of the set may be shifted with respect to the rotor and also the stator of the other machine in the set. After the cradle is once set correctly, it is not necessary to change its position for future parallel operation with most frequency-changer sets.

Special cradle construction may be used to shift load from one set to another by shifting the cradle so as to cause the terminal emf. of the one on which the load is to be shifted to lead the terminal emf. of the other machine. Such construction, however, is expensive and undesirable, and is seldom used. This cradle construction is not applicable on a single set connecting together two systems, since there is no fixed phase relation that must exist as between sets in parallel. The rocking of this cradle cannot be used, as sometimes thought, to regulate the energy flow between two systems. The amount and direction of energy flow can be controlled only by the regulation of the prime movers. The energy must flow from the system whose prime movers have the greater driving torque to the other system, since the emf. on that side will be in angular advance of that on the other system.

Behavior of Ammonia in Refrigerating Plants

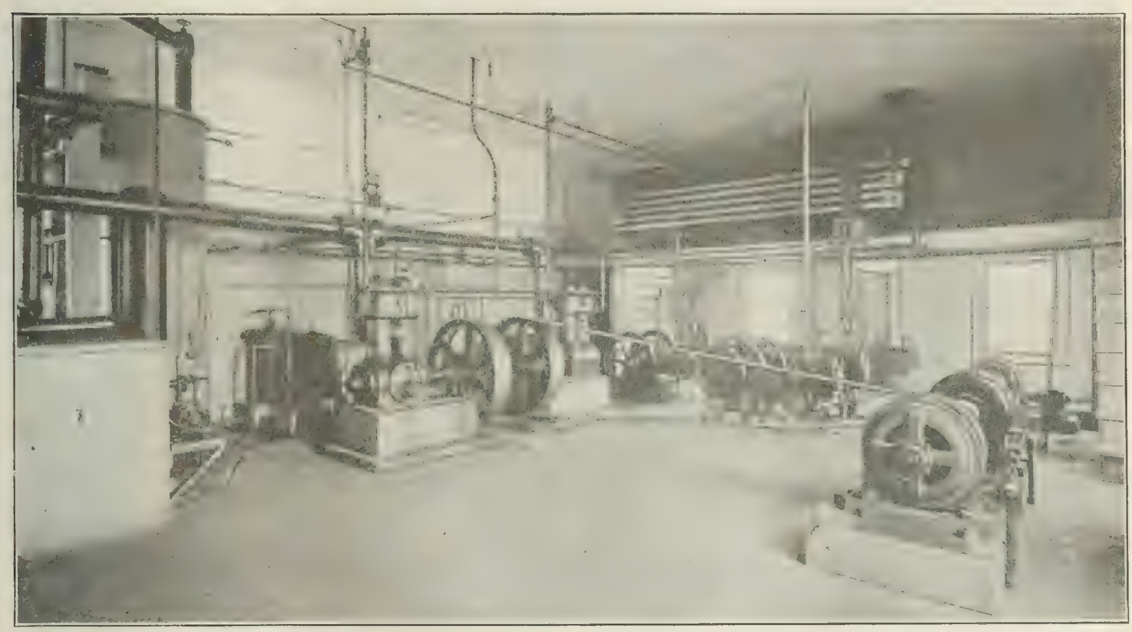
BY JOHN H. RYAN

How to calculate the quantity of ammonia required in a new plant is available in most handbooks, but to find the quantity necessary to add to the charge of a running plant is quite another matter. The author tells how he does it.

THE amount of ammonia required in a new plant varies greatly with the type of plant. A brine-circulating refrigerating plant in which the compressor, condenser, receiver and brine cooler are close together, with short connecting pipes, requires only ten pounds of ammonia per ton of refrigerating capacity. A plant in which the cooling is done by direct-expansion ammonia piping in the rooms often requires as much as fifty pounds per ton of capacity, and if the coils are not defrosted occasionally, a large quantity will lie along on the bottoms of the pipes and slowly boil out. A direct-expansion ice plant requires from twenty to seventy pounds of ammonia per ton of daily ice capacity, depending on its type. An ice plant with top expansion to the tank coils and no unnecessary frills requires even less.

I know a plant of fifty tons capacity in Pennsylvania that worked and defied competition until its owner died, and when we got control of it we found that seven hundred pounds of ammonia gave it a sufficient working charge. It took us a few years to realize how good the old plant was, and in the meantime we had built "hyphenated" plants with different suction pressures, flooded condensers, liquid coolers and regenerators, flooded expansion coils with accumulators and traps, until we required over two hundred pounds of ammonia per ton of ice capacity.

It is usually in the smaller plants that trouble is encountered from too much ammonia in the system. To illustrate the importance of defrosting the coils, an incident in a candy factory is characteristic. The compressor was hitched to a large surface of direct-expansion piping and run day and night. New rooms were piped and connected in. There was a gage glass on the receiver, and the engineer put in ammonia from time to time to keep the liquid showing about one-third full in the glass. The right-hand compressor crankpin worked loose, and when cool weather came the machine was shut down a few days while a new pin was put in. The engineer wanted to do some work on the low side and pumped down while the compressor was running slow, trying out the new crankpin. The water was running through the condensers all right, so the engineer went out in the factory to pack some of the expansion-valve stuffing boxes. He heard some commotion and soon found that the ammonia had driven out a number of people. A fitting had burst on the ammonia condensers and killed two horses hitched to a coal wagon delivering to the plant.



MACHINE ROOM OF A 10-TON IMPROVED RAW-WATER ICE PLANT USING ELECTRICALLY DRIVEN, INCLOSED-TYPE COMPRESSORS

The candy man made a claim for damages, alleging defective material, and I was sent to put on the new fitting and make a report. This was in Massachusetts. The engineer was young, was sure of his facts and presented them like a lawyer. He had a record of the water temperature for the day and the amount being used per minute. The speed of the machine was slow and there was evidence that the "king" valve on top of the receiver was shut. The pressure was equal on the high and low sides at 90 lb. when he started the compressor. It had pumped down to 45 lb. on the low side in a few minutes. He had no recollection of what the high-side pressure was when he went out, but it must have shown all right on the gage for he would have noticed it if wrong. He had a number of valves to pack that were ordinarily under high pressure, and as he was going to oil them only and put another ring in each, the low pressure on them was safe. He assumed that if the packing did blow out of one, it would be only a few minutes until the compressor would pull the pressure down and enable him to get the packing back. .

The broken fitting did not show any flaw; it was slightly rusty from water that had been played on it and it was divided in two. The engineer laid emphasis on the poor weld of the fitting and right then I "got his number." He still had to get his commonsense engineering. I got at the cause of the trouble when he claimed that the fitting let go at comparatively low pressure, because all the noise he heard was what he thought was the fireman blowing down the boiler.

Liquid Ammonia Being Discharged

The sound of a boiler blowing out water is characteristic, is soon recognized and not likely to be mistaken for any other noise. This showed me that liquid ammonia was being discharged to the atmosphere at the time of the break. They were positive that the valves between the condensers and receiver were open and that the anhydrous showed nearly a glass full while the machine was being repaired. I made plain to him how the liquid would lie in the heavily frosted coils, that the frost melted off while the machine was shut down and that when he started it the bare pipe allowed the ammonia in it to get heat and boiled out rapidly. When the receiver was full, the liquid ammonia had to store up in the condenser until something had to let go. He saw the point and went to the office with me, where we got an order for a larger receiver.

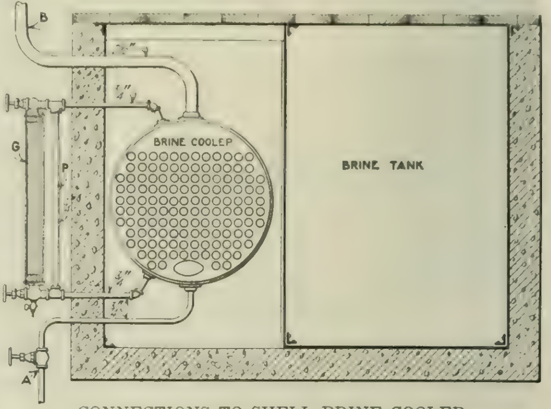
When a Plant Needs Ammonia

To tell when a plant needs ammonia we are informed that the back pressure will fall and the capacity fall off as the charge runs out. A gage glass on the receiver will show the amount in reserve, but the majority of small plants do not have gage glasses so placed, and the engineer guesses the amount. The falling back pressure is not quickly enough noticed as the wider opening of the expansion valve will hold up the back pressure until the charge is small. My method of regulating the charge in all plants is the same. Years ago I acquired the habit of firmly grasping the liquid pipe on the high side of the expansion valve every time I passed by. I made it just as much a part of the regular routine as feeling the compressor rods for packing and oil condition. If there is enough ammonia in the system, the liquid pipe will be cooler to the touch than that of the condensing water leaving the ammonia condensers. The solid stream of ammonia in the liquid pipe has a characteristic "feel" the same as you get from a water pipe in which the water is in motion. If the plant is shy of ammonia, the liquid pipe will be warm to the touch and the mixture of gas and liquid rushing through will rattle the liquid pipe and the vibrations can be plainly felt. Once an operator gets the "feel" of the thing, he never forgets it. And instantly, in any plant, he can tell if it has ammonia charge enough by looking at the gages and feeling of the liquid ammonia pipe.

I have had some odoriferous experiences with ammonia gage glasses, and now I never use them. When I first got the feel of the liquid going to the expansion valves, I abandoned the use of gage glasses on the high-pressure side, but still used them on process coolers on the low side.

Preventing Breakage of Gage Glasses

Once I had a brine cooler of the type shown in the sketch. It was much like a return-tubular boiler with 2-in. tubes set in a head; the brine was circulated through the tubes by a pump. The expansion valve is shown at *A*, the suction to the compressor at *B* and a gage glass about as shown. With the exception of the ¾-in. pipe connecting the top and bottom gage pipes, the pipes from the cooler to outside the brine tank were two feet long and "springy," so that there was trouble with glasses breaking and leaking. In elevator pressure-tank practice the same kind of trouble is experienced, and some bright fellow had the idea of connecting the top and bottom gage pipes together with pipe and fittings to stiffen the gage cocks and glass. I had operated elevators in which the pressure-tank glass for indicating the amount of cushion air was arranged as shown. The first chance we got we stiffened the gage connections as illustrated. I was agreeably surprised to find the frost line on the pipe *P* kept at the same level as the liquid in the glass *G*, and soon learned to depend on this frost line as the means of telling when to open or close the expansion valve *A*. We left the gage glass closed off.



CONNECTIONS TO SHELL BRINE COOLER

Connected as shown, a piece of bare pipe is a reliable indicator of the liquid level in coolers, and there is no danger of bursting compressors with liquid as the contrast between the bare pipe and frost can be seen from a considerable distance, while it needs close scrutiny on the part of the operator to see the liquid in a cloudy, damp glass.

When the first feel of gas in the liquid pipe shows, connect a drum of anhydrous and let it run in until all the pipes are sealed, and then shut it off, as ammonia lying idle in the system is using the firm's money ahead of time.

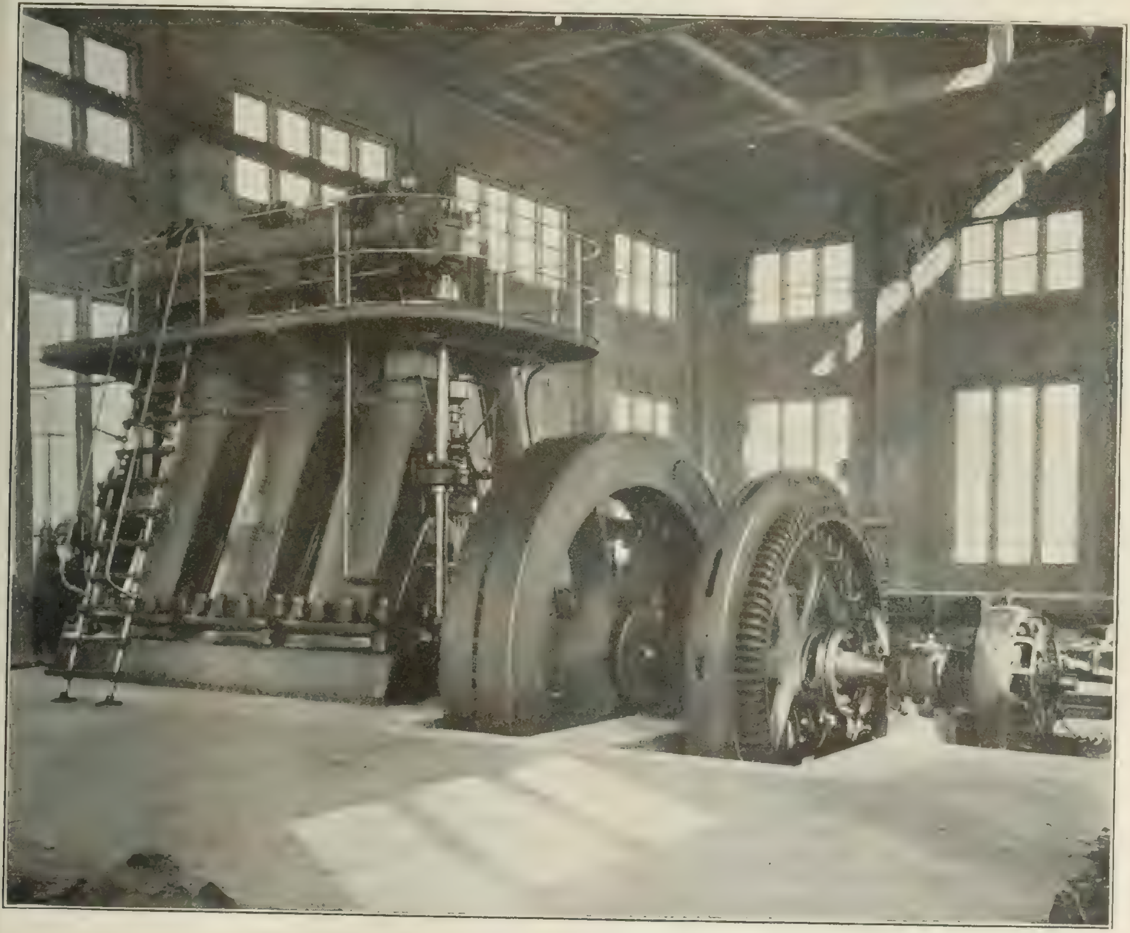
A Diesel-Engined Municipal Light Plant

In Marked Contrast to the History of Small Steam-driven Municipal Power Plants, the Miami, Oklahoma, Diesel Station Shows Decided Earnings

THE history of the average municipal light and water system is not an attractive one. Even the advocates of municipal ownership of public utilities base their arguments on grounds other than low cost. The town of Miami, Oklahoma, however, has a light and water system that not only is able to meet all expenses, but also shows a substantial net earning each month. Miami is one of the newer towns in the northeastern part of Oklahoma which came into existence as a result of the discovery of lead and zinc deposits in that section of the state.

The plant, originally installed to furnish water and light to the city, consisted of a Corliss engine and horizontal-tubular boilers. The water was handled by a steam-driven pump. Even though the town is in close proximity to the Kansas coal fields as well as to Oklahoma oil and gas fields, the plant was always a burden to the community; each year a tax was levied to meet the current expenses of the system. This deplorable condition forced the city to issue additional bonds and install a modern plant.

In the spring of 1919 a concrete building was erected and a Fulton-Tosi 385-hp. Diesel engine direct-connected to a 250-kva. Westinghouse alternator was installed. The steam-driven water-works pump was replaced by an airlift system. The air is furnished by a motor-driven Sullivan angle compound compressor, while a motor-driven two-stage centrifugal pump forces the water into the city mains. The power required by these motors is supplied by the Diesel set with a recording watt-hour meter, and a bookkeeping charge is made against the water department for this power at $0.05 per kilowatt-hour.



MIAMI, OKLAHOMA, DIESEL-DRIVEN ELECTRIC-LIGHT PLANT

The Fulton-Tosi engine has been in operation for more than a year, giving 24-hour service. The unit is shut down on Sunday mornings, when any necessary adjustments are made. The service is extremely severe, since the shutdown period is insufficient to allow any considerable amount of work to be done. Notwithstanding this the operation has been entirely successful, and it is doubtful if any one-engine plant can show a better record of continuity of service.

The fuel used is a 28- to 32-deg. fuel oil and is of a character that causes but little valve trouble. The exhaust valves are ground every four months, while the practice is to pull the pistons every nine months. During the year of operation no serious trouble has occurred beyond the burning of one piston pin. The lubricating device for the piston pin is fastened on an angle iron, which in turn is secured to the A-frames. This angle became displaced, and since no oil reached the pin, the latter was ruined.

TABLE I. POWER PLANT COSTS PER KILOWATT HOUR, MAY 1-30, 1920

Kilowatt-hours output	178,000
Fuel oil, gal	14,003
Fuel cost per kilowatt hour ($2.55 per bbl.)	$0.00483
Labor cost per kilowatt hour	.00518
Lubricating oil, etc	.00580
Insurance and taxes, 4 per cent	.00170
Depreciation, 6 per cent	.00250
Interest, 6 per cent	.00250
Total cost per kilowatt hour	$0.02251

The load caused by the engine ranges from one-third load for fifteen hours to full load for about three hours in the evening. The heavy load comes on rather suddenly, but the engine shows no bad effect from it. There is no tendency toward overheating of any of the parts. The cooling water is kept at a low temperature, never exceeding 110 deg. As a result of the successful record of the engine the city has recently purchased a second Fulton Diesel of 600 horsepower.

In the accompanying tables is shown the financial record of the plant for the month of May, 1920. Considering the light plant alone, the cost of producing power is 2.25c. per kilowatt-hour. This includes fixed as well as operating charges. This compares quite favorably with larger plants in view of the low load factor.

TABLE II. INCOME AND EXPENSE OF LIGHT SYSTEM

Total investment, water and light	$330,080.76
Depreciation, 5 per cent	1,375.00
Interest on bonds, 5 per cent	1,375.00
Labor	923.02
Maintenance	30.60
Lubricating oil, supplies, etc	1,040.42
Total charges	$4,744.04
Income	
Commercial lighting	3,584.47
Power	484.81
Water collections	2,105.46
130 Street lights at $2.50	525.00
89 fire hydrants at $4	356.00
City Hall lights	9.60
Total income	$7,065.34
Net earnings	2,321.30

Operation and Adjustment of Turbine Machinery

IX—Assembling and Draining Packing

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

CARBON packing and the packing casing should be carefully cleaned. A sharp putty knife is the best tool for this purpose. Try the packing in the groove of the casing to make sure that it works freely. Also, as a final test before assembling, the entire ring should be assembled around the shaft. It can then be seen immediately if the ring is smaller than the shaft, and an idea can be gained of how much it exceeds the shaft diameter.

In using strings for tying packing when assembling, be careful to remove these, as they are liable to slip out of place and become jammed. With garter-spring packing it is permissible to tie up a ring with string and assemble the garter spring directly over the string to hold it in place. However, it is never necessary to leave strings inside the packing casing.

Metallic labyrinth packing rings sometimes rub on the shaft when assembled and produce vibration. It is often possible to wear these rings large enough to clear the shaft by bringing the turbine up to speed a number of times. Each time the machine is brought up to the speed at which it vibrates, hold it there a few minutes before lowering. Each time the ring will be cut out a trifle more, and with only a slight clearance to be gained thus, it can be made to operate satisfactorily without the necessity of dismantling.

With some types of packing it is often noticed that leakage occurs after the shaft has been moved, as would be required in taking out a bearing. This leakage will gradually disappear, often requiring several days' time, and is caused by the rings not easily coming back to their proper position. They can be made to take their right position by tapping the carbon casing with a hammer, which would be better than having them leak for a day or two.

The drains in carbon packing should always be open while the machine is shut down. There is often slight leakage from the throttle valve or sealing steam line, which causes water to collect in the casing. When the machine is put in operation, it is necessary, of course, in condensing turbines, to turn on the sealing steam. This acts best when the atmospheric drains are closed. In this case the excess steam condenses and leaks out of the casing a few drops at a time. The water contained in the casing acts as a lubricant during operation. Sometimes it is good practice to open these drains into the engine room itself, so that the excess steam will come out of the drain and indicate that there is sufficient sealing steam present.

Packing rings generally need no lubrication. If the steam contains alkali or sticky sediment, it is advantageous to lubricate with water and powdered graphite at proper intervals in accordance with conditions.

On windy days it is sometimes noticed that carbon packing from high-pressure stages or those pressures above atmosphere leaks badly. This is often caused by the outlet for the packing drains being in such a position outside the building that the wind blows directly into it, causing back pressure.

In starting a condensing turbine, there is usually a quantity of water condensed in the pipe that supplies the sealing steam. It is therefore necessary to be careful in turning on this steam when starting the turbine. It should be turned on slowly until the water has drained through the rings so that water hammer will be prevented and damage to the delicate packing rings thus avoided.

It is not always necessary that shaft packing should hold tight. When sealing against a vacuum, a slight leakage is often desirable to insure a sufficient amount of steam for sealing purposes. On account of the limited space an elaborate arrangement of packing rings cannot always be placed, and therefore these rings are made as few and as durable as possible.

The actual limits of performance of shaft packing are often determined by the piping of the drains. These should not be led into a sewer where back pressure exists, as this, in nearly every case, will cause leakage at the machine.

Comparison of Power Flow

By Leonard A. Doggett*

In a steam-power plant raw material in the form of fuel is manufactured into either mechanical or electrical power. It may occur to the power-plant engineer to follow his product through the manufacturing process, which may easily be visualized as in Fig. 1. Energy is stored in chemical form in the coal pile. When the coal is burned under the boiler, power flows from the boiler through the pipe to some sort of prime mover, in this case a steam engine, which converts this thermal power into a mechanical form at the shaft. Thence it is transmitted as mechanical torque at some definite speed to the receiver of power, which may be mechanical load in the shape of lineshafting or what not, or it may be an electrical generator as in the figure. In this latter case the mechanical power is converted into electrical power and as such is transmitted over wires to the various receivers of electrical power, which is represented by a motor.

In order to picture in a more definite way the "size" so to speak, of the different parts in various power-generating equipment, Fig. 2 and the table have been prepared. The interpretation these may be given is somewhat as follows:

For example, in the first case about 400 kw. of power flows along the 3-in. steam pipe, requiring the use of 8 lb. of material per running foot. The next step consists of the extraction by the prime mover of some 55 kw. of power, which is passed along a shaft to a set of reduction gears. Approximately 53 kw. reappears at the 1,200-r.p.m. generator shaft, which is 3¾ in. in diameter and weighs 38 lb. per running foot. Following the power still farther through the generator, it will be found that 50 kw. is available and that this power is in such a form that it can now be supplied by a 0.7-in. diameter wire, weighing a little less than 2 lb. per running foot. Electrical power differs from the other forms of power in that it needs a return circuit, so that half of the area of the 0.7 in. wire is to be allotted to the outgoing current and the other half to the return current. A similar analysis may be applied to the other cases, but in all the conclusion is the same—electricity is the most compact form in which power can be transmitted. Fig. 1 simply shows to scale the size of shafts, steam pipes and electric wires, going and return, for four small steam-electric units. These figures neglect all considerations of shaft bearings, pipe lagging and supports, and electric-wire insulation and spacing. The great number of variables entering into the design of all three of these tabulated figures, such as speed, steam pressures, superheat, voltage, length of line, etc., would inevitably lead to a wide variation in the sizes of the circles. However, one generalization from Fig. 2 is true for all ordinary cases—the cross-section representing the electric wires is the smallest of the three cases.

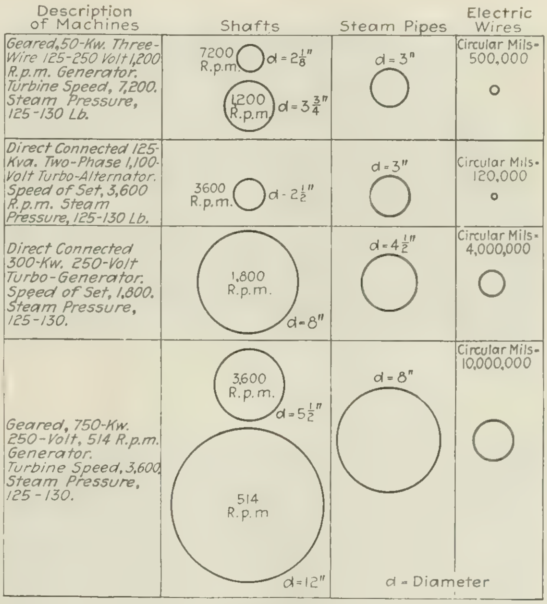

Description of Machines
Shafts
Steam Pipes
Electric Wires
Geared, 50-Kw. Three-Wire 125-250 Volt 1,200 R.p.m. Generator. Turbine Speed, 7,200. Steam Pressure, 125-130 Lb.
7200 R.p.m.
d = 2⅛"
1200 R.p.m.
d = 3¾"
d = 3"
Circular Mils = 500,000
Direct Connected 125-Kva. Two-Phase 1,100-Volt Turbo-Alternator. Speed of Set, 3,600 R.p.m. Steam Pressure, 125-130 Lb.
3600 R.p.m.
d - 2½"
d = 3"
Circular Mils = 120,000
Direct Connected 300-Kw. 250-Volt Turbo-Generator. Speed of Set, 1,800. Steam Pressure, 125-130.
1,800 R.p.m.
d = 8"
d = 4½"
Circular Mils = 4,000,000
Geared, 750-Kw. 250-Volt, 514 R.p.m. Generator. Turbine Speed, 3,600. Steam Pressure, 125-130.
3,600 R.p.m.
d = 5½"
514 R.p.m
d = 12"
d = 8"
Circular Mils = 10,000,000
d = Diameter

FIG. 2. TABULATION OF SIZES OF SHAFTS, STEAM PIPES AND CONDUCTORS

POUNDS PER LINEAR FOOT OF TRANSMITTING MATERIAL

Size of Set		Shafts	Steam Pipe	Electric Wires
50 kw.	Turbine	12	8	1.8
	Generator	38		
125-kva		17	8	0.5
300-kw		171	12	12
750-kw	Turbine	81	30	31
	Generator	385		

The electric wire sizes represent the area of cross-section of the wires, going and return, and have been determined by the rules laid down in "Current-Carrying Capacity of Electric Cables, U. S. Navy," by Lieutenant Commander A. M. Charlton, U. S. N., Vol. XXXI, No. 4, November, 1919, A. S. N. E. Proceedings.

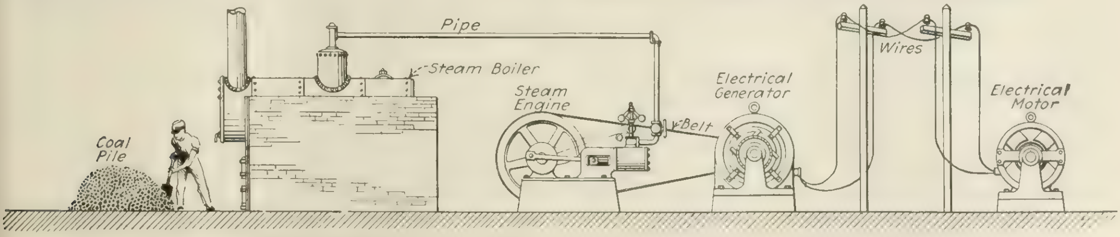


FIG. 1. POWER-GENERATING EQUIPMENT FROM COAL PILE TO ELECTRIC MOTOR

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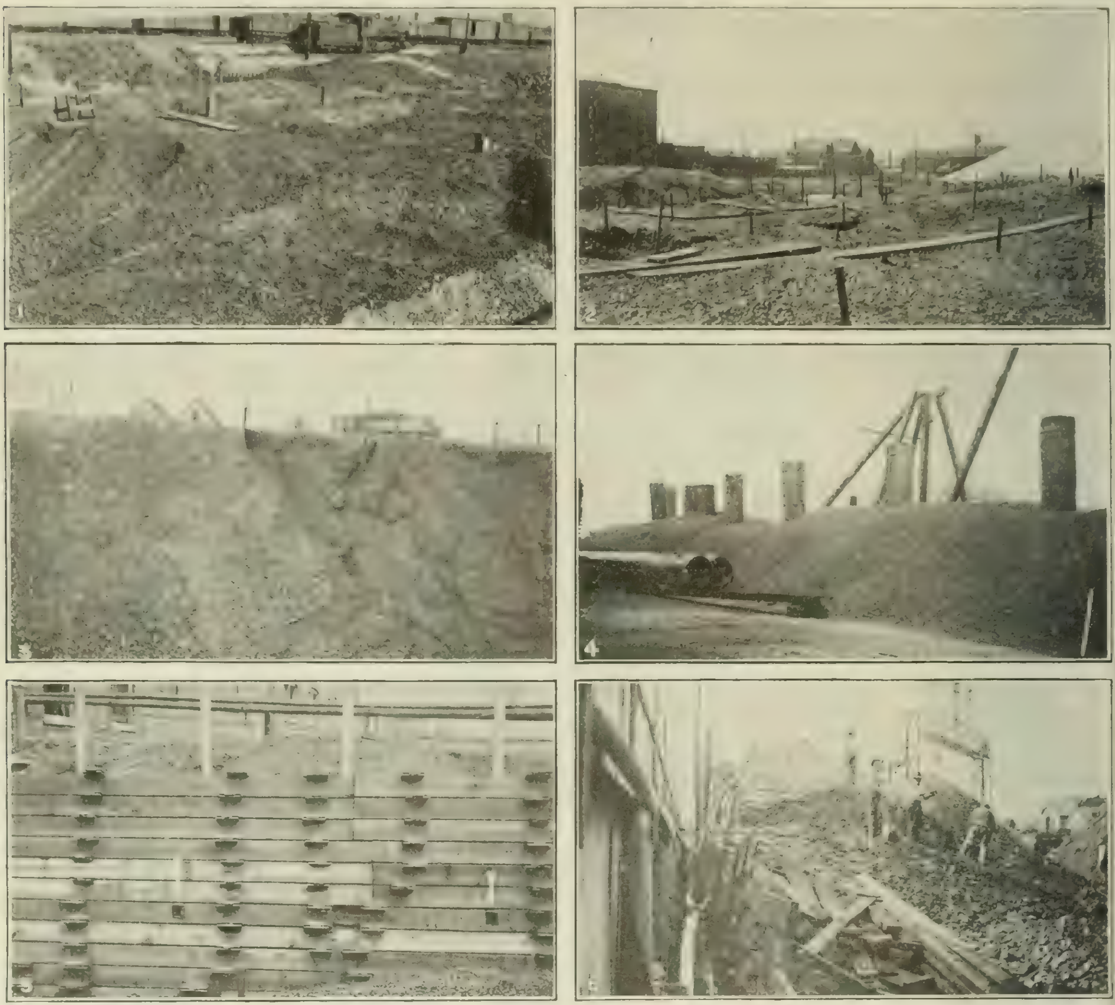
*Professor of Electrical Engineering, United States Naval Academy, Annapolis, Md.

Ventilation of Coal in Storage

By W. D. Langtry
President, Commercial Testing and Engineering Company, Chicago, Illinois

THERE seems to be a great difference of opinion on the subject of the ventilation of coal in storage. The accompanying views give some idea of the methods employed by chief engineers and managers of industrial and municipal plants. During the war the owners of storage piles tried to protect them as much as possible. Invariably, "ventilation" was the one method thought best, until the pile started "to go up in smoke." It might be interesting to notice that the coal piles in Figs. 1, 2, 3 and 5, all of which show attempts at ventilation, caught on fire. Fig. 4 shows a pile of sized coal, $1\frac{1}{4} \times \frac{3}{4}$ in., ventilated by large pipes. There is little doubt that this coal would have stored just as successfully without the pipes as it did with them inserted. When this pile was inspected, the suggestion was made to leave the pipes as originally placed to see if a fire would start, but there was no evidence of spontaneous combustion three or four months later. No attempt was made at ventilation of the pile shown in Fig. 6, but the wooden anchors were the means of admitting the air into the pile, which later caught on fire.



FIGS. 1 TO 6. SOME ATTEMPTS AT VENTILATION

Fig. 1—Vents made out of wood. Fig. 2—Numerous gas pipes for ventilating purposes. Fig. 3—Vapor coming out of ventilator pipe. Fig. 4—Large flues inserted for ventilating purposes. Fig. 5—Horizontal ventilation. Arrows points to ends of wood vents. Fig. 6—Retail yard in which wooden anchors admitted air to pile.

There is no doubt that ventilation is a good thing and will make the storage of coal safe, if sufficient air is supplied to carry away the gases and keep the coal below the ignition temperature. How to determine the degree of ventilation is the problem. Where air is admitted into the interior of a pile of coal oxygen comes in contact with the coal and oxidizes it. It is necessary that there be ventilation sufficient to take away the gas so generated, but in many cases there has been just enough oxygen admitted to start trouble.

A rather interesting incident happened at a plant in Michigan. Coal had been placed under cover in a bin about 25 ft. wide, 50 ft. long and 20 ft. deep. As the coal built up two ventilating pipes were inserted, one extending about two feet and the other about four feet above the top of the pile. Smoke from a cigarette was blown across the mouth of the shorter pipe, and strange as it may seem, it was immediately drawn downward. Smoke blown across the top of the longer pipe indicated an upward current. There was a chimney effect pure and simple. This storage pile had to be moved to save it from complete destruction.

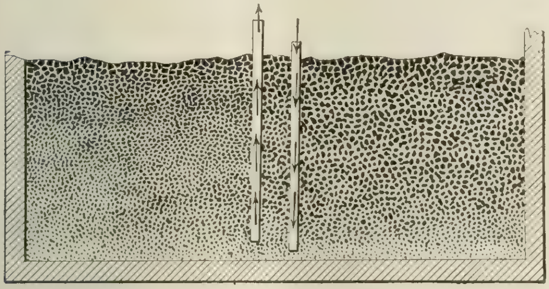


FIG. 7. CHIMNEY EFFECT FROM VENTILATORS

In Canada the railroads have made a practice of ventilating their coal-storage piles. By observing rigid precautions they claim that spontaneous combustion can be prevented. It should be kept in mind, however, that the temperatures in Canada range somewhat lower than in this country. Climatic conditions may have an important bearing on the success of any method of ventilation, and what seems to be satisfactory in a cooler climate might not be so in a locality where the temperature is higher and the humidity greater.

This question always presents itself, Would not the pile that has been ventilated successfully have gone through without a fire if no ventilation had been attempted? It is almost impossible to place two piles of coal in exactly the same way and have the same percentage of fine and lump in each, and then try to ventilate one and not the other for comparison. There are too many variables to contend with, so conclusions or opinions can be reached only from experience. In this regard the following quotation from Bulletin No. 116 from the University of Illinois, now in the course of printing, may be of interest:

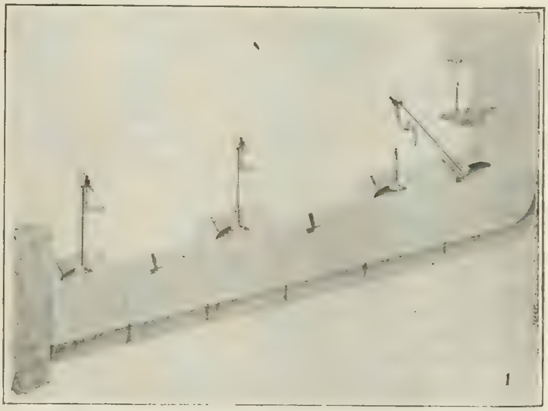
> In 16 of 303 storage piles reported on, an attempt had been made to ventilate by means of iron or wooden pipes. In 11 of these 16 piles fire occurred. These results do not suggest that ventilation as carried on is an efficient means of preventing spontaneous combustion, and they agree well with the data secured in the study of the fires in Chicago.

It would seem from the evidence presented to date that ventilation should be looked upon as more of a danger than a corrective for the successful storing of coal, the reason being that it is really never known when sufficient ventilation actually takes place. It may be the means of supplying just the ingredient that is wanted to start combustion.

Stevens Suspended Sprung Arch

A suspended sprung arch designed to eliminate the spawling of the flat arch and the intense lateral compression of the sprung arch, has been recently developed by E. P. Stevens, now associated with the James A. Brady Foundry Co. of Chicago. The features of the new arch are shown in the accompanying illustrations. It will be noticed that the arch is formed of a series of rows of brick interlocking one with another, each row consisting of a series of standard shaped brick tapering sufficiently to give a slight curvature to the arch and to prevent any individual brick or a piece that has become separated from falling out of the arch. The bricks in every other row have extended heads perforated and slotted to accommodate cast-iron hanger plates supporting four adjacent bricks. The hanger plate is suspended from a transverse beam by a bolt having its head between two ribs of the plate and extending through a special hooked plate and nut at the top, engaging with the steel supporting beam.

In the alternate rows the bricks are shouldered to interlock with the others and can be removed by inserting a key into a slot provided for lifting them out of place. Thus the arch is suspended in groups of four brick, and the entire weight is carried on the supporting beams, so that it is independent of any support by the side walls or brickwork. In the side walls provision is made for free movement of the arch to eliminate the side thrust or compression strain in the arch itself that might otherwise be imposed, due to expansion and the curvature of the arch.



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TWO VIEWS OF THE STEVENS ARCH

To supply the slight side pressure necessary to keep the bricks together, the two outside supports are connected by link rods and a spring, which is compressed as the arch expands. When the arch cools and contracts, the spring exerts enough pressure to keep the brick in lose contact. The spring is carried in the side wall, where it is away from the heat and can easily be inspected or replaced. The compression of the spring may be adjusted from outside the setting.

Owing to the method of supporting separately the brick in groups of four by independent hangers which are adjustable in all directions and carry only the weight of the four bricks, it is an easy matter to repair the arch, as each group is independent of the other and one may be removed without disturbing the balance of the arch. The alternate rows can be removed without difficulty even though the furnace be in use at the time. As the brick are slightly welge-shaped, they may be lifted out readily through the top of the arch by means of the key provided for this purpose. As the supports are exposed to the cooling air above the arch and are not buried in the brickwork itself, there is little likelihood of deterioration, so that the arch cannot fall except by the actual burning off or wearing away of the brick.

It has been stated that arches built on this principle have been in constant service in boiler practice for 3½ years. The same arch can be built of silica brick at any slope to the horizontal, so that it is particularly suitable for open-hearth furnaces and other forms of metallurgical service in addition to use in the boiler plant.

Water Power in Brazil

By J. B. Crane

With growing scarcity of coal a country that has twenty million horsepower in undeveloped waterfalls, as well as most of the raw materials that have made the United States famous, is of interest.

The falls enumerated in the table are on or near the Atlantic coast. Nothing is known of the potential water powers in the western and northern parts of the country on the vast watershed that makes the mighty Amazon, but it is quite probable that here also are falls that will add many more million horsepower to the undeveloped resources of Brazil.

The table herewith has been compiled from an article by Dr. Frontin in "A Hulha Branca No Brazil" (The White Fuel in Brazil), published in *Brazil Ferro-Carril*, and from personal investigations conducted by the writer.

Name of Fall	Height in Feet	Name of River	Estimated Horsepower
Paulo Affonso	260	San Francisco	1,000,000
Bannerais	...	Paraguassu	30,000
		Parauna	60,000
		Carandahy	30,000
San Mauricio	320	Nova	18,000
Sapucaia	90	Parahyba	100,000
Pombas	75	Parahyba	80,000
Piabanha	...	Piabanha	78,000
Lage	...	Pirahy	60,000
Dourada	190	Paranahyba	400,000
Marinbonda	...	Rio Grande	800,000
Avanhandava	45	Tiete	60,000
Itapura	37	Tiete	50,000
Urubu Punga	33	Parana	450,000
Onca	...	Parana	220,000
Sete Quedas	420	Parana	20,000,000
Iguassu	210	Iguassu	3,000 000

The tabulation gives a total of over 26,000,000 hp., of which Lage (60,000 hp.) and 3 000 hp. at Mauricio have been developed.

The table does not include the many small powers, 500 to 15,000 hp., already developed and supplying power and light to neighboring towns, for there is scarcely a town of 1,000 inhabitants within 600 miles of the coast that does not have a modern electric lighting system operated from hydro-electric power with a "white way" that beats that of any city of a similar size in the United States.

There have been several references to the falls of the Iguassu, and even in Brazil the information was as vague and general as here. One geography there ascribes 14,000,000 hp. to this fall, and, until the writer reached Paraguay, he was unable to obtain any reliable information on the possibilities of this fall.

The Parana and Its Tributaries

The River Parana rises in the state of Minas Geraes, Brazil, flows in a southerly direction and is reinforced by innumerable other streams. Finally joined by the Uruguay River, it forms the dividing line between Argentina and Uruguay and flows into the Atlantic Ocean as the Rio La Plata. It drains the fourth largest territory in the world and is about as large as the Mississippi.

River	Approximate Square Miles of Drainage Area
Amazon	2,320 000
Nile	1,620,000
Missouri-Mississippi	1,238,642
Parana-La Plata	1,200,000

The Falls of Guayra, or Sete Quedas (seven falls), are located on the Parana River about one hundred miles north of Iguassu. These are a series of falls giving a drop of 420 ft. in a distance of six miles. Readings of flow were made by the Argentine government in 1914 and show flows of from 180,000 to 400,000 cu.ft. per sec. during three months of that year. On this basis there would be capable of development but 7,000,000 hp. at minimum flow instead of the 20,000,000 hp. shown in the table.

The Iguassu River flows into the Parana about one hundred miles south of Guayra and forms the boundary line between Brazil and Argentina at this point. Paraguay is on the west side of the River Parana. The falls are four miles from the junction point, and in the Parana River just below the junction is a deep gorge. During periods of high water this gorge chokes back the water so that the fall is only 70 ft. instead of 210 ft. This means 700,000 hp. instead of 3,000,000 hp., but it is still quite a respectable power and fully large enough to supply the needs of a city like Buenos Aires for several years to come.

Brazil's Industrial Development

Brazil has made a large industrial development since the war started, especially along textile lines, and is now importing cotton instead of exporting it. Some of the large plants near Rio de Janeiro are:

Company	Output	Employees
Fiat Lux Match Co	Matches	400
Brago, Costa & Co	Hats	200
Bangu Textile Mills	Cotton Goods	3,000
Pola Shoe Co	Shoes	240
Fabrica de Roupas, Cometas	Collars, cuffs and shirts	400
Glass Factory	Tumblers, lamp shades, etc.	200

Most of the factories are one story with a tile roof, as this gives a temperature inside about ten degrees cooler than outside. One factory tried asbestos shingles, but the inside temperature was so high it was necessary to substitute tile. The operatives are intelligent and easily taught, but have not yet begun to develop their powers of initiative and invention. It will be many years before the industries of Brazil will require much of the available water power, but anyone who is looking for large quantities of hydraulic power where there is an abundant supply of labor, easily taught, will find it in Brazil.

Steam-Engine Operation and Maintenance

Piston-Rod Packing

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

MUCH time is spent and money wasted in keeping piston-rod and valve-stem packings tight. Of course nothing else can be expected if engineers will persist in using soft packings. There are various kinds of fibrous packings manufactured with claims of superior qualities. They may have a rubber core or a rubber back to give them elasticity; metallic wires may be inserted spun with asbestos, flax or some other fibrous material. Canvas, cotton, wool, soft metal and any other substance with a fiber are spun, woven or braided into all shapes and forms. Some are round, others square, flat, triangular, wedge-shaped, conical or any other form that strikes the manufacturer as particularly useful and for which a special claim of long wear and excellent service can be advanced. A few of these packings are shown in Fig. 1.

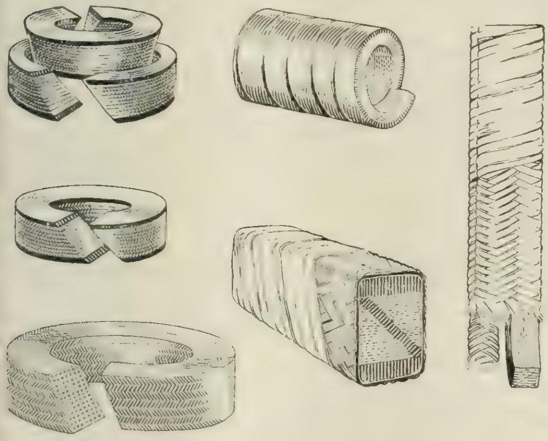
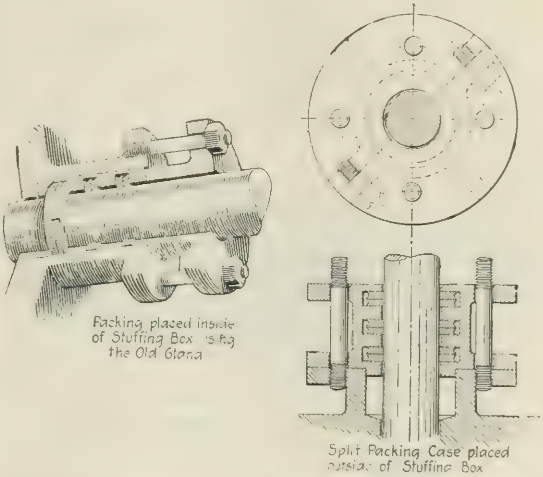
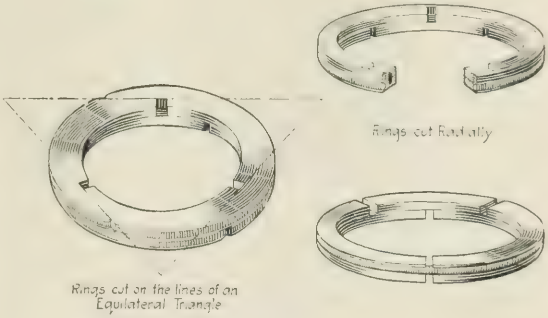


FIG. 1. SOME FORMS OF SOFT PACKING COMMONLY USED IN STEAM ENGINES

These soft packings stand up satisfactorily under some conditions. In present-day engine practice metallic packings are extensively used, for with reasonable care they will give excellent service for years without bother and loss of steam and will keep the rods in good condition. As the name implies, these packings are made of metal—soft metal in many cases, but also of cast iron. They are made to suit any condition, even to take the place of soft packing, as shown in Fig. 2. In the former case the packing is made to fit into the bore of the old stuffing box and held in place by the gland, while in the latter (right, Fig. 2) a complete new packing box takes the place of the old gland. The packing rings are held against the rods by means of flat or spiral springs. Except for small rods and valve stems the cases should be split to facilitate their removal and to give access to the rings. It is of importance that no steam gets back of the rings, otherwise they will wear rapidly and are likely to score the rod. The most careful design and workmanship are essential. The rings must be self-adjusting to accommodate themselves to slight variations in the diameter of the rod and to take up wear.

In Fig. 3 two kinds of sectional rings are shown. The one to the right is cut in such a way that the faces of contact of the segments form an equilateral triangle, the center of which coincides with the center of the rod; within certain limits, therefore, any slight inward or outward motion of the sections will not disturb this relation. Since the rings are cut in the form of a triangle, it is evident that there is a limit to the size of the rods for which this packing can be used. The other rings shown are split radially and the number of sections can be arranged to suit the size of the rod. For small and medium diameters three sections are mostly used, while for large rods the number can be increased to four, five or six, whichever is the most convenient.


Packing placed inside of Stuffing Box using the Old Gland
Split Packing Case placed outside of Stuffing Box
FIG. 2. APPLICATIONS OF METALLIC PACKING RINGS


Rings cut Radially
Rings cut on the lines of an Equilateral Triangle
FIG. 3. TWO KINDS OF SECTIONAL RINGS

A Question of Service Cost

By Julian C. Smallwood,*

This is the tale of a three-cornered fight between oil, gas and electric current.

A certain small but thriving manufacturing company in Baltimore has derived its power during the last ten years from an old-fashioned low-compression 50-hp. oil engine built by a prominent company. This engine has a remarkable record. Since installation its cylinder head has never been removed, its valves have never been reground, and it has required no repairs save for the renewing of a single bearing. In spite of the fact that its fuel has been low-grade kerosene (with water injection), it has never given trouble from carbon, it has started easily and plugged away faithfully nine hours a day throughout the working week and, were it not for the rising price of oil, would probably continue to do so up to the bitter end, like the Deacon's one-horse shay.

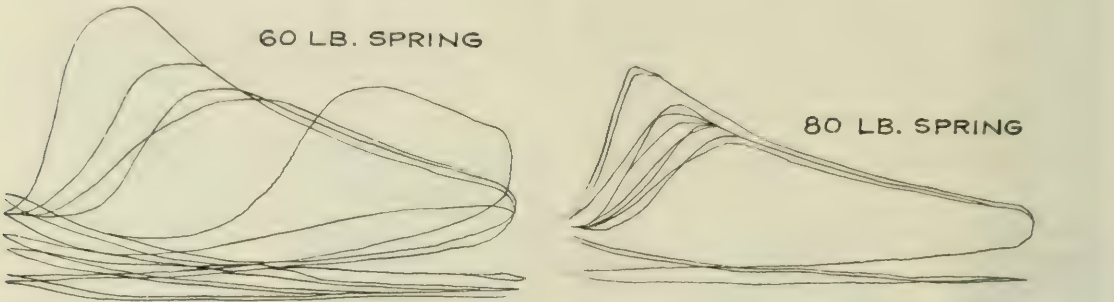
Up to the present all proposals on the part of the local electric company to displace this source of power have been met by the assertion that "the oil engine gives such excellent service as it stands." But, lately, with oil at fifteen cents and threatening to reach eighteen, the owner has given more serious attention to these proposals. The writer, as a result, worked out the costs of power to the owner under old conditions and compared them with costs, first, if the engine were converted to illuminating gas, and second, if electric current were bought.

The first step was to investigate general factory conditions attending the use of oil power. It was found that the engine was operated by one of the mechanics, who was "broken in" to this work by the foreman, who was familiar with the engine and knew its tricks. In the morning the engine was started by compressed air, but it required three men to turn its flywheel to starting position, and these men generally stayed in the engine room for ten minutes or more until the engine was well under way. The same procedure took place when starting after the lunch hour.

The shops (on three different floors) are plentifully equipped with light machine tools and a few heavy ones, conspicuously a planer. Light operations are performed for the most part, but occasionally some heavy machines are thrown on. When this happens, the line-shaft slows down, whereupon the mechanic in charge of the engine drops his work, rushes to the engine room and nurses the oil and injection valves until normal speed is reached. Occasionally, when the planer goes on, all machine operations of the shop slow down because of the failure of the oil engine to meet the demand. This condition had become so usual that it was hardly noticed except by the engine operator, and in consequence the owners felt that their oil engine gave excellent service.

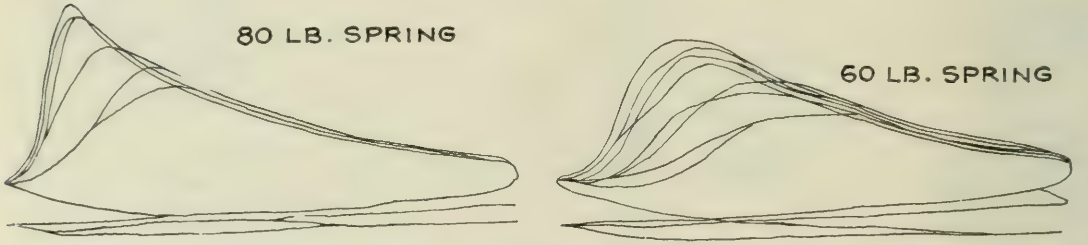
It is probably not too much to say that on this item alone the money loss during the last six years has run into the thousands.

As a next step the engine was indicated, the resulting diagrams being shown herewith. As the governor action was very irregular, composite diagrams were taken. The diagrams disclose slow burning at all loads



IDLING - MAIN CLUTCH OUT

AVERAGE SHOP LOAD. M.E.P. = 30.4
I.H.P. = 25.8



MAXIMUM LOAD, STALLING ENGINE
M.E.P. = 45.2 I.H.P. = 38.5

LINE SHAFT LOAD ONLY. M.E.P. = 23.2
I.H.P. = 19.7

INDICATOR DIAGRAMS SHOWING BEHAVIOR OF OIL ENGINE IN SMALL PLANT and ridiculously low compression pressure (30 lb.), probably due to leaky valves. As the engine would not idle, measurable friction diagrams could not be obtained. The diagrams show about 10 per cent of the net indicated horsepower to be used for pumping. Assuming 6 per cent of the maximum rated capacity for mechanical friction gives three horsepower to be subtracted from the net indicated horsepower to reach an estimate of the delivered horsepower. It was found that on this basis the maximum horsepower that could be held without material slowing down was only 36 instead of 50. This, of course, was due to the low compression and the late ignition. An average value of the delivered horsepower when no heavy tools were on was 23. The friction horsepower of the lineshafts and belts, found during the lunch hour, was 17. It thus appears that the actual working load under ordinary conditions is 6 hp. and that nearly three times this value is carried as transmission loss.

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*Associate professor of mechanical engineering, Johns Hopkins University.

COSTS FOR BLANK MFG CO MONTHLY BASIS

Oil		
Fuel, 1,070 gal. a month at 18c		$192 60
Lubricant ($76.23 for six months)		12 35
Attendance (say one hour a day), at 80c for 24 days		19 20
Water, at ½ cu.ft. per min. and 65c. a thousand		4.23
Allow $300 selling value of engine, 6 per cent interest, 2 per cent taxes and insurance, and 20 per cent depreciation (depreciation on repairs), making 2⅓ per cent per month		7.00
		$235 38
Gas		
Fuel, 28 cu.ft. per hp.-hr. for 6,510 hp.-hr. hours at 65c. per thousand		$118 40
Lubricant		6 00
Attendance, ½ hr. a day at 80c for 24 days		9 60
Water, at 1 cu.ft. per hp.-hr		2 11
Same overhead expense as for oil, say		7 00
Extra investment: Fittings for engine	$150.00	
Pipe line	300 00	
	$450.00 at 1 per cent per mo.	4.50
		$147 61
Electric Current		
Average load with group drive as recommened, 15 hp. = 217 hr. use per month. Allowing 80 per cent efficiency of motors calls for 14 kw.		
Monthly consumption = 14 × 217 = 3,038 kw.-hr.		
Maximum demand = 27 hp. = 20.25 kw.		
400 kw.-hr. at 8c	$32.00	
2,638 kw.-hr. at 3c	79.14	
	$111.14	$111.14
Investment:		
Motors	$1,917 00	
Wiring and installation	700.00	
	$2,617 00	
Interest, depreciation, insurance and taxes on investment at 13½ per cent		29.44
Total monthly cost		$140 58

The fuel consumption averaged over a year gives 1,070 gal. per month of 217 working hours. This oil has a heat value of 133,000 B.t.u. per gallon. Assuming an average brake horsepower of 25 gives nearly 0.2 gal. per hp.-hr., or a thermal efficiency of only about 9 per cent.

Yet the oil engine gave excellent satisfaction! When analyzed, the satisfaction was due to the fact that it had occasioned no trouble.

The high fuel consumption is partly due to too low a jacket temperature for good vaporization of the oil. It seems that, because the operator was engaged in other work, a high jacket temperature might occasion unobserved overheating.

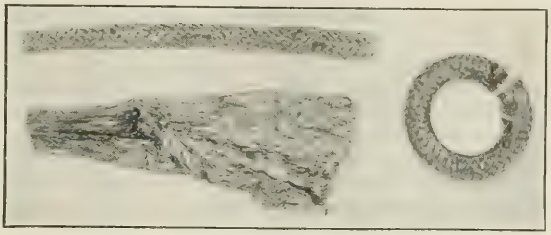
The writer was anxious to convert this engine to gas, raising its compression pressure to 100 lb. for 500-B.t.u. gas. But owing to the fact that the cost for current with group drive worked out less (due to the big friction loss), he was obliged to advise in favor of central-station current. There were other considerations also, principally that of slowing of production due to the engine, even at rated capacity, being unequal to the maximum demand, future requirements, etc.

The accompanying table shows the reckoning of costs.

This story, of course, has to do with only a small quantity of power, but it has a big lesson if you wish to take it. How many manufacturers of power, small and large, really know the costs of power? How many engine operators really know whether their engines are actually giving good service and not merely occasioning no trouble? And finally, would the central station in this case have won if this particular engine had been kept up to maximum efficiency, with full compression pressure and proper timing of ignition?

"Metalpac" Flexible Metaliic Packing

A flexible all-metallic packing known as "Metalpac" is manufactured by the Goodsell Packing Co., Inc., Maywood, Ill. It is composed of continuous thin metallic sheets that are passed through a lubricant bath and crinkled so that the material is as pliable and compressible at the center as it is at the outer surface, and at the same time it is indestructible against high pressure. These metal sheets are covered with soft braids of copper wire, which eliminates the possibility of flaking.



METALLIC SHEETS, COPPER BRAIDING AND FINISHED PACKING RING

This packing is made for steam, air and vapor, also hydraulic pressure and all liquids. It comes on reels, when desired, in a continuous length, thus avoiding waste, and is also made in coils and rings.

English Railroad Adopts Fuel Oil

Many of the Western railroads, after using fuel oil on their locomotives for many years, have returned to coal. The meager oil supply and the consequent high prices have made its further use uneconomical. It is somewhat surprising to learn that an English road, the London & North Western, has equipped one of the locomotives with oil burners. Extensive tests appear to prove that the operation is superior to that of a coal burner.

In view of the cost of fuel oil it is hardly probable that it will be used very extensively on English roads, but it will provide a means of continuing operation even though a general strike of the coal miners does occur.

There is an increasing demand that all fuel entering into interstate commerce should be inspected just as grains, cotton, and other agricultural products now are subject to Government inspection. There is evidence that coal operators are viewing with more favor the proposed extension of this work.

Stowe Forced-Draft Stoker

A NEW type of forced-draft stoker consisting of traveling chain-grate elements alternating with stationary tuyeres has been developed by the Laclede-Christy Clay Products Co., of St. Louis. The entire grate surface is inclined at an angle of twenty degrees to the horizontal to facilitate the conveying function of the chains. Both the moving and stationary parts of the grate are provided with air spaces of relatively small area through which air is forced by a uniform draft pressure not exceeding two inches of water. The tuyeres are made up of short interchangeable sections containing varying percentages of air space, so that the total passage of air, including that through the chains, through any particular section of the grate, may be varied to suit the fuel. With high-volatile fuels such as the bituminous coal of the Middle West or with the caking coals of the East, the air space is made greatest at the front of the stoker, while with coke breeze or other fuels containing little volatile, the tuyere sections containing the larger air spaces are placed farther back. By concentrating the reflected heat at the front of the stoker the coking qualities of Eastern coals are destroyed so that on the grate they burn as any other fuel, admitting air freely through the bed. Because of an even grate surface and no agitation of the fuel bed, highly volatile, high-ash bituminous coal is burned without clinkering. The stoker is thus designed to consume a wide variety of fuels at different rates of combustion up to sixty pounds of coal per square foot of active grate surface.

From the accompanying illustrations an idea may be obtained of the general arrangement and construction of the stoker. Fig. 2 shows the inclosed front of the stoker, and Fig. 1, a sectional elevation, indicates the relative positions of the grates, feed gate and hopper. The coal resting on the chains and dead plates just below the hopper forms an air seal between the windbox and the furnace. As the chains move forward, they carry the fresh coal under the feed gate, where it is leveled off and the depth of bed adjusted by means of the handwheel *A*, Fig. 2. The indicator *B* is to show the operator the thickness of the fuel bed. The initial uniformity is maintained as the fuel bed is not disturbed after it leaves the gate, but is supported and carried forward by the conveyor chains without undue agitation.

Fig. 3 shows the grate surface, consisting of the conveying-chain elements *A*, alternating with the stationary tuyeres *B*. The chains are 4$\frac{1}{16}$ in. wide and the tuyeres about 2$\frac{15}{16}$ in. The tops of the tuyeres are smooth and depressed slightly below the chains. From the feed gate to within a short distance of the bridge wall the grate surface slopes downward at an angle of twenty degrees to the horizontal. Near the bridge wall the grate surface rises to form a short section which is practically horizontal, to hold back the spent fuel, giving the remaining particles of combustible an opportunity to burn and also increasing somewhat the thickness of the fuel bed at the rear of the furnace.

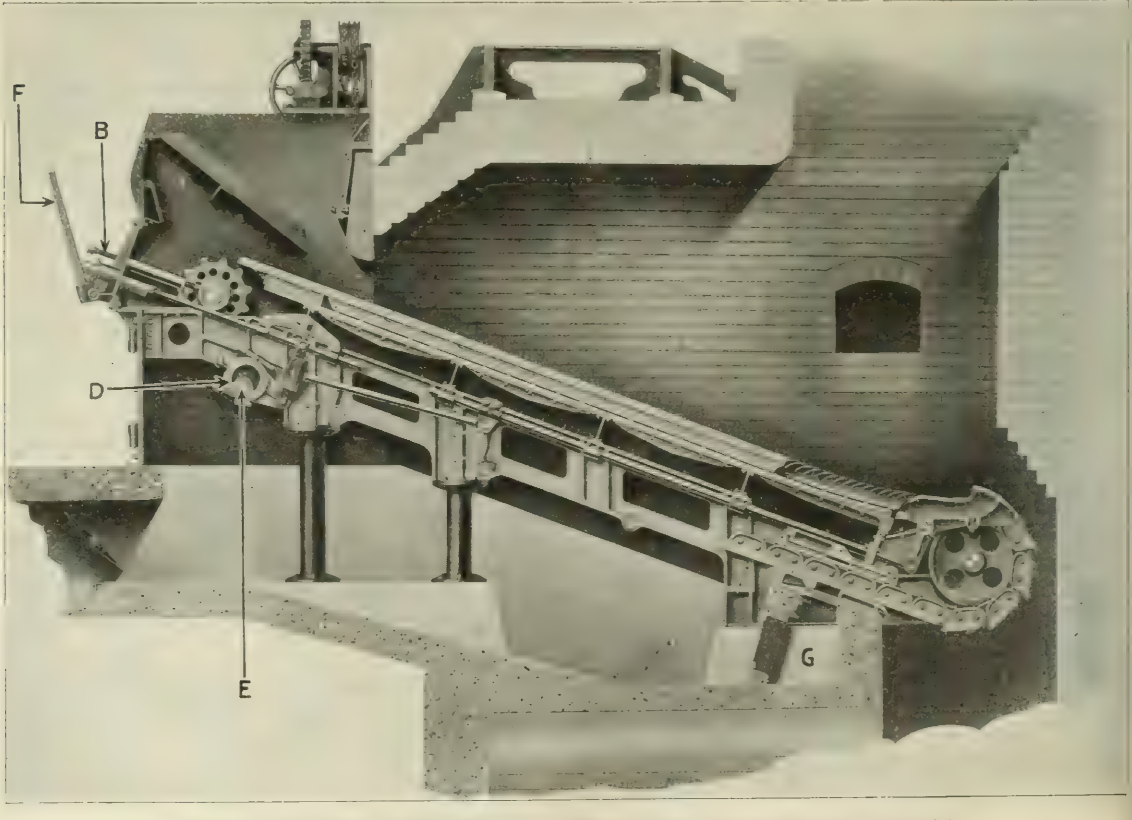


FIG. 1. SECTIONAL ELEVATION OF STOWE STOKER IN POSITION IN FURNACE

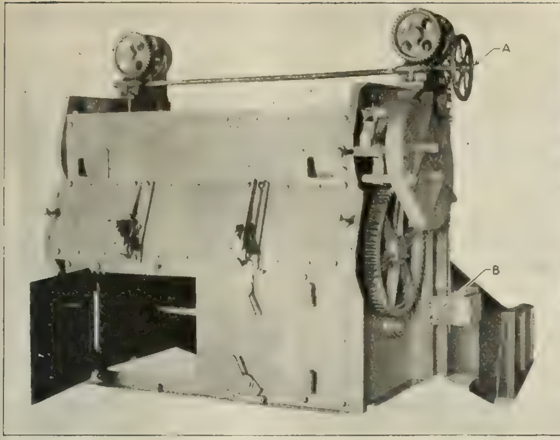


FIG. 2. INCLOSED FRONT OF STOWE FORCED-DRAFT STOKER

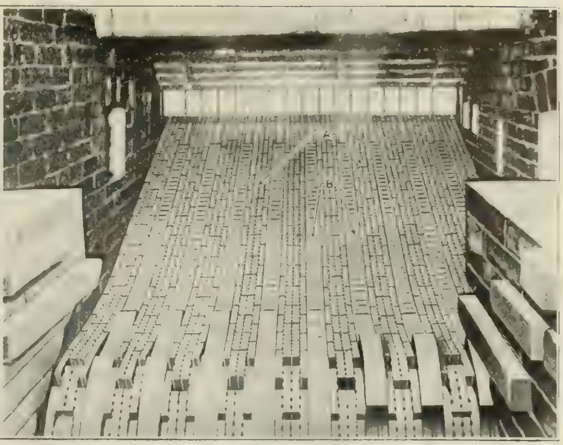


FIG. 3. SHOWING STATIONARY TUYERES AND TRAVELING ELEMENTS

Referring again to the sectional view, Fig. 1, it will be seen that the high arch, the large area of the face of the bridge wall and the sharp incline of the grate, all combine to subject the fuel bed to intense reflected heat, so that high fuel-bed temperatures must prevail; but as there are no restrictions to the gas passage, the heat is not "bottled up" in the furnace. These high fuel-bed temperatures tend toward high rates of burning and efficient operation.

Reference to Fig. 4 will show that the chains are made up of four rows of links, which are short, deep and narrow when compared with the conventional chain-grate link. The deep web and the air veins give proportionately greater cooling surface, and this feature, combined with protection afforded by the thick layer of refuse and combustible near the bridge wall, tends to increase the life of the links. The chains are fabricated with eccentric steel pins mounted within steel bushings that extend through the two inner links only. As the chains break over the idlers and sprockets, the pins rotate within the bushings. In driving these chains, the teeth of the sprockets press against the bushings, so that wear is confined to the steel parts. The chains can be adjusted for length by turning a few of the eccentric pins, which are held in either of two positions by lugs on the sides of the links engaging cotter keys.

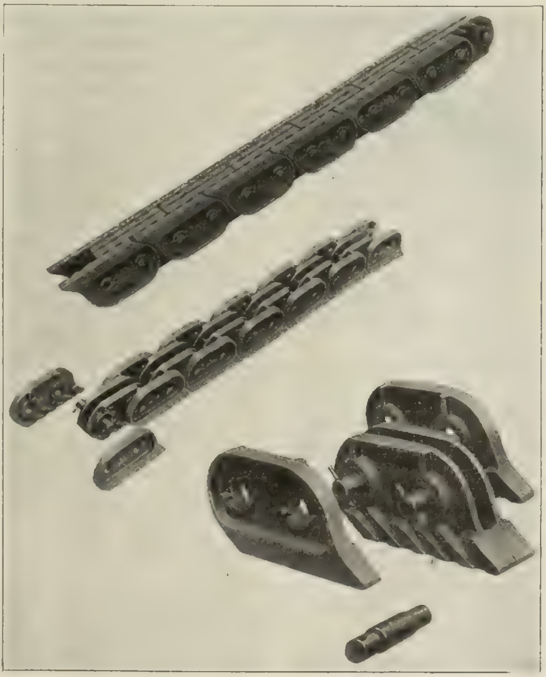


FIG. 4. DETAIL OF LINK CONNECTION

A complete tuyere unit from the dead plate to the retarding bar at the rear is shown in Fig. 5. As previously stated, the tuyeres are cast in short interchangeable sections containing varying percentages of air space, so that they can be placed at any position in the length of the grate, depending upon the air requirements. Each tuyere terminates in short vibrating bars that slowly rise above and then drop below the chains. In the upper position they stop the movement of the fuel and hold it back on the active grate, while in the lower position they permit the chains to carry the refuse to the ashpit. These rocket tuyeres, or retarding bars, are actuated by eccentrics *D* fastened to the belt-driven shaft *E* in Fig. 1. Adjustment of the travel of the rocker tuyeres is effected by means of the lever *F*. It may take place all above the top surface of the chain, entirely below, or in varying proportions partly above and partly below this level. Each eccentric and adjustment lever governs the rocker tuyeres for about three feet of the furnace width. This arrangement sectionalizes the fuel bed so that each section of grate can be treated individually to conform to any unusual conditions arising in that section. The thickened fuel bed makes possible the use of uniform windbox pressure and, in preventing holes in what would otherwise be the thin part of the fire, increases the percentage of CO_2 obtainable and the over-all efficiency of the furnace.

Drippage through the grate is minimized as the individual air openings are comparatively small so that the percentage of air space is reduced over natural-draft practice, and the higher air velocity through the spaces prevents the small particles of coal falling through.

The chain elements are driven by sprockets keyed to a single shaft extending across the stoker. For narrow stokers this shaft rotates in two bearings mounted in the hopper frames, while for wide stokers one or more additional bearings are supported on center frames.

The shafts of the sprocket are driven by an eccentric and ratchet through a nest of spur gears. The wider stokers are equipped with gear nests on either side, and very wide units may be driven by two eccentrics and ratchets, one on each end of the shaft. Chain tension is adjusted by the take-up bolts *B*, Fig. 1. These bolts move the bearing boxes in an arc about the main driving pinion, so that the driving gears remain in mesh.

As the chains move down through the furnace, they are supported by cast-iron skids that bridge between the transverse steel members of the stoker. These skids also serve as supports for the tuyeres and are provided with ample openings for admission of the necessary quantity of air to the grates.

After the chains leave the lower skids, they ride on cast-iron idlers in rounding the turn. The idlers are larger in diameter than the sprockets, they are spaced by means of spools and are free to turn about the idler shaft. After turning around the idlers, the chain elements pass through air-sealed tunnels and then are supported on pipe rollers during the remainder of the travel.

Double Seals Prevent Leakage

Air for the stoker is admitted from a chamber extending beneath the entire grate that serves as a windbox and drippage pit. At the rear of this chamber there is a concrete wall on which is mounted a series of cast-iron tunnels through which the returning chains pass. Each tunnel is made up of two seals with an opening between that communicates to the atmosphere through duct *G*, Fig. 1. The advantage of this arrangement is apparent, because the pressure tending to force diluting air into the furnace is only the difference between the furnace draft and atmospheric pressure. With a single seal the full windbox pressure would operate to cause leakage. The seal is completed by a transverse channel, steel baffle and special design of that portion of the skids and tuyeres immediately above the tunnels.

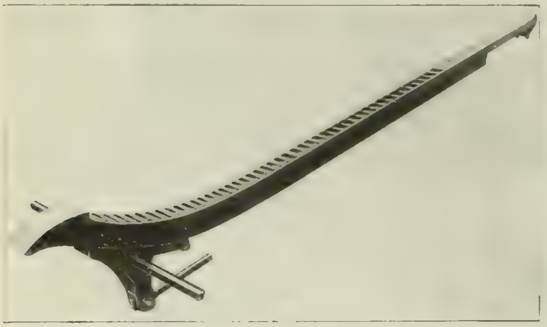
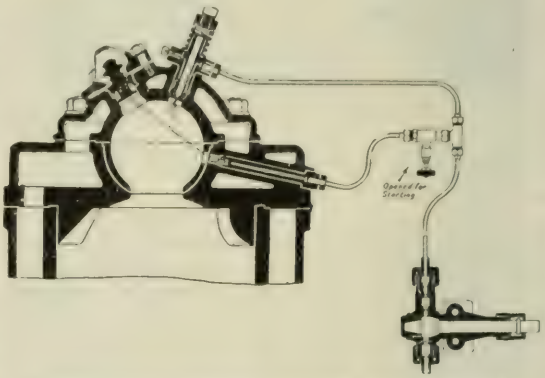


FIG. 5 COMPLETE TUYERE UNIT

The Plenty Oil-Engine Combustion

Few American or foreign builders of semi-Diesel oil engines retain the old form of combustion space. It was the prevailing belief for many years that a hot, uncooled surface, such as a bulb or plate, was necessary to insure ignition. The development of the dry, or water-injectionless, engine led to the adoption of a separate combustion chamber located in the cylinder head. The frequency of fractures in the head from improper cooling compelled the water-jacketing of the entire combustion space. The walls no longer contained sufficient heat to raise the temperature of the cylinder charge to the ignition point, and the compression pressure was then increased to about 250 lb. per square inch.



COMBUSTION CHAMBER OF THE PLENTY ENGINE

The cylinder head illustrated is employed on the Plenty semi-Diesel engine, manufactured at Newbury, England. The combustion cavity, spherical in shape, is formed by the two parts of the cylinder head. The head is entirely water-jacketed, the water passing from the cylinder jacket at the head joint. To insure positive ignition, a cast-iron shell is placed in the lower half of the combustion chamber. Since this shell is cooled only through contact with the cylinder head, it attains a fairly high temperature.

To secure the first explosions upon starting, a steel plug is placed at the top of the combustion space and is held in place by a ring. Two injection nozzles are fitted into the cylinder head and connected to the pump discharge. On starting, the fuel passes through the nozzle at the side of the head and strikes the plug, which has been heated by a torch. After the engine has warmed up, the needle valve is closed and the oil is forced through the main nozzle at the top of the head. The oil is sprayed downward toward the opening to the cylinder.

The starting plug remains quite hot, since it is uncooled. On low loads, when the ignition is somewhat faulty, the auxiliary nozzle can be used, the fuel spraying onto the starting plug. It is a somewhat less cumbersome arrangement than is usually found on semi-Diesel engines.

Often the cylinder joint blows when a semi-Diesel engine begins to fire. It should not be assumed that the gasket is ruined; tightening up the nuts will often stop the leaks. It is always advisable to retard the pump plunger stroke until the engine comes up to speed.

EDITORIALS

Where All Is Confusion

FORTUNE does not smile upon all of us when we are born, and so some start their careers comparatively handicapped. The young man without college training or the equivalent entering power-plant work on the operating side and determined upon it as a career, is invariably "stumped" by the overwhelming, confusing variety of machines, endless piping, miles of wire, gages, instruments and apparatus. If the plant happens to be one serving a large office building or hotel, the situation for him is at first seemingly impossible of comprehension. Steam lines, water pipes, hot and cold and of various pressures, vacuum lines, heating pipes, brine pipes, ammonia lines—all in unending confusion, under, over and through buildings, machinery and numerous apparatus, each performing a different function. A three-ring circus or an income-tax blank to be filled are simple in comparison.

The mind of an ambitious young man, particularly here in America, is somewhat like a jitney bus—it wants to get there in a rush and miss nothing on the way. But this cannot be done. Nevertheless, the young fellow speeds on and eventually changes his method of attack and succeeds, or throws up his hands in despair and finds a job selling ribbons or as helper in a garage.

He has not learned that while there is an interdependence among the maze of equipment he sees, the whole is nothing more than a number of individual systems, each complete in itself and, after all, not terribly complicated. It is unfortunate that such young men do not have this pointed out to them by some of the older engineers in the plant.

What Are You Doing To Save Coal?

A COUPLE of years ago, when the demand for fuel was enhanced by the forced rate at which all industries were being run and the fuel supply was limited by shortage of man power and lack of transportation facilities, strenuous efforts were made to save fuel. The high price demanded for coal even under governmental price regulation inspired such efforts, but a more compelling force was the intimation by the agents of the Fuel Administration that the man who wasted coal would be the first to have his supply cut off when apportionment became necessary.

Under this spur and through the suggestions of committees of professional and practical engineers very considerable savings were made by ordinary precautions and simple expedients within the reach of the ordinary engineer or manager of a power plant.

With the termination of the stress of war conditions and the disorganization of the Fuel Administration there has been a serious let-up. The reins have been loosened, effort has been relaxed, and many plants have relapsed into their old slipshod methods of keeping going at any cost and without much if any attention to what that cost may be.

The engineer who can give an intelligent report of what it costs to run his department is the exception.

And yet the price of coal is higher than ever, and the threat of shortage in some sections of the country is so serious as to cause widespread alarm.

It is as essential as ever that the best possible use be made of every pound of coal; essential to the sections whose supply is threatened, essential to make more difficult the machinations of the pirates who profit by the necessities of others.

What are you doing to save coal?

Do you really know how much you are burning, what you are doing with it and how your results compare with those of others whose conditions are similar or reducible to your own? Have you coal scales, water meters, steam-flow meters, draft gages, pyrometers, CO_2 recorders, etc., so that you can tell how much coal you burn, how much steam it makes, what kind of steam it is, how much air are you heating unnecessarily and sending up the stack? Have you indicated your engines and pumps and seen that the valves and pistons were tight, have you trapped discharges from the system and have you seen that the traps were working properly?

We should welcome contributions telling what engineers have done to save coal and to record the results of their efforts, and we pay for those which are usable in our columns.

The Oil-Engined Central Station

THE ever-rising fuel costs and increasing wages have served to make even more perplexing the financial problems of all public utilities, both corporately and municipally owned. Few even of the most intelligently managed central stations have been able to avoid deficits during 1919 and 1920. The municipal light and water plants are, as a rule, deeply mired. Fortunate, indeed, is the management that can even meet operating expenses without regard to overhead charges, which in the main must be taken care of by tax levies in those localities.

On page 615 appears the record of the Miami, Oklahoma, municipal light and water department for the month of May, 1920. This represents very fairly the average monthly balance sheet. This plant meets not only all operating costs, but fixed charges as well. In fact, after taking care of all charges on an excessive investment representing the cost of the discarded plant, there is a substantial balance remaining.

The results obtained are not due to any exceptionally favorable load conditions nor to unusually high rates for current and water. The plant is an example of the efficiency that can be secured by proper selection of prime mover. The oil engine possesses certain characteristics, such as no stand-by losses, high thermal efficiency and an excellent low-load fuel consumption, that make its selection for light and water plants especially advantageous.

Synchronous Motor-Generator Frequency Changers

WHEN alternating-current systems are to be operated in parallel, there must exist between them a similarity of voltage phase and frequency. Voltage and phase change can be obtained through static transformers, but a change of frequency can be accomplished commercially only through rotating machinery, usually a synchronous motor-generator set.

As long as each locality or industry was supplied by its own power system, the question of frequency was not of serious importance and a large number of frequencies came into use, varying from sixteen to one hundred and thirty-three cycles. But when the economies to be realized by interconnecting power systems began to be appreciated, the frequencies of the various systems became of vital consideration, since wherever a difference of frequency existed it necessitated the installation of special machinery which to a certain extent nullified the benefits to be obtained from interconnection. This has very forcefully brought home the necessity of a standard frequency and has resulted in the elimination of practically all frequencies in this country except twenty-five and sixty cycles. Due to the interconnection of large power systems frequency changers have become an important part of many power-plant equipments. Therefore the article on "Operation of Synchronous Motor-Generator Frequency Changers," by M. W. Smith, in this issue, will be of interest.

In the distribution of alternating current there is, in general, a prejudice against the use of rotating machinery, largely on account of the simplicity of the static transformer, which may be operated for long periods before requiring attention, while a frequency-changer set requires an attendant. With the latter the efficiency is also lower, being around ninety per cent, compared to ninety-eight or ninety-nine per cent for the static transformer. However, where power is supplied from a frequency changer, the conditions existing in the load are not reflected back into the main system as when static transformers are used. Where the power factor of the load supplied from a frequency-changer set is low, the only machine on the system that is affected is the generator of the set; but with static transformers, the wattless current would be transmitted all the way back to the generating station unless corrective devices were used out on the system. Furthermore, the motor of the set will also correct for power factor, even if the only adjustment made is to regulate the field current to give unity power factor at full load. Such a load would improve the power factor of the system, and if the load is reduced on the motor it will automatically begin to supply a leading wattless current to the system to neutralize the effect of an equal amount of lagging current.

Where large blocks of power having low power factor are being supplied from a system of fifteen thousand volts or less and it is desired to correct the power factor, there are cases where a synchronous motor-generator set can compare economically with the static transformer. By using the motor-generator set, the transformers will be eliminated (which will amount to a large percentage of the cost of the set), the low power-factor load will be isolated from the main system, and the motor driving the set may be capable of correcting largely the lagging wattless of the main system.

Do We Want a Fool-Proof Machine?

IN a technical magazine there appeared recently an advertisement which in large type set forth a claim of "a fool-proof machine." Proceeding, the advertisement explained the automatic and continuous operation of weighing and proportioning the materials to be mixed in the equipment. All of this raises a question of the extent to which we can safely go in this direction.

Anything that savors of absolutely automatic operation is generally regarded as undesirable. In order to offset undue dependence upon automatic features gages or indicators of some type are very often put in such positions that the operator must actually go near the machine or device in order to read them at the intervals required. This judicious placing of indicating devices at what would otherwise be inconvenient locations should not be overlooked. The operator who gets to regard a machine as a thing which will go by itself and which he can forget, is reaching a dangerous frame of mind.

Let us by all means save human labor by making our devices as nearly automatic as may be practicable, but let us not go too far in eliminating the intimate supervision and the vigilance upon which safe plant operation depends.

Another Coal Dope

THIS time it comes from Denver and the claims made for it are even more than ordinarily brash. Listen!

> COALSAVER is a powder which in a moment's time is dissolved in a little water and sprinkled over the coal. It is a wonderful combination of minerals which at a certain heat produces oxygen. This oxygen combines with the gas in coal and consumes it all, leaving nothing but a small percentage of slate or ashes.
>
> It is a well-known fact that when coal is burned under ordinary conditions as much of the heat stored in it goes to waste up the chimney or smokestack as remains to be utilized. When COALSAVER is used the dampers or drafts are shut off once the fire is under way, thus keeping all the gases in the stove. COALSAVER gradually consumes these gases, which are the real vitality of heat-producing energy in the coal, and thus utilizes the enormous amount of heat which ordinarily is wasted. Everyone knows that air is required to burn coal, and so quite naturally wonders how the fire can be made to burn when the dampers are shut off. Right here is the secret of COALSAVER—it supplies this air in its purest form and in exactly the proper amount.

It would take 2⅔ tons of oxygen to burn a ton of coal if the coal were pure carbon and every atom of the oxygen got into combination with some of it. It is proposed to furnish this nearly three tons of oxygen or its equivalent by dissolving the contents of a dollar package of powder in water and sprinkling it over the coal.

To supply this 2⅔ tons of oxygen 11.520 tons, or 285,696 cubic feet, of air is required—enough to make a cube about sixty-six feet large, and you get the equivalent of all this in a dollar package.

It will save one quarter to one-half your coal, give a hotter, brighter, cleaner and more cheerful fire and do away with clinkers, soot-shaking and dirty work. All that is needed now is to put in a pinch of some other secret and mysterious chemical to make it shovel out the ashes and put the teakettle on.

And a lot of poor simps are falling for it.

CORRESPONDENCE

Where Should the Beginner Start?

On page 402 of the Sept. 7 issue of *Power*, C. F. Dewey's article relates to starting the beginner where he can learn to do his own repair work. It would be a wonderful help to the young engineers, water tenders and firemen, but it is not essential for the fireman because he is not generally called upon to make repairs. His job is to produce the maximum volume of steam with the minimum amount of fuel.

He does not always do so, however, for about nine out of every ten firemen fire as if the coal pile had no bottom. These men have never had any supervising as to how to produce steam with economy. I have found from experience that it is necessary to spend hours explaining the method of proper firing and the draft that will meet the requirements of the load with the least fuel.

How many engineers know what draft they carry or what drafts they should have for the grade of fuel being used? If they did they would go into the boiler room and spend hours with the firemen explaining the different drafts to meet the different requirements of the various loads. If you were to ask a man what his over-all and boiler efficiencies were no doubt he would put them high enough, and if you were to inquire as to how much excess air was being admitted he would doubtless take an oath that the settings were absolutely tight. The settings may have been tight at one time, but the question is, Are they tight at all times? That is what counts. If you inquired as to the condition of the baffles no doubt you would be told they were in first-class shape. But I venture to say if they were looked at while the furnace was in operation plenty of leaks would be in evidence. Such cases are too prevalent.

The fireman is the biggest problem we have to deal with. He can be wasteful or he can be saving. He handles a large sum of money in the form of coal. He handles it with a shovel, getting all of the dollars through the furnace door that he can and letting the small change mix with the ash instead of sending it to the bank to be credited to the company's account.

I would start the beginner for the boiler room in the boiler room and with a man who knew how and could produce high efficiency. Then by the time he is well broken in he will understand all the appliances and will begin to like the work. I have had firemen that have started in the engine room and I will admit that they have been failures in the boiler room, but by re-entering the engine room they have made good.

Latrobe, Pa. R. M. JENNINGS.

Pit Holes in Feed Pipe

In the issue of Sept. 28, page 514, W. A. Wallace asks for information regarding pit holes in feed pipes to boilers.

I have had some experience with pitting in pipes to boilers, which has been traced to free carbonic-acid gas in the water. This has caused brass pipes to disintegrate, but not nearly so fast as steel, either galvanized or black. Wrought-iron pipe also has given trouble in similar locations. Cast iron has been more or less free from it, and in one or two cases we have substituted cast-iron pipe for steel with very good results.

The best results, however, were obtained through the use of an open feed-water heater, which allows the free carbonic-acid gas to escape through the vent.

In this case I imagine it would probably be impossible to replace the closed heater by an open one, and I would suggest the placing of a pocket reasonably close to the heater where the gas can rise, and the installation of an air separating valve such as is used on forced circulation of hot-water systems, to free the line of the carbonic-acid gas and therefore prevent this doing any serious damage.

I am not positive that this will eliminate the trouble, but I believe it will go a long way toward it.

Boston, Mass HENRY D. JACKSON.

I would advise J. A. Wallace to cover his feed pipe between the feed pump and the boilers with asbestos or magnesia. This will prevent the cold air coming in contact with the hot pipe. Unequal temperatures are the chief cause of pit holes coming on the pipes. Unequal temperatures will shorten the life of any pipe, whether it is steel or iron.

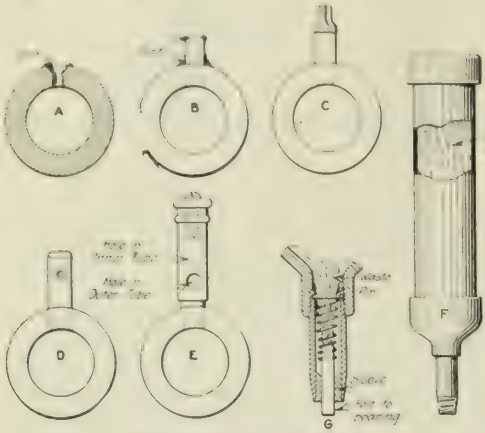
If the pump is not in good working condition it will either go too fast and flood the boiler, or sometimes when the fireman shuts off the steam to slow it down it will stick, and if the check valve or the pump discharge valves are not tight the water at over 300 deg. temperature will leak from the boiler back through the pump.

The best way to maintain an equal temperature in the boiler-feed pipes is to run the feed pump fast enough to keep a steady water level, and then the feed water will have a chance to get heated to a uniform temperature at all times. I advise putting in two check valves and a new set of pump valves, also a pump governor. Then, if the feed pipe is covered, the trouble will be ended. PATRICK MALLOY.

New York City.

Protecting the Oil Hole

Even on high-class machinery provision for oiling many of the bearings is by a countersunk hole, as shown at *A*. A straight hole would be bad enough, but the countersinking really makes it worse by providing an enlarged lodging place for dirt, which will continually find its way into the bearing. An inexpensive improvement on this is to drill out the hole and screw or drive in a brass tube or length of pipe, as at *B*. There will then be much less liability of the dirt getting into the bearing, and still less if a wood plug is fitted into the end of the tube as is usually done as shown by *C*. It is easy to plug up permanently the end of such a tube, as at *D*, and drill the oil hole on the side, giving still greater protection from dirt, at least as compared to the open tube, and furthermore, there is no plug to lose.



TYPES OF BEARING OILERS

The final improvement in the improvised oiler is shown by *E*, where a cap is slipped over the tube and a screw put into the inner-tube plug to prevent the cap from being taken off. A hole is drilled in the cap lower than the one in the tube, so that the latter must be lifted to apply the oil can spout.

When an open bearing is located in an inaccessible place, with plenty of room above it, it is a good plan to screw a pipe nipple into the box, then a reducer and a large pipe nipple and a cap, as at *F*. The large pipe is stuffed with waste and oil poured in, which will slowly find its way into the bearing.

A further refinement is to plug up the lower end of the nipple with a brass plug drilled for a felt wick. A spring retained by a pin driven through the upper end of the nipple forces the wick against the shaft (see *G*), the action being similar to the wick oiler found on small electric motors. H. H. PARKER.

Oakland, Cal.

How Can Shavings Be Burned with Coal?

I have charge of a power plant where there is a considerable quantity of shavings to burn. The factory mill makes enough shavings in a day to run the power plant about five hours. When I took charge of the plant, the shavings were shoveled into the furnace by hand, although there was a shavings chute with connections to the boilers. The cyclone that receives the shavings from the mill is on the boiler-room roof, and just below is a shavings vault with a bypass to run them either into the vault or directly under the boilers.

By connecting the piping and feeding shavings directly under the boilers from the cyclone, more coal was used than when the shavings were shoveled by hand. By feeding in this way, it was thought to do away with opening the firedoors for long periods. The air blowing under the boilers with the shavings made matters worse. After two days' running it was necessary to shut down to roll the leaking tubes of the horizontal return-tubular boilers in use.

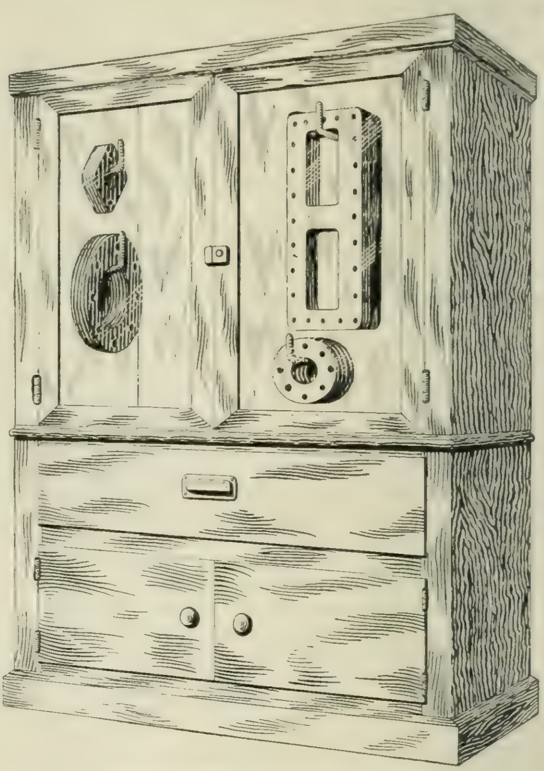
Can any *Power* reader suggest a remedy?

I should be glad to know how other plants burn shavings direct from the cyclone. Information from engineers who have had experience in burning shavings will be appreciated. ERNIE SCHATZ.

Racine, Wis.

Cabinet for Emergency Gaskets

There is perhaps not a power plant in the country that has not met with an emergency blowout where everybody rushes madly about trying to get the line back into service. I recently stepped into a plant where they had provided a large double glass-door cabinet wherein were hung in plain sight, with a sign on each, a new gasket for each important steam joint on the main lines and feeders. The idea is shown by the illustration. CHARLES H. WILLEY.

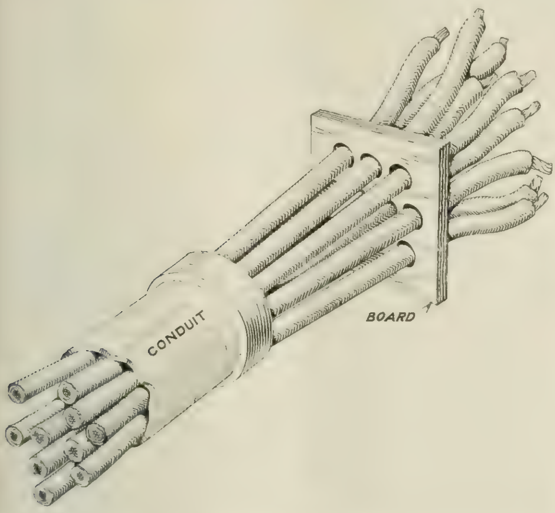


HANDY ENGINE-ROOM CABINET

Concord, N. H.

Method of Keeping Wires Straight When Being Pulled Into Conduit

Where a number of conductors are being pulled into a conduit, such as for the connections between a controller and its resistance or motor, from a field-rheostat dial and operating mechanism on the switchboard to the resistance located some distance away, etc., the problem of keeping the wires straight and properly laid up during the pulling-in process is always present. I have found the scheme illustrated in the figure one that solves the problem very nicely.



ARRANGEMENT OF CONDUCTORS WHEN BEING PULLED INTO A CONDUIT

In a piece of board a number of holes are bored, and through these the wires are passed and then connected to the pull-in line. When the wires are connected the board can be held away from the end of the conduit by a man while the wires are being pulled. Since the holes in the board hold the conductors in a given position on entering the conduit they will maintain this position throughout the latter's length. This greatly facilitates cabling up as the wires occupy practically the same relative position in each end of the conduit. When they are tested out the top conductors at one end will be found on top at the other and the bottom conductors at one end on the bottom at the other, which is seldom the case excepting where some means is provided to hold each wire in a given position in the cable. W. A. HARRIS.

New York City.

Static Electricity in Belts

In our plant there are a number of belts that are highly charged with static electricity. There has been considerable discussion among the members of the operating force as to just what effect this static will have upon the operation of the motors. I contend that, outside of being annoying to work around, these static charges will not affect the motors in the least. Some of the others claim that static charges in belts will cause the insulation on the motor windings to break down, but cannot recall any specific case where this has occurred.

I would like to have the opinion of some of the readers of *Power* on this matter. Is there an actual case on record where it is known specifically that static electricity in belts has destroyed the insulation on electrical machinery, and also what is the best way of overcoming the static charge? B. A. BRIGGS.

New York City.

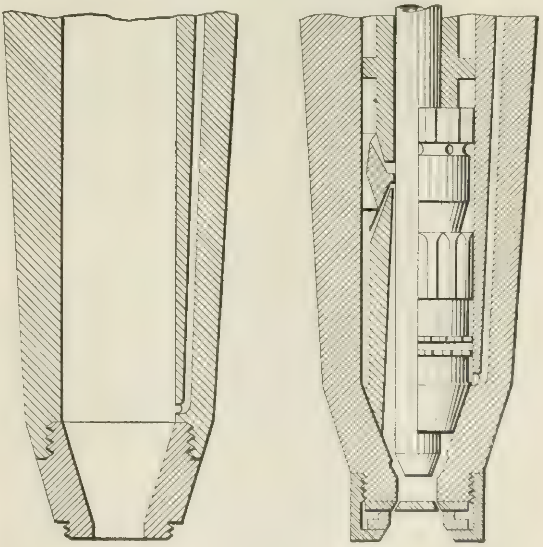
Repair of Diesel Fuel Valve

With the closed-nozzle type of fuel valve the needle often scores the seat. Minor scores or cuts can be removed by grinding. If the valve seat is very rough, it may be repaired by re-reaming. Frequently, the wear is so very rapid that constant reaming finally allows the tip of the needle valve to protrude and strike against the flame plate.

It is impossible to fully determine what causes the rapid cutting. Some engineers, thinking the spring compression too high, have slacked back the adjusting screw. The valve then apparently cuts as fast as before. Evidently, if the spring resistance is not high, the needle valve chatters on the seat when closing. If the spring compression is high, the valve seats with a blow, but does not chatter. There is, evidently, a point in the adjustment of the spring where the cutting effect is at a minimum. This can be determined by trial.

When the valve-cage seat has worn to such an extent that the needle valve tip protrudes, some engineers discard the cage and obtain a new one. At a small expense an engineer recently repaired several fuel-valve cages, making them fully as serviceable as new ones.

In Fig. 1 appears the McIntosh & Seymour fuel valve and cage, showing where the valve seat began to cut.



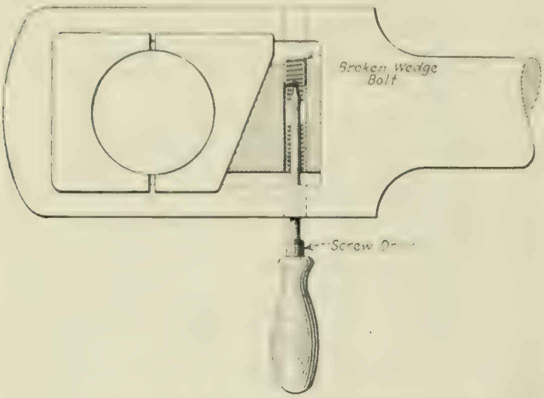
When the valve functioned no longer, the cage was removed from the engine. The end was cut off, bored and threaded. A tip was turned out of steel and screwed into the cage, as shown in the drawing to the left. This repair enabled the operator to avoid the purchase of a new cage. The cost of repairing was about five dollars, if the engineer's time be charged to the job. H. LONG.

Dallas, Tex.

Removing a Broken Wedge Bolt

In H. Hamkens' article on "Steam-Engine Operation and Maintenance," page 96 of the July 20 issue of *Power*, he mentions the trouble of removing wedge bolts when broken off short in the wedge. Drilling the wedge bolt and backing it out with a reamer requires time, and usually the housing has to be removed first to make room for the drill, which requires more time.

After the wedge bolt is machined and threaded, a groove can be cut crosswise of the threaded end of the bolt with a hacksaw, or in large wedge bolts it can be done in a shaper, the depth and width of the groove depending on the engineer's judgment.



REMOVING A BROKEN WEDGE BOLT

Then if the top bolt should break off short in the wedge, the bottom wedge bolt can be removed and a screwdriver or a piece of flat steel, finished on one end to fit the groove in the end of the top wedge bolt, can be passed up through the hole in the connecting rod and the broken wedge bolt backed out, and vice versa in case the bottom bolt breaks.

Humboldt, Ariz. H. J. Baker.

Engineers' License Laws

Discussions regarding engineers' license laws are of more or less interest to engineers. Some believe that such laws are necessary, and others are of the opinion that they are useless. Some hold that a license law is mostly a means of preventing the possibility of an overproduction of engineers; others are convinced that it is the only means of protecting the public from the results of accident.

As I understand it, the intent and purpose of the license law, as originally conceived, was to protect the public against boiler explosions. That in itself was commendable, because innocent workmen and others passing by the plant might be exposed to injury if the boiler plant were in charge of an incompetent man.

It stands to reason that the boiler attendant should be familiar with the operation of a boiler and have a general knowledge of its construction. Naturally, too, the engineer in charge of the plant should understand boilers, their design, operation and upkeep. Further than that, why should an engineer be obliged to work under a license?

Suppose that a man seeks a position in a steam plant. If he can pass a satisfactory examination as to the care and management of the boilers, why should he be obliged to satisfy the examiner that he knows how to set the valves on the various kinds of engines that are being operated? The public is not concerned, and there would be no menace to them if the valves were so faultily set that the engine would almost as soon run backward as forward. In fact, it would make no difference to the public if the engine was loose in every bearing and its thumping could be heard a mile away.

Then an engineer is examined regarding indicating an engine and is supposed to know all about steam economics. But these do not interest the public. Why, then, the necessity of an examination? The present-day engineer is also supposed to know all about motors and generators, but the public would not be concerned if an engineer burned one up every hour of the day.

It is true that engine flywheels explode and that the damage is carried outside of the plant, but a license won't prevent a flywheel accident, and it is safe to say that more flywheels explode in plants operated by licensed engineers than in non-licensed plants. So the license does not protect the public in this regard.

Some may say that a licensed engineer is necessary to protect the employer against incompetent engineers. That the plant owner is benefited is doubtless true, but why should an engineer be made to pay a license fee so that the plant owner may be benefited? He should take the same chance when hiring an engineer that he does when he engages an efficiency engineer, and the Lord knows that he is taking a chance with the latter individual.

If a plant owner engages an incompetent engineer, it is his own fault if he does not find it out and get another man in his place. I do not see, however, why engineers should be taxed so as to guarantee that a competent man is applying for a job. Holding a license does not make a competent engineer in any event, and the condition of many plants in charge of licensed engineers proves that this is so.

If we are to have license laws let us not fool ourselves that they are enacted for the benefit of the public, because they are not. Every engineers' license law that I know anything about has been proposed by operating engineers under the guise of protecting the public, but in reality to keep the supply of engineers as small as possible.

Legislatures have opposed such laws on the ground that they would be expensive and a tax on the public, and so the engineers agree to be fined in order to make the inspection department self-supporting, so that they can protect the public, who don't care a whoop one way or the other. It's a joke.

The employers in most cases oppose the adoption of a license law, but the operating engineers insist that they be licensed so as to prevent the plant owner from putting a $100,000 steam plant in charge of an incompetent man. In other words, they insist on paying a license fee in order to act as a guardian for the plant owner.

I hold a Massachusetts license. Therefore, I am not sore because I cannot get one, but it is my firm belief that the only reason that engineers have favored license laws is in order that they may feel more secure in their jobs, knowing that the harder the examination the fewer engineers there will be looking for their positions.

Boston, Mass. W. F. Lockwood.

INQUIRIES OF GENERAL INTEREST

Proportions of Corliss Engine Cylinders—Why are Corliss engines made with cylinders longer in proportion to their diameters than in most other types of cutoff engines? J. R. F.

The speed at which an engine can be run with regular Corliss valve gear is limited to the time required for the various parts of the valve gear to adjust themselves and for the dashpot pistons to work properly; and to obtain a proper piston speed with the slow rate of revolution required, the stroke of piston and length of cylinder are made long in proportion to diameter.

Priming of Portable Boiler—What would cause priming of a threshing-engine boiler after about ten days' use with the same quality of fuel and of feed water? E. R.

The priming of the boiler may be caused by sediment accumulated out of the feed water, or carrying the water level so high as to afford insufficient steam room, or may be due to local violent boiling of the water from greater concentration of the furnace heat upon the heating surfaces of the firebox, caused by dirty fire tubes. Frequent washing out of the boiler and cleaning of the tubes will result in better quality of steam and improvement of fuel economy.

Advantage of Superheated Steam for Reciprocating Engine—How is advantage gained by the use of superheated steam for a reciprocating engine? G. L.

The principal advantage is derived from prevention of initial condensation. The higher the degree of superheat the drier the steam at cutoff, and by sufficiently superheating the steam supplied to an engine, it is possible to prevent any cylinder condensation and deliver dry or superheated steam during the exhaust. By using superheated steam, single-cylinder engines which are subject to large losses from cylinder condensation when supplied with saturated steam, may be operated successfully through a greater range of expansions and such an engine may be run economically with either a light or a heavy load.

Evaporation for Stated Number of Boiler Horsepower—What quantity of feed water must be evaporated per hour for development of 200 boiler horsepower capacity with steam generated at 150 lb. pressure and feed water at the temperature of 176 deg. F.? C. M.

A standard boiler horsepower is equivalent to the evaporation of 34.5 lb. of water from and 212 deg. F., or 34.5 × 970.4 B.t.u., per hour. Each pound of steam generated at 150 lb. gage, or 165 lb. per sq.in. absolute, contains 1,195 B.t.u. above 32 deg. F., and having the feed water temperature at 176 — 32 = 144 deg. above 32 deg. F., each pound of the feed water would receive 1,195 — 144 = 1,051 B.t.u. Hence, under the conditions stated, evaporation into dry saturated steam of 970.4 × 34.5 ÷ 1,051 = 31.85 lb. of water per hour would be required per boiler horsepower, and 200 boiler horsepower would require evaporation of 31.85 × 200 = 6,370 lb. of feed water per hour.

"High-Pressure" and "Low-Pressure" Steam—What is the difference between high- and low-pressure steam? L. B.

The higher the pressure of steam the greater its density, the higher its temperature and the greater the number of heat units contained per pound of heaviness. In other respects the physical characteristics of different pressures are identical. The designations "high-pressure" and "low-pressure" steam are purely empirical and vary in significance in different localities, establishments and operations. High-pressure steam generally is understood to apply to steam received directly from a boiler at high enough pressure for power purposes and without having sustained a reduction of pressure by passage through an engine, pressure-reducing valve or heating apparatus; and "low-pressure" steam generally is applied to exhaust steam or to steam that has been used first-handed in an engine, or steam whose pressure is not high enough for use in a noncondensing engine, or whose pressure has been lowered by passage through a reducing valve or in the performance of some useful operation.

Current-Capacity of No. 18 Copper Wire—What is the minimum length of No. 18 B. & S. copper wire that can be connected across a 110-volt circuit and have the temperature of the wire remain within a safe limit? A. F.

A safe temperature limit is rather indefinite, since for one set of conditions it would be one thing and something else for another. If fibrous insulation is used on the wire, the temperature would have to be limited to about 200 deg. F., while with asbestos it could easily be double this value. If the wire were run in open air, it would carry a considerably higher current without overheating than when wound in a coil. If insulated with cotton and wound into a coil, the current should be limited to a value where the watts expended in the coil would not exceed the coil's outside area, in square inches, times 0.75. This value will vary with the shape of the coil. If the wire is run in open air, it will carry approximately 10 amperes continuously without overheating and would require a length of about 1,600 ft. to limit the current to this value on 110 volts.

Polyphase Wattmeter Reading—A switchboard polyphase watt-hour meter is connected through two potential and two current transformers on a 2,300-volt three-phase circuit. If the potential transformer and current transformer connected to one of the meter elements are removed from the circuit, what percentage of the load would the other meter element register? W. T. L.

When a polyphase watt-hour meter is correctly calibrated and connected to a balanced three-phase circuit operating at unity power factor, each element will register 50 per cent of the power transmitted. If the power factor is less than unity, or the load is unbalanced, then one element will record more than 50 per cent and the other will record less, but the sum of the two in all cases will equal 100 per cent. From the foregoing it is evident that if one of the meter elements is disconnected and the load is balanced at unity power factor, the other element will record 50 per cent of the power transmitted. But under any other condition the registration of one element will depend upon the circuit conditions.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Some Economic Considerations in Design of Power Plants for Steel Mills*

By T. E. KEATING
Power Engineer, Westinghouse Electric and Manufacturing Company

IT IS the purpose of this paper to indicate in a general manner some of the important economic considerations that enter into the design of a power plant for a modern steel mill with particular reference to the utilization of blast-furnace gas and the efficiencies and costs that may be expected to prevail in such an installation. It is not intended to discuss matters external to the power plant any more than necessary to determine the fuel supply and power demands. For this purpose certain assumptions have been made.

The plant is to consist of four 500-ton furnaces and mills requiring an average load of 15,000 kw. to be maintained 20 hours per day for 310 days per year. Four hours per day of this same period the load will be 9,000 kw., while for the remaining 55 days of the year a load of 6,000 kw. will be required for the continuous operation of the blast furnaces, cranes and repair work.

To take care of these load conditions two 10,000-kw. units will be required a greater part of the time, and a third is installed as a spare, so that the power-generating equipment will consist of three 12,500-kva. 0.80 power factor 60-cycle 6,600-volt turbine-generator units. With the load demand outlined, the annual station load factor will then be approximately 40 per cent.

One of the first conditions to be determined is the steam pressure and temperature satisfactory for a plant of the type under consideration. The average steam pressure that has prevailed in the mills using reciprocating engines is about 140 lb., while in some large central stations power companies are satisfactorily using pressures as high as 300 lb., and three stations operating on 350 pounds.

Trend Is Toward Higher Pressures

The trend in steam practice is toward higher pressures rather than extreme superheat. There are two reasons for this: First, a practical consideration that with present-day materials it is more difficult to design equipment to withstand continuous operation on high temperature than on high pressure; second, a thermodynamic fact that for any definite total temperature of steam the amount of heat available for conversion into work when expanding to a certain vacuum is greater for high pressure and moderate superheat than for lower pressure and correspondingly higher degree of superheat. For example, if a total temperature of 600 deg. F. is desired with 150-lb. pressure, there will be required 234 deg. of superheat, and if expanded adiabatically to 28.5-in. vacuum there will be available for conversion into work 388 B.t.u. With the same total temperature of 600 deg. and a pressure of 350 lb., only 164 deg. superheat will be required, and if expanded through the same range, there will be 426 B.t.u. available for work. To obtain this latter value of 426 B.t.u. with 150 lb. pressure, there would be required 386 deg. of superheat, which is equivalent to a total temperature of 752 deg. This means that to obtain the same amount of energy available for work, a steam temperature of 752 deg. would have to be obtained and equipment designed to withstand it if 150-lb. pressure were used, while if 350 lb. were used a total temperature of only 600 deg.. with equipment to correspond, would be required.

The quality and quantity of cooling water, pumping head, cost of treating water, cost of maintenance, as well as initial cost of equipment, all have some bearing on determining the proper type of condenser for a particular installation. A summary of the relative values used for this problem is given in Table I. In evaluating the different types a fixed charge of 15 per cent on the respective installations is used, taking into account only the condenser equipment and necessary auxiliaries, assuming that the remaining power equipment and building will be identical for all types. However, in figuring the fuel costs it has been necessary to use the B.t.u. per kilowatt-hour for the complete installation, inasmuch as the amount of power required for air and condensate pumps varies with each type, and if turbine-driven auxiliaries are used the different amounts of exhaust steam affect the temperature of feed water and heat required per kilowatt-hour. With the surface-condenser installation the requirement at 15,000-kw. net station output, charging the station with power required for pumping from the river, auxiliaries for the condenser, excitation, boiler-feed pumps and blowers for boilers, is 24,100 B.t.u. per kilowatt-hour for 93,000,000 kilowatt-hours per annum. The corresponding values for the jet and barometric installations are 24,600 B.t.u. and 25,000 B.t.u. respectively. The last two values are based on obtaining water from the condenser discharge wells for treating with a loss of only 8 deg. of temperature. If the condensers discharged back into the river, the B.t.u. values would be increased. The over-all economy was established at both 9,000-kw. and 6,000-kw. loads and evaluated for their respective periods, and the result is given in Table I.

TABLE I. COMPARATIVE ECONOMIC COSTS OF VARIOUS TYPES OF CONDENSERS OPERATING WITH THREE 10,000-KW. TURBINES

1 Type of condenser	Jet	Barometric	Surface
2 Water required, gallons per minute per unit	12,000	12,000	14,000
3 Pumping head, in feet	44	64	56
4 Installation cost of condensers, including air and condensate pumps and exhaust connections	$112,000	$78,000	$195,000
5. Pumphouse cost, including screen and motor-driven pumps ..	135,000	137,000	138,000
6. Water-treating plant, cost	65,000	65,000	12,000
7. Total installation cost............	312,000	280,000	345,000
8. Fixed charges at 15 per cent ..	46,800	42,000	51,800
9. Operating charges:			
(A) Water-treating plant	17,000	17,000	2,500
(B) Tube maintenance, including regular cleaning and complete retubing of 2 units in 4 years	.....	...	10,000
(C) Pump maintenance	2,000	2,000	2,100
10. Total fixed and operating charges...........	65,800	61,000	66,400
11. Fuel costs generating 112,000,000 kw.-hr. per annum..................................	360,100	364,800	353,300
12 Total items 10 and 11	425,900	425,800	419,700

Comparative Values of the Three Types

It will be seen that the final values for these three types differ from one another by only a small amount, and while the surface condenser is the most economical investment for the conditions assumed, there is not enough in its favor from the dollars and cents point of view to determine positively its selection if any local condition exists which makes its installation undesirable. However, in addition to the considerations tabulated there is another item in favor of the surface condenser; that is, the conservation of heat in the condensate. With a jet or barometric condenser this heat is generally lost in the circulating-water discharge and, if charged against either of these installations, would amount to between $5,000 and $6,000 per year. However, in computing the fuel charges for Table I it is assumed that with either a jet or barometric the water for the treating plant is taken from the condenser discharge well and that there is only 8 deg. loss in temperature.

The charge for condenser-tube maintenance assumed is much in excess of any data available, but is used so that there may be no indication of favoring the surface type. If comparative data were available, there should properly be some charge against the jet and barometric types for boiler tube maintenance. Even with water treatment, deposit is carried over into the boilers, limiting the rating and increasing the heat loss due to blowdown.

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*Abstract from a paper presented at the Fourteenth Annual Convention of the Association of Iron and Steel Electrical Engineers, held in New York, Sept. 20 to 24, 1920.

Inasmuch as there are no local conditions prohibiting the use of a surface condenser and, in addition to the financial advantage already shown, the boiler operation will be materially benefited by its installation, further consideration of the station is based on the use of this type of condenser.

In order to maintain the vacuum specified each turbine exhausts into a 17,000-sq.ft. condenser circulating 14,000 gal. of water per minute.

Turning to the thermal economy, steam drive for the auxiliaries up to the point where the exhaust can be absorbed in the feed water costs about 3,500 B.t.u. per hp.-hr. of auxiliary power. However, such auxiliary turbines as exhaust to the atmosphere may require from 35,000 to 100,000 B.t.u. per hp.-hr., depending on the economy of the turbine used. Such auxiliary power as is developed by steam that is to be returned to the feed is obtained in the most efficient manner, while such power as is developed by steam exhausting into the atmosphere is obtained in the most extravagant manner. As it is impossible to have all auxiliaries driven by individual steam units and be able to utilize the exhaust at all station loads, it is necessary to consider other means of obtaining power for the auxiliaries.

Such auxiliaries as are driven by motors off the station bus operate on a B.t.u. cost equal to that of the main generating unit plus the losses in lines, transformers and motors. That is, if the main unit is generating power at a cost of 24,000 B.t.u. per kw.-hr., the cost of auxiliary power is approximately 28,000 B.t.u. per kw.-hr. or 21,000 B.t.u. per horsepower-hour.

The Blowing of the Furnace

While it is desired to limit this paper to a discussion of power problems, the blowing of the furnaces is so closely allied that it will have to be included. Turbo blowers have given such satisfactory service that they undoubtedly would be considered in this plant, and the blowers should be in the same operating room as the generators and take steam from the same boiler room. Therefore, in calculating the steam consumption of this plant, four 40,000-cu.ft. per minute blowers with four 5,000-sq.ft. condensers are included.

Table II gives an estimate of the steam consumption for this station and is based on five 1,500-hp. boilers operating at 170 per cent of rating. In calculating the boiler-feed pump requirements, it is assumed that two out of four 500-g.p.m. pumps are operating. While it would be possible to carry this load more economically on one pump of larger capacity, it is well to have considerable leeway in capacity of pumps operating on a variable load. The resulting feed temperature of 207 deg. is, of course, subject to variation a few degrees one way or the other, and is probably so high that steam might be lost on swinging load. In order to have this factor under control, it is therefore recommended that instead of putting in a larger pump resulting in less steam consumption and correspondingly lower feed temperature, that with an installation of four pumps there be two steam-driven and two motor driven.

TABLE II. ESTIMATED STEAM CONSUMPTION ON 15,000-KW. LOAD ON TWO UNITS AND FOUR 40,000-C.F.M. BLOWERS WITH AUXILIARIES*

		Total Steam per Hour
1.	Net station output; 15,000 kw. on turbine generators—2 units	186,000
2.	Turbo-blowers—4 units	101,000
3.	Circulating pumps serving condensers for generators and blowers	9,700
4.	Air and condensate pumps serving condensers for generators and blowers	2,700
5.	Excitation	1,300
6.	Induced-draft fans	30,800
7.	Forced-draft fans	1,400
8.	Station lighting and for house-service pumps	700
9.	Total items 1 to 8	333,600
10.	Makeup; boiler blow-off, leaks, etc., 8 per cent	27,000
11.	Sum of items 9 and 10	360,600
12.	Boiler-feed pumps	9,000
13.	Contingencies	11,000
14.	Total demand on boilers	380,600
15.	B.t.u. in auxiliary exhaust 40,990 × 1,190 =	48,600,000
16.	B.t.u. in condensate, 311,900 × 55 =	17,130,000
17.	B.t.u. in make-up, 27,710 × 38 =	1,055,000
18.	B.t.u. total items 15 + 16 + 17 =	66,785,000
19.	Item 18 ÷ Item 14 =	175 deg
20.	Boiler-feed temperature = 175 deg. + 32 deg. =	207 deg.

* All auxiliaries motor-driven, except boiler-feed pumps and induced-draft fans

By a computation similar to Table II a feed temperature of 210 deg. is obtained at a station load of 9,000 kw. if two steam-driven feed pumps are operating, and at 6,000 kw. a temperature of 194 deg. with one steam-driven pump.

In order to determine the amount of gas available, a coke rate of 2,000 lb. is assumed, resulting in 140,000 cu.ft. of gas per ton of coke, and a heat value of 95 B.t.u. per cu.ft. With four 500-ton furnaces operating, this is equivalent to 1,110,000,000 B.t.u. per hour. Allowing an availability factor of 80 per cent to take care of loss of gas during tapping, poor gas and irregularities in supply, a value of 888,000,000 B.t.u. is obtained. Allowing 30 per cent for heating stoves, there is available for blowing the furnaces and power purposes 622,000,000 B.t.u. per hour. Four blowers and auxiliaries require 134,000 lb. steam per hour, which with 76 per cent boiler efficiency and 207 deg. feed water, is equivalent to 196,000,000 B.t.u. per hour, or 22 per cent of 888,000,000 B.t.u. This leaves 426,000,000 B.t.u. per hr. available for power generation, which at the rate of 24,100 B.t.u. per kw.-hr, is equivalent to 17,700 kw. net station output.

TABLE III. ESTIMATED COST OF POWER PLANT FOR STEEL MILL, INCLUDING THREE 10,000-KW. TURBINE GENERATORS AND FIVE 40,000-C.F.M. TURBO-BLOWERS

1.	Excavations and foundations	$500,000
2.	Building of structural steel and brick	400,000
3.	Boilers; eight 1,500-hp., including superheaters and brickwork	650,000
4.	Stacks and breeching	100,000
5.	Gas cleaners, piping and burners	300,000
6.	Stokers, fans, shafting and air ducts	120,000
7.	Induced- and forced-draft fans	75,000
8.	Coal storage, crane, ash handling	50,000
9.	Feed-water heaters	15,000
10.	Feed and water, power-house service pumps	20,000
11.	Water-treating plant	12,000
12.	Turbine generators and air washers	640,000
13.	Turbo-blowers	650,000
14.	Condensers for generating and blowing units, including pumps and exhaust connections	300,000
15.	Pump house, including screen and pumps	150,000
16.	Piping and covering, steam and water	320,000
17.	Exciters, motor-generator set, switching, house transformers	125,000
18.	Gages, flow meters, laboratory equipment, etc	25,000
19.	Crane	15,000
20.	Construction-plant equipment	20,000
21.	Total	$4,487,000
22.	Contingencies—5 per cent	224,000
23.	Total	$4,711,000
24.	Engineering and supervision—10 per cent	471,000
25.	Total	$5,182,000
26.	Interest charges on portion of capital required during construction—5 per cent	259,000
27.	Grand total	$5,441,000

Looking at the gas supply from another angle, assume that at the time of tapping, when gas from only three furnaces is available, there is an availability factor of 90 per cent and the stoves require 30 per cent, leaving 523,000,000 B.t.u. per hr. for blowing and power. A power load of 15,000 kw. will require 362,000,000 B.t.u., and three blowers under load, with the fourth running light, will require 155,000,000 B.t.u., giving a total of 517,000,000 British thermal units.

Exact Balance Between Gas Supply and Power Demand Impossible

Of course such an operating condition as an exact balance between gas supply and power demand is a practical impossibility, and it will probably be necessary to burn coal under one boiler a greater part of the time. For this station it is suggested that eight 1,500-hp. boilers be installed, the average load to be handled by five units at 170 per cent rating, while 20,000 kw. load will be carried on six units at the same rating. All boilers would be equipped for burning gas and four for burning coal. It is not intended that the boilers should burn coal and gas simultaneously, but that four boilers would ordinarily burn gas and one burn coal, and enough boilers should be equipped with stokers to carry the load in case of loss of gas.

In Table III is given an approximate estimated cost of an installation such as has been outlined. It is understood that the various items are intended to indicate the relative rather than the absolute costs and may be subject to considerable variation, depending on the location of the plant, the type of equipment bought and the method of installing it. Costs of excavation and foundations may readily differ 100 per cent in various locations. The total figure, which is the most important, represents a fair estimating cost for such a plant under present-day conditions.

Out of the total cost of $5,441,000 approximately $3,600,000 is chargeable to the electric power plant. This cost of $120 per kw. represents a fair price under present conditions. Some central stations with refinements to obtain the highest economy, machine shops for repairs, and switchgear for operation on systems of large capacity have run as high as $150 per kilowatt.

Assuming 15 per cent fixed charges on $3,600,000 and 112,000,000 kw.-hr. per year, the kilowatt-hour cost for fixed charges is 0.481c., or practically half a cent per kilowatt-hour.

Using the fuel charge of $353,300 per annum, as given in Table I, this is equivalent to 0.315c. per kw.-hr. for fuel alone, based on charging blast-furnace gas equivalent to coal at $3.50 per ton. If $5 coal is used, this figure for fuel becomes 0.45c. per kw.-hr. The fuel cost in stations of this type is usually between 75 and 80 per cent of the total operating cost. Using a factor of 75 per cent, the operating costs per kilowatt-hour for $3.50 and $5 coal are respectively 0.42c. and 0.6c. Adding these figures to the fixed charges mentioned gives total power costs of 0.9 and 1.08c. per kilowatt-hour. That is, the fixed charges and operating costs are approximately equal and power may be expected to cost about one cent per kilowatt-hour when generated in a station of the type outlined.

When the paper was presented there was considerable discussion on the question of a central power station for large steel mills, it being maintained by some that this was the solution to the steel-mill power problem. However, others took the view that there was greater insurance of continuity of service if the power plant was divided into two or more units located at advantageous points in the works. One case was referred to where all the power generating equipment was located in one central station and that trouble with boiler-feed pumps, in one instance, had practically caused a shutdown in the station. Since that time arrangements have been made to install a second plant at another location in the works.

It was considered a good plan to use waste-heat boilers and turbines located at the open-hearth furnace. Objection was raised to long high-pressure steam lines since they gave considerable trouble and the maintenance costs were high.

Placing the fixed charges at 15 per cent as in the paper, caused considerable difference of opinion. These were placed as high as 25 per cent by some, it being generally conceded that probably 20 per cent would be a fair average value at the present time.

Test for Softening Point of Fireclay Brick

The American Society for Testing Materials has adopted as standard the following test to determine the softening point of fireclay brick, by comparison of test cones with standard Orton pyrometric cones heated in a suitable furnace:

A 1-kg. (2-lb.) sample shall be taken by chipping off approximately equal portions from the corners of the brick. These fragments shall be reduced in size by means of rolls or a jaw crusher adjusted to pass a lump 6 mm. ($\frac{1}{4}$ in.) in diameter. They shall be mixed thoroughly and the amount of material reduced to about 250 g. (5 lb.) by quartering. A magnet shall be repeatedly passed through the crushed material until all particles of metallic iron are removed. This portion shall be ground in a porcelain or agate mortar to pass a 60-mesh Standard sieve. In order to avoid excessive reduction of the fines, they shall be removed frequently during the process of reduction by throwing the sample on the sieve and continuing the grinding of the coarser particles until all the sample will pass through the sieve.

The sample thus prepared shall be thoroughly mixed and, after the addition of sufficient dextrine or glue and water, shall be formed into test cones in a metal mold in the shape of tetrahedrons measuring 5 mm. ($\frac{3}{16}$ in.) on the sides at the base and 25 mm. (1 in.) high.

When dry the test cones may be subjected to a preliminary burn at a temperature not exceeding 1,300 deg. C. (2,372 deg. F.) for the purpose of sintering them into a firm condition to permit handling.

The test cones shall be mounted on plaques of refractory material of such a composition as will not affect the fusibility of the cones.[1] They shall be mounted with the base embedded approximately 1 mm. (0.04 in.) in the plaque and the face of one side inclined at an angle of 75 deg. with the horizontal. The arrangement with respect to the Orton cones shall be substantially as shown in Fig. 1; that is, alternating with the Orton cones in such a way that Orton cones of successive numbers will be placed opposite each other. The plaque may be any convenient size and shape and may be biscuited before using if desired.

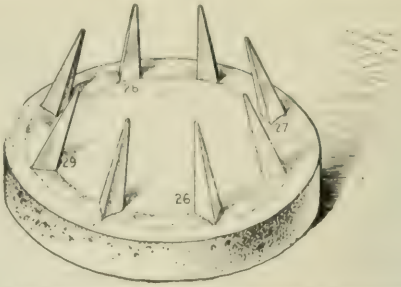

FIG. 1. ARRANGEMENT WITH RESPECT TO ORTON CONES

The heating shall be done in a suitable furnace at a rate not greater than 15 deg. C. (27 deg. F.) per minute, nor less than 10 deg. C. (18 deg. F.) per minute after cone No. 1 is reached, or as nearly within these limits as possible.

That type of furnace in which a neutral or oxidizing atmosphere may be maintained is to be preferred. Excessive reducing conditions should be avoided. Care should be taken that the flame does not strike directly against the cone or cone plaque. The furnace should be tested at intervals for the determination of the uniformity of the distribution of the heat.

The softening of the cone will be indicated by the top bending over and assuming the position shown in Fig. 2. The bloating, squatting or unequal fusion of small constituent particles should always be reported. The softening point shall be reported in terms of Orton cones and shall be that cone which most nearly corresponds in time of softening with the test cone. If the test cone softens later than one Orton cone but earlier than the next Orton cone and approximately midway between, the softening point shall be reported thus: Cone No. 31-32.

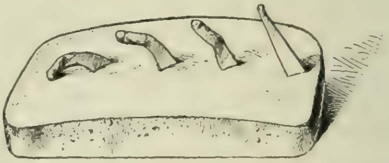

FIG. 2. INDICATING SOFTENING OF THE CONES

If the test cone starts bending at any early cone but is not down until a later cone, the fact should be reported.

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[1] A mixture of equal parts of a highly refractory clay, such as a good grade of china clay, and fused alumina which will pass a 100-mesh sieve has been found satisfactory.

The construction of a power plant capable of developing 350,000 hp. the year-round may be a direct result of the passage of the Federal water-power bill. This new plant will be located at Priest Rapids, on the Columbia River in eastern Washington, and the development of this immense hydro-electric power plant will cost around $150,000,000, including the construction of manufacturing industries and of irrigation systems that will reclaim thousands of acres of the surrounding land.

Smoke Prevention Association Holds Annual Convention in Chicago

AFTER a lapse of two years the Smoke Prevention Association convened from Oct. 5 to 8 for the fourteenth annual convention at Hotel Sherman, Chicago. An interesting program dealing with industrial, railway and domestic smoke had been prepared. The attendance was exceptionally good and representative of the various branches of the field. Tuesday morning was taken up with registration and the usual brief addresses of welcome. At the first professional session on Tuesday afternoon, Nathaniel B. Wales spoke on "Smoke Prevention in Stationary Plants." He said that very little progress had been made in the design of settings for fire-tube boilers. In the usual design of return-tubular boiler three factors were of importance in getting the best results. There must be secondary air admission to the zone back of the bridge wall and turbulation to thoroughly mix the air and the volatile, with sufficient heat in the refractory to maintain the mixture above the critical ignition temperature of the gases. The speaker would accomplish this by means of a specially designed checkered bridge wall, of which no detail was given.

In discussing the practical side of smoke prevention L. R. Pyle said that the first essential was an honest interest and determination to prevent smoke, and that this determination must start at the top of the official family. At least 90 per cent of the smoke reduction should result from education. The men must be taught how first, and then properly supervised, with a follow-up system to make sure that they do not slow up in their work. The city should provide schools to educate the firemen and have a staff of experts to demonstrate efficiency methods. There should be very close co-operation between city and railway smoke inspectors. The best results cannot be obtained unless the equipment is maintained constantly in excellent condition.

In a paper on "Chimneys and Chimney Draft." Thomas F. Clark mentioned more types of stack than most of the listeners thought existed. He dwelt briefly on the well-known types such as steel stacks, guyed and self-supporting, concrete stacks with their reinforcing steel, common brick and radial brick stacks and even wooden stacks such as are used in certain chemical industries. The principal requirements of good design were reviewed, and some attention was given to losses of draft in the stack, flue and through the boilers. The total drop determines the height of stack necessary, and the velocity of the gases, which should be about 30 ft. per second, as well as the volume, determines the area at the top. Some interesting information was given relative to the movement of high stacks such as are employed in smelteries to carry away the acid fumes, and the necessity of keeping these gases at a high temperature so that the acids will not condense n the stack and cause deterioration.

INDUSTRIAL DAY

Wednesday, Industrial Day, brought out a number of nteresting papers. Dr. E. Vernon Hill, chief sanitary nspector of Chicago, suggested a solution of the municpal-smoke problem. Reference was made to burning coal n the home and the long process from the mines to the basement furnace, accompanied by an increase in cost for the fuel of 75 to 100 per cent. With the arrival of the coal the trouble is only beginning. The coal is dirty to handle, is burned at an efficiency ranging from 20 to 65 per cent and produces such quantities of smoke and soot as to cause impairment of public health and deterioration of property. Fundamentally, the whole method is wrong. As an improvement Dr. Hill suggested that the City of Chicago obtain the properties of the gas company and add byproduct ovens so that all domestic coal coming to the city could be treated or distilled to recover the byproducts. The gas could be turned into the mains as usual, and the semi-coke that was left distributed for smokeless domestic fuel. Although years must pass before such a scheme could be thoroughly worked out, it is entirely feasible and practicable. The byproducts would much more than pay for the recovery, and the gas and coke could be sold cheaper than the present supply of either.

To simplify the solution suggested, the smoke association and all other engineering organizations should father a plan to advance the block plan of heating. If a central plant was installed to supply an entire block or perhaps several blocks, the best equipment could be installed and the operation would be economical. Such an arrangement would make the basement clean and dispose of the unsatisfactory janitor service. Even with the recovery plant in operation, it still would be necessary to distribute the coke, and the latter problem would be lightened, owing to the reduced number of plants that would have to be supplied. The plan has been held back by the general apathy of the public, but it would be of interest to state that surveys are now going on in certain blocks on the north side, so that the coming winter may see block plants in operation in Chicago. It was the final suggestion of the speaker that the various engineering societies should first carry on the fight against a smoky city; second, foster and encourage the block plan of heating; and third, distribute educational propaganda for a city gas plant to be operated as outlined. When accomplished this would mean a smokeless city, improvement in public health and a saving of $2,000,000,000 in fuel throughout the United States.

PULVERIZED COAL IN POWER PLANTS

Perhaps the most interesting paper of the day to power-plant operators was a talk on the use of pulverized coal under power-plant boilers from the smoke-prevention standpoint, by Henry Kreisenger, formerly of the Bureau of Mines. He spoke of his work at the Oneida Street Station of the Milwaukee Electric Railway and Light Co., for which the Combustion Engineering Corporation is furnishing the funds and the Bureau of Mines the trained men and instruments necessary. For awhile thirteen men were employed and there are now five on the job. The first question on which the testing force concentrated was the amount of solids or ash going up the stack. As is well known, the boilers are of the Edge-Moor horizontal water-tube type, vertically baffled for three passes. They had found that in general about one-third of the ash settled at the bottom of the furnace, another third in the combustion space below the second and third passes, and the final third found its way to the breaching and the stack. A considerable amount of this remaining third collected at the bottom of the smoke flue and at the base of the stack, only the finest ash floating out at the top of the chimney. By sending the final third of the dust that ordinarily reaches the stack through a cyclone separator, they had been able to collect 88 per cent of it, so that only 12 per cent of the final third of the ash floated out through the stack to the atmosphere. The ash was pulled out of the bottom of the furnace every twelve hours. It had thus been demonstrated to their satisfaction that the objection commonly offered to burning powdered coal under boilers, that of the ash going up the stack, could be successfully met without any great expense.

The character of the ash differs from that from a stoker or hand-fired furnace. The coal is ground very finely and when blown into the furnace a large part of the ash is in separate particles. Owing to the high temperature in the furnace, these particles fuse slightly and when leaving the furnace look like small molten beads of mineral matter, some of them transparent like glass, some white and some black. This is what looks like smoke when issuing from the stack, but is of entirely different composition. If a powdered-coal furnace is operating properly, there is no such thing as soot, but unfavorable conditions may cause small globules of coke to float along with the beads, the amount of coke depending upon the furnace volume relative to the fuel burned and the quantity of air that is supplied.

To obtain the best combustion, the speaker said it had been found that 1½ lb. of bituminous coal per hour per cubic foot of combustion space should be burned. When it came to 2 lb. per cubic foot of furnace, there was difficulty in preventing coke formation. In the particles going up the stack they had found about 10 per cent carbon, when the excess air ranged about 10 per cent. The particles were from 0.0002 to 0.0001 in. in diameter. The draft in the breeching ranged from 0.06 in. to 0.1 in., and in the first pass there was practically atmospheric pressure. That there was little infiltration of air had been demonstrated by the small difference in analyses of the flue gases at different parts of the setting.

Questioned in the discussion as to the respective merits of coal distillation and recovery of byproducts versus the use of powdered coal, the speaker contended that he favored the former for low-ash coal. Coke with 15 per cent ash was fairly good fuel for domestic heating and metallurgical purposes, but to secure coke of this quality it was necessary to use coal with not more than 10 per cent ash. Roughly, all coal having less than 10 per cent ash was suitable for byproduct plants and coal having a greater percentage of ash should be burned raw in stokers or pulverized coal plants. Questioned as to the highest percentage of ash that would be permissible in a pulverized-coal plant and still give satisfactory commercial economy, it was the speaker's guess that coal containing up to 20 per cent ash could be used. The rating obtained from the boiler and the quantity of coal burned depended entirely upon the furnace volume. At the Oneida Street Plant they had been operating the boilers between 125 and 175 per cent of rating, to which they had been limited because of the comparatively small volume of the furnace. With Illinois coal containing about 12,000 B.t.u. per pound, they were getting an evaporation of 8½ lb. of water per pound of coal, with a steam pressure of 175 lb., superheat at 100 deg. and feed-water temperature of 100 deg. The coal entered the furnace at a velocity of about 60 ft. per second and passed out at 5 ft. per second.

H. A. Savage, of the Combustion Engineering Corporation, followed with an illustrated talk on several powdered-coal installations, mentioning in particular the Morris plant at Oklahoma City, where Texas lignite containing 11 per cent ash and 33 per cent moisture had been burned at an efficiency of 78 per cent.

Wednesday Afternoon Session

At the afternoon session Prof. A. C. Willard gave an extended and interesting talk on "Heating Boilers and Furnaces, Power Plant Design and Ventilation." The speaker emphasized the importance of excess air. By analyzing in detail the various losses that take place in the furnace and the boiler, he showed that the loss from excess air was proportionately large and it might easily amount to 10 per cent of the heat in the coal. In the average plant, depending of course upon the fuel used, from 15 to 18 lb. of air per pound of coal should be considered good practice rather than the 24 to 40 lb. so often used. There was no doubt that a decided saving could be made by reducing the excess air. In the first place it lowered furnace temperatures, was the cause of smoke and, as more gas than necessary was passing through the setting and the flues, a higher draft was needed to pull these gases through. With a greater differential between the pressure inside the furnace and outside, more air infiltrated through the setting and was the cause of a proportionate drop in efficiency.

In conclusion, the speaker discussed air leakage into buildings, the high cost of ventilation, and the effect of air in piping and radiators. The air leakage from natural causes was based on the lineal feet of crack around and between the window sills. At a wind velocity of thirteen miles an hour, which was taken as a fair average, the leakage amounted to 0.147 cu.ft. of air per minute per foot of crack per mile velocity of the wind. It was important to realize that as the wind increased the pressure varied as the square of the velocity, so that the leakage increased rapidly with the wind velocity. Calculations were made on typical buildings to show that this leakage was a big factor, warranting investment in weather strips or other means of stopping the cracks.

Thursday, Railway Day

Thursday was Railway Day, and a number of interesting papers in this field were presented. On Friday morning St. Louis was chosen as the next meeting place, the convention to be held early in June of 1921. The following officers were elected:

President, Joseph M. Lonergan, of New York; first vice president, W. A. Pittsford, of Kewanee, Ill.; second vice president, J. W. Burrows, of St. Louis, Mo.; secretary-treasurer, F. A. Chambers, of Chicago.

Throughout the convention entertainment was provided for members and visiting ladies in the way of automobile rides, theater parties and inspection trips to places of interest, such as the Municipal Pier, the big mail-order house of Sears, Roebuck & Co., and the Union Stock Yards. A trip through the parks, ending up in a dinner at the Marigold Gardens, was particularly enjoyed.

Kansas City Railways Plant Operation

The report of Robert P. Woods, city member, Board of Control, Kansas City Railways, as detailed in the *Electric Railway Journal* for Oct. 9, includes some facts of interest to readers of *Power*.

This report shows that the switchboard cost in 1920 was 1.2336c. per kilowatt-hour, compared with 1.3264c. in 1919; the average price of coal per net ton in 1920 was $3.64, compared with $3.74 in 1919; and the average price of oil in 1920 was $1.68 per bbl., as compared with $2.56 in 1919. The fuel cost per kilowatt-hour in 1920 was 8.86 mills, while the labor cost was 1.38 mills.

Particulars are given of efforts that are being made to bring up the temperature of boiler-feed water and to reduce the trouble caused by scale. According to the report considerable improvement has been made in the feed water temperatures, although the average is probably under 170 deg. F. Steps are being taken to install a bleeder connection between the third and fourth stages on the 15,000-kw. turbine and the auxiliary exhaust which passes close by the turbine. It is estimated that these connections will cost approximately $250. Check valves will be installed so that when the turbines are shut down or operated under light loads, no steam will flow from the auxiliary exhaust to turbine. When the turbines are operated at load, steam will be bled from the turbines into the auxiliary exhaust, enabling the water to come from the underfeed heaters at approximately 210 deg. instead of at 170 deg. Besides the heat gained by this arrangement, it is hoped to deposit approximately two-thirds of the scale-forming compound in the heaters instead of in the boiler tubes. This will be accomplished by raising the feed-water temperature in the heaters. Most of the carbonate scale will be deposited if the temperature is kept at about 180 deg., and it is estimated that at least two-thirds of the scale-forming compounds are carbonates.

The presence of scale and the large amount of boiler cleaning necessary have resulted in the loss of a considerable number of boiler tubes In combination with the bleeding scheme, the board's engineer recommended, and the suggestion is being placed in effect, that six boilers be used for purely evaporator service. Under this scheme all raw water will be sent to a certain group of boilers which will always be operated at relatively low ratings on account of the bad water conditions in them; all other boilers in the plant will then be fed from pure, condensed water.

No scale whatever would, therefore, exist in a great majority of the boilers in the plant, and a higher efficiency of heat transfer would result, making it unnecessary to waste heat for blowing down and avoiding delay for replacing any tubes. It is proposed to feed all raw makeup water to one of the small heaters on the north side of the boiler room.

Capacity and Maintenance*

By Charles A. Cahill†

The erroneous opinion seems to have spread abroad that central stations, such as serve the larger cities, must consume about all the fuel that is used in the neighborhood. This is far from being true as the great coal consumers of the country are the industrial interests at large, although none of the individual plants will approach in size and electrical output that of the public utility.

To illustrate, the public utilities of Wisconsin, electric and gas, exclusive of steam railroads, use in round figures, 10 per cent of the coal consumed. This percentage will not hold good for other states, but it is safe to say the total fuel burned by these utilities is a small percentage of the whole. In the development of these large central stations the design may be described as good, passable or indifferent, as is the case with plants in general. Following our national mania for "big things," we have been inclined to turn to the large central station as a model for all plants, large or small, without regard to the conditions of service demanded.

Fixed Charges Must Be Kept Low

In financing and in the design of the modern central station where the output is electrical energy only, with uninterrupted continuous service and low load factor, it is imperative to keep the fixed charges down to the lowest possible limit. This has been done largely by working the equipment to the limit during the hours of peak load. This practice may be considered correct for the central station except where it is not carried to a ridiculous extreme. But, because this is the best practice for this type of plant, it does not follow that the average industrial plant should have the same design or should be operated in the same manner.

The plan of operation previously outlined has been copied by some industrial establishments to their sorrow in maintenance costs, unreliable power, light and heat service and, worst of all, in the general demoralization of the power plant's operating crew. Efficient service from these men is of vital importance in producing first-class low-cost service. The present chaotic coal conditions, requiring in many localities the use of any quality of coal that the market affords, have complicated operation, and this is intensified when the men are handicapped with insufficient heating and grate surface for the ever-increasing steam demands. A 400 per cent boiler rating looks well on paper and can be obtained for a few hours with good coal. If this state of affairs becomes a steady diet, demoralization begins with the chief operating engineer and rapidly extends down the whole line. There is nothing so fatal to low power costs. As nothing "succeeds like success," so on the other hand, nothing demoralizes like more trouble continually piling up. The maintenance costs usually go up to an excessive figure in the boiler plant where the larger part of the operating costs is absorbed.

Sizes of Boiler Units

It is not possible to overload to such a degree the generating end of the plant unless electrical burnouts are invited. With the overrating that is now prevalent, generators and motors in a measure protect themselves. It was the writer's belief that boilers, stokers and auxiliary equipment should be operated at the point of their highest efficiency, and that the boiler units should be of such size as to give the greatest number of boiler hours possible to the plant as a whole. Large boiler units are all right for large stations, but some industrial plants have become so impregnated with this disease that when a boiler is taken out of service 50 per cent of the boiler capacity is eliminated.

A close observer will have noticed that things change in power-plant equipment after the fashion of spring styles in ladies' hats. Many of these things are put over by much advertising and efficient sales organizations rather than by sound engineering principles. One thing that has not changed is the fact that to get the results that the best-designed plants are capable of giving, requires the perfect teamwork of a well-trained operating crew led by an engineer who knows his business, both in theory and practice, and has executive ability and tact to get along with the management. Best results are impossible where operating conditions are maintained at the breaking point. Emergencies can be taken care of now and then, as occasion may demand, but with continuous performance at high pressure, men grow stale and good results fall off. Plant records prove this.

More Attention Should Be Given to Maintenance

Not enough attention is given to maintenance. A certain amount of money should be appropriated yearly to keep the plant in strong operating condition. The tendency to put things off until a future date is pernicious in its results, yet the practice seems to prevail in many plants. The difference between a successful operating engineer and a conspicuous failure, is that one keeps ahead of troubles in one case, and in the other the troubles keep ahead of the engineer. A man who has the foresight to anticipate what may happen and promptly rectifies a defect that would cause trouble is worth five times as much as the man who can patch a thing up after it smashes through actual neglect. Here again is where a plant that is pushed to the limit is at a great disadvantage. Repairs cannot be made thoroughly and are more or less temporary in character. This procedure always lowers the vitality of the plant. If a certain sum of money is annually provided for maintenance, it creates a much better impression with the management than a large lump sum required all at once, after a term of years.

Distinction is to be made between maintenance and so-called improvements. When it comes to the latter, some hard thinking is necessary. Improvements are justified, first, to increase the plant's safety, second, to increase its reliability, and third, to increase its economy. Many so-called improvements do not help in these directions, and at the end of the fiscal year there are large direct expenditures embarrassing to explain. When matters have been considered carefully and it is thought beyond any reasonable doubt that a saving of 6 per cent in operation can be made, it is better to guarantee the management a saving of 4 per cent. If the improvements show a saving of 8 per cent, so much the better.

Present Conditions Demand Careful Work

The present high price of coal and the demoralization of the country's transportation system call for the best possible work in power plants. These calamities have awakened a great deal of interest in the management of power-plant affairs that were formerly passed along unheeded and taken as a matter of course. Power-plant costs have become a serious thing and must be given attention. The competent engineer can now get a respectful hearing, which he always could have had in the old days if he had been able to express himself in a plain straightforward manner, always granting that he was sure of his ground. That there is a wide difference in handling maintenance matters is evidenced from the following examples:

Case one is where there is a fairly equipped repair shop for handling all maintenance except the heavy work on the largest machines. The crew make most of the renewals and apparently have no heavy repairs, as they are continually at work on some plant equipment. Everything is going along smoothly, and the plant's record for good service and high economy is excellent.

Case two is where the repair crew is on call as is practiced with a city fire department. Things are supposed to be done with a rush and always with a hurrah and a great deal of fuss. Like the fire department, they wait until the fire starts before there is anything done. The operating records show that in case one the costs are lower and interruptions in service from power-plant trouble are almost unknown.

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*Abstract of paper read at the annual convention of the National Association of Stationary Engineers, Milwaukee, Wis., Sept. 13-17, 1920.

†Consulting mechanical engineer, Milwaukee.

One of the advantages the engineer has in a small plant is that he is in closer touch with his equipment and men at all times than one who has a large plant and organization. The maintenance of a good organization in a large plant is more of a task than to maintain the equipment. What may be expected with a given piece of equipment is known. On the other hand, little is known of the possibilities of the complex human beings that look so much alike in general but are so widely variable in their mental make-up.

The engineer who is anxious to make the best possible record must give more attention to human engineering than he has in the past. The only reason today that makes all engineers seem of so little consequence in public affairs is because they have been dealing with natural laws and materials to such an extent that the ever-important human factor has slipped away from them and has been worked to the limit by others.

A. A. E. Conference on Employment and Education

With a large attendance assured, the conference on employment and education sponsored by the American Association of Engineers, which will be held in the Congress Hotel in Chicago on Nov. 12, promises to be an inspiring meeting. All free employment bureaus and agencies are being invited, as well as representatives from engineering societies and engineering colleges. The purpose of the meeting is to consider the general problems of employment. The following subjects are not all that will be considered at the conference, but are merely those which have been determined upon definitely:

George P. Hambrecht, chairman of the Industrial Commission of Wisconsin, will speak on "Employment Office Administration and Technique."

A. B. Crawford, director of the bureau of appointments of Yale University, will deliver an address on "Placing the Graduate in His First Position."

A. B. McDaniel, development specialist in construction for the War Department at Camp Dix, will speak on "Educational Work for the Permanent Army."

Prof. Arthur F. Payne, chairman of the trade and industrial department of the college of education in the University of Minnesota, has selected as his subject, "Vocational Analysis and the Engineer."

James P. Munroe, vice chairman of the Federal Board for Vocational Education in Washington, will discuss "Vocational Advisement as a Prime Function of Educational Institutions."

R. O. Kramer, manager of the mechanical department of Montgomery, Ward & Co., of Chicago, will speak on "Engineering Opportunities in Large Mercantile and Mail-Order Houses."

A. A. Potter, dean of engineering in Purdue University, will speak on "Summer Employment for Men in Teaching Service."

The Coal Situation in Brief

According to the weekly report of the Geological Survey, Department of the Interior, the production of bituminous coal fell off sharply during the week ended Oct. 2. The total output (including lignite and coal coked) is estimated at 11,348,000 net tons, a decrease when compared with the preceding week of 506,000 tons, or 4.3 per cent. The cause of the decrease is not yet clear. Up to Thursday, Sept. 30, loadings were proceeding at a rate in excess of the previous week, but on Friday and Saturday they declined sharply. Analysis of the reports of the railroads shows that the decrease centered in the fields north of the Ohio and Potomac.

Production during the first 234 working days of the last four years has been as follows (in net tons): 1917, 417,141,000; 1918, 449,334,000; 1919, 352,794,000; 1920, 404,114,000.

The year 1920 is thus about 13 million tons behind 1917 and about 45¼ million tons behind 1918, but is 51⅓ million tons ahead of 1919. In this connection it should be remembered that production during 1918 exceeded consumption and provided for a net addition to consumers' stocks by the end of the year of approximately 30,000,000 tons. In 1919 this condition was reversed; consumption exceeded production and there was a net draft on stocks of perhaps 40,000,000 tons for the year.

Expressed in net tons, the dumpings over tidewater piers as reported to the Geological Survey by the Tidewater Bituminous Coal Statistical Bureau were 1,280,000, almost exactly the same as during the preceding week. Dumpings for New England account declined sharply, amounting to 203,000 net tons, or at the rate of 870,000 tons per month. Exports rose from 582,000 to 653,000 tons for the week, or at a monthly rate of 2,800,000 net tons.

Comparative Tests of Sulzer and Still Oil Engines

At the final meeting of the Liverpool Conference of the Institute of Naval Architects considerable attention was given to the results of a series of tests of a Sulzer Diesel and a Still steam-oil engine.

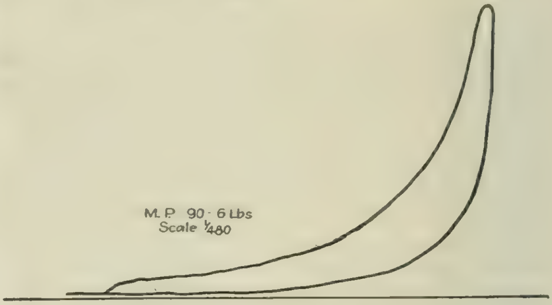

FIG. 1. INDICATOR DIAGRAM FROM SULZER ENGINE

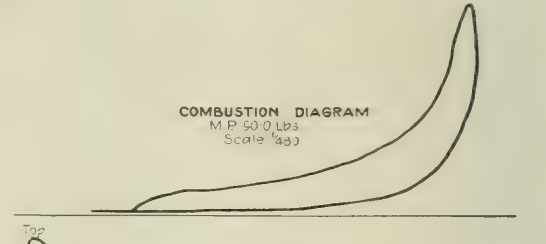

FIG. 2. INDICATOR DIAGRAMS FROM STILL ENGINE

The Sulzer Diesel is well known, and the Still engine has been described in numerous technical papers. In the Still engine the oil combustion acts upon one side of the piston while steam acts on the other side. A small boiler is a part of the equipment and absorbs the heat from the water gases of the internal-combustion side of the engine. The cycle of the steam portion of the engine is quite along customary steam practices, a condenser, boiler-feed pump, etc., forming part of the equipment.

In the tests a small vessel was fitted with a set of Still engines of 250-hp. capacity. Tests as to thermal efficiency on shaft horsepower were run. These units were then removed and a Sulzer set installed. These engines were tested while all conditions, so far as possible, were the same as during the Still tests.

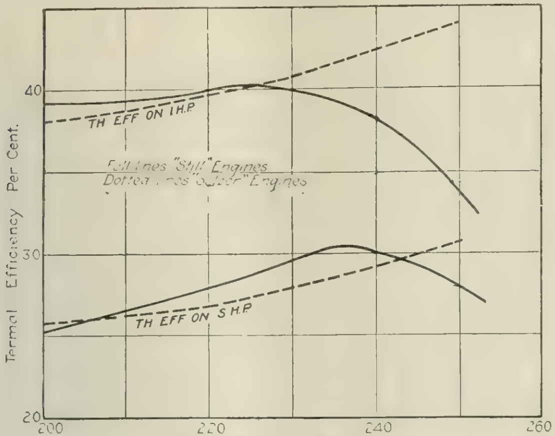

FIG. 3. THERMAL EFFICIENCY OF SULZER AND STILL ENGINES

A representative of each firm was present at the trials and was satisfied that the tests had been carried out in an approved manner. The oil used was shale of 0.85 gravity. —*Engineering.*

Water-Power League Holds Convention

That water-power developments are being intensively studied in many quarters was demonstrated beyond question at the convention of the Water Power League of America, in Washington, Oct. 7 and 8. The League is a new organization, and as it was founded by men who had not been identified in the water-power movement, it lacked the general appeal of an organization with established prestige. Nevertheless, the sessions were well attended. Each address was followed by discussion which indicated that a large proportion of those in attendance were studying carefully the problems of power development. Those interested in the super-power survey being made of the Boston-Washington area were particularly in evidence.

The sessions were presided over by Dr. George F. Swain, professor of civil engineering at Harvard University. Just prior to the convention Dr. Swain accepted the presidency of the League.

The convention, very apparently, gave the Water Power League additional impetus. Committees are to be appointed to make studies of various problems connected with the development of water power. It was announced that the organization is to be composed of operators of water-power projects and consumers of water power, in the hope that these interests may gather around the table and arrive at agreements that will permit the stimulation of water-power development and at the same time protect the consumers from excessive charges. It is the intention of Edward Terrill and Frederick L. Long, the founders of the League, to open a Washington office in the near future.

Addresses were made at the sessions by Dr. George F. Swain, president of the Water Power League; O. C. Merrill, executive secretary of the Federal Power Commission; Col. William Kelley, chief engineer of the Federal Power Commission; Alexander T. Vogelsang, assistant secretary of the Interior; John A. Britton, vice president and general manager of the Pacific Gas and Electric Co.; John W. Dorsey, of the University of Manitoba; and W. S. Murray, chairman of the Super-Power Survey.

The question of the possibility of improved method of mining our coal does not seem to be engaging the necessary attention. The late Sir William Ramsay, it will be remembered, maintained that it was practical to gasify thin coal seams *in situ,* a feat which would enormously increase our fuel reserves and might greatly reduce costs. His scheme did not commend itself as practicable to mining engineers, but some experiments were made, which, however, were impeded by his ill health and brought to an end by his death. In view of present developments it might be well if the committee would add to the list of investigations that they have now in hand a thorough inquiry into the practicability of Sir William Ramsay's schemes, forbidding though the attendant difficulties appear. —*Engineering.*

Manufacturers of Ontario, Canada, who will need electric power this winter, are facing a serious situation. The Ontario Hydro-Electric Commission has apparently contracted to supply more power than it is at present possible to develop, unless there is an early and abundant rainfall, or unless water is released from storage in the Trent watershed. This latter course, however, would be a gamble, as it would cause a worse shortage in case no rain should be forthcoming. It would also be likely to cause litigation with riparian owners who have an agreement as to the level at which certain lakes shall be kept. The Department of Railways and Canals is in charge of the water conservation of the Trent area, and seems to have a problem before it which will be difficult to solve.

In an address before the National Safety Council recently, D. J. Price brought out some interesting facts about dust explosions. He pointed out that dust explosions have taken place recently in several industries where the dust produced had not previously been regarded as dangerous. Explosions of this sort have occurred in starch factories, sugar refineries, cocoa and chocolate plants, spice works, paper mills, woodworking establishments, shoe factories and aluminum-ware polishing works. Special methods for the prevention of these explosions are being investigated by the engineers of the Bureau of Chemistry at Washington.

That power plants in the United States are not alone in their fuel-shortage troubles is indicated by a report from South Africa. Vice Consul Charles J. Pisar, of Cape Town, reports that the principal coaling stations in southern Africa are suffering from a coal shortage that is causing considerable delay to vessels calling at these ports for bunkers. This situation is entirely due to the lack of engine power and rolling stock on the railways, which handicaps the transport of coal from the mines to the coast.

The total production of coal in France during 1919 was 21,610,000 tons, as compared with 26,322,000 tons in 1918. It is estimated that the present monthly requirements are 5,600,000 tons and that in 1920 it will be necessary to import at least 45,000,000 tons from foreign countries. The amount of coal imported into France during 1919 and the first four months of 1920 was as follows, according to country of orgin: England, 15,300,000 tons; Belgium, 1,700,000 tons; Germany, 2,000,000 tons; total, 19,000,000 tons.

The international coal situation is discussed by Joseph A. Broderick, vice-president of the National Bank of Commence, in the October number of the bank's magazine, the *Commerce Monthly.* Mr. Broderick says that French industries are receiving but two-thirds of the coal they need to run at capacity. Norway is getting only half enough, Italy three-fifths, and the Netherlands about one-half of what is required.

The United States Department of Commerce reports that the export of coal from Swansea and Port Talbot, South Wales, has decreased from 401,824 tons in January to 249,844 tons in August. This decline was due to shortage in output at the mines and consequent limitation of export under control of the government.

I. C. C. Takes Measures to Relieve Middle West and Northwest

By canceling all outstanding permits for the use of open-top cars for purposes other than the transportation of coal and by modifying its order giving assigned cars to public utilities, the Interstate Commerce Commission has taken action which is expected to make possible a weekly coal production in excess of twelve million tons. The cold wave which struck the Middle West and Northwest early in October called forcible attention to the fact that householders had been unable to lay in their winter's coal. This gave rise to such a demand that it became imperative for the Commission to make possible the initiation of the distribution of domestic coal in that section. The minimum requirement was 2,000 cars daily. When the railroads were called upon to divert that number of cars from the Lake coal movement they declared it would be impossible under conditions which then existed. The railroads called to Washington representatives of the operators and of others interested.

It became quite clear after several conferences that action by the Interstate Commerce Commission would be necessary. This resulted in the Commission conducting a series of executive hearings, after which they issued Service Orders 20 and 21. There was great protest from the building industry and from other industries which were making use of open-top cars, but the Commission reached the conclusion that other industries would have to be without these cars, except when en route back to the mines, until navigation closes on the Lakes.

To administer the public utilities order, a committee of three has been named, made up as follows: W. L. Barnes, American Railroad Association; D. B. Wentz, president of the National Coal Association, and George W. Elliott, chairman of the National Committee on Gas and Electric Service. If a public utility needs emergency coal application should be made to this committee. The operators' representative on the committee will attempt to secure delivery of the necessary coal without invoking the service order. In case immediate delivery cannot be secured by that means the Interstate Commerce Commission then will provide that particular utility with assigned cars which will be set in at the most available mine.

The Oil Situation

Henry L. Doherty & Co., in their Investment Bulletin, state that since August, 1919, the oil industry has been facing an unprecedented demand for all petroleum products, with consumption running ahead of domestic production. The situation would be far more critical than it actually is were it not for the wide expansion that has occurred in imports from Mexico in the last eighteen months. The average daily consumption of oil in the United States since August, 1919, has been 1,159,016 bbl., against an average domestic production of 1,103,085 bbl. The Government reports show that in June, 1920, there was on hand but 20 days' supply of gas and fuel oil, but 418 days' supply of lubricating oil and 43 days' supply of gasoline.

The average daily consumption of gasoline increased 32 per cent in the first half of 1920 over the first half of 1919, being at the rate of 11,773,106 gal. daily. Consumption of fuel and gas oil rose to 22,013,227 gal. daily.

The "Aquitania," the second large liner to be converted into an oil burner, has been very successfully operated with fuel oil. On her first voyage since conversion 47,000 shaft horsepower was developed. When she used coal approximately 200 firemen and coal passers were required while now only 50 firemen are needed. The average rate of speed as an oil burner was $\frac{1}{10}$ of a knot greater than the vessel ever made as a coal burner, saving five hours between New York and Liverpool.

New Publications

EMISSIVITY OF HEAT FROM VARIOUS SURFACES. By V. S. Day. Bulletin No. 117, issued by the Engineering Experiment Station of the University of Illinois, Urbana, Ill. No charge.

This bulletin deals principally with an investigation of the value of insulating material commonly employed in warm-air furnace installations, as affecting the economy of the system. The results of the tests are convincingly illustrated by diagrams and tables.

BITUMINOUS COAL STORAGE PRACTICE. By Prof. H. H. Stoek. C. W. Hippard and W. D. Langtry. Bulletin No. 116 issued by the Engineering Experiment Station of the University of Illinois, Urbana, Ill. No charge.

This bulletin deals with the prevention of fires caused by spontaneous combustion in stored bituminous coal and gives the results of actual experiences with fires in storage piles. The safe storage of coal is becoming more and more necessary to relieve the congestion of transportation systems, which are overtaxed at one time and able to handle more at other times.

THE LOCOMOTIVE UP TO DATE. By Charles McShane. Published by Griffin & Winters, Chicago, Ill. Second Edition. Cloth, 6 x 9 in.; 893 pages; 376 illustrations. Price, $5.

The original work was published twenty years ago, and the advancement in locomotive practice is responsible for the many changes that have been made in this second edition. The text throughout has been revised and much of it has been rewritten in order to present certain subjects more fully or in a new aspect in accordance with recent developments in locomotive design and practice. The plain, commonsense language of the first edition is maintained in the second one, and the book is understandable to anyone who can read English. Over three hundred pages are devoted to valve gearings, going into the construction, advantages and disadvantages of one over another and the operating results. Special instructions are given regarding the link motion and as to valve-gear breakdowns and their remedies for each type of gear and the procedure in case of accident while on the road. Other subjects treated are the air brakes, superheaters, feed-water heating, blows and pounds and methods of accurately locating and remedying them. The volume contains much practical information that enginemen should know. The book is well illustrated and the text matter is presented in an interesting manner.

Personals

F. Van Buren Connell has accepted a position as sales engineer for the Automatic Fuel Saving Company, of Philadelphia, Pa.

Harry H. Bates has returned to the employ of the Westinghouse Electric and Manufacturing Company in the Stoker Engineering Dept.

Leroy P. Sterling, formerly with the Huasteca Petroleum Company, is now with the International Petroleum Company, Tampico, Mexico.

Wilford Y. Cannon has been promoted from assistant consulting engineer to chief engineer of the Utah-Idaho Sugar Co., Salt Lake City, Utah.

John S. Paul, formerly mechanical engineer, American Brake Shoe & Foundry Co., is now with The McCann-Harrison Company of Cleveland.

R. W. Leeper, formerly with the General Electric Co. in Cincinnati, Ohio, is now with the Management Engineering and Development Co., Dayton, Ohio.

Edward E. Lamberson has left the Manila Electric Co., P. I., to take a position with the Brooklyn Edison Co. as assistant steam engineer of the entire system.

J. P. Maloy, for about twenty-five years connected with the Lagonda Manufacturing Co., has recently formed the Chicago Engineering Co., of which he is the head.

C. H. Vickers is now designer and draftsman with the Moore Steam Turbine Corp., of Wellsville, N. Y. He was formerly with the Walworth Manufacturing Co., Kewanee, Wis.

J. R. Masferrer has resigned his position with the United States and Cuban Allied Works Engineering Corporation, to enter the Dodwells (Cuba) Ltd., Havana, as a sales engineer.

William S. Hill, formerly superintendent of the electric department of Springfield (Mo.) Gas and Electric Co., is now manager of the Arkansas Light and Power Co., Stuttgart, Ark.

D. G. McMillan, formerly with the Williams Printing Co., New York City, as maintenance engineer, has been appointed power superintendent with the Willys Corporation at Elizabeth, N. J.

R. D. Koplin is now assistant mechanical engineer for the Lehigh Valley Coal Company, Wilkes-Barre, Pa., having left the engineering department of the Atlantic Refining Company, Philadelphia Pa.

Charles H. Bromley, associate editor of **Power** for over eight years, is giving up this position to take up engineering and commercial executive duties with the Richardson-Phenix Co., Milwaukee, Wis.

Kneeland A. Mereness has accepted a position as instructor in the department of machine design at Cornell University. He was formerly with the Remington Typewriter Co., Smith Premier Works, Syracuse, N. Y.

George A. Evans is now with the Grasselli Chemical Co., Grasselli, N. J., as head of the power department. He was formerly assistant mechanical engineer, Public Service Electric Company, Newark, N. J.

Howard I. Holleman, formerly in the construction-engineering department of the General Electric Co., Schenectady, N. Y., is now with the Bethlehem Chile Iron Mines Company, Mina Tofo La Higuera, Coquimbo, Chile.

M. J. Dempsey has resigned his position as chief draftsman with the Chase Metal Works, of Waterbury, Conn., and is now connected with the Miamus Motor Works, of Stamford, Conn., in the capacity of production manager.

F. M. Bond, who for the past six months has been manager of the Corticelli Silk Mills (Nonotuck Silk Company) at Leeds and Haydenville, Mass., has been appointed general manager in charge of all the mills of the Company, with headquarters at Florence, Mass.

H. H. Couzens, manager of the Toronto Hydro-Electric Commission, has been appointed general manager of the combined Toronto Railway Co. and Toronto Civic railways, the appointment to take effect when the Toronto System is taken over as a civic enterprise next year.

Dr. Frederick H. Newell, for the last five years head of the department of civil engineering at the University of Illinois, has recently resigned his position, and Dr. Ira O. Baker, professor of civil engineering and for many years head of the department, has again been placed in charge of the department as acting head.

James A. Elliott, formerly chief accountant, Cooley & Marvin Company, Boston, announces that a partnership under the firm name of Elliott, Davis & Company, has been formed between himself and Herbert T. Davis, also of Cooley and Marvin Company. The new company will conduct a general practice of public accounting. The main office is in Boston; a branch office is located in New York.

Arthur Cutts Willard, professor of heating and ventilation in the department of mechanical engineering at the University of Illinois, has been appointed head of the department to succeed Dean C. R. Richards, who, since his election as dean of the College of Engineering and Director of the Engineering Experiment Station, has continued to serve as the acting head of the department of mechanical engineering.

Society Affairs

The Philadelphia Section, A. S. M. E., will meet on Oct. 25 to hear an address by Albert Kingsbury, Consulting Engineer, on "Bearings."

Metropolitan Section, A. S. M. E., will meet Oct. 22 to discuss the "Relative Advantages of Modern Steam and Electric Locomotives." Frank J. Sprague, consulting engineer, will make the introductory remarks.

The Engineers Society of Western Pennsylvania will meet in the William Penn Hotel, Pittsburgh, on Oct. 19. M. T. Montgomery, of the Pittsburgh Railways Co., will present a paper on "Stores Engineering."

The Boston Section of the A. S. M. E. is to make a visit of inspection of the Fore River Plant of the Bethlehem Shipbuilding Corp., at Quincy, Mass. The trip will start at the plant promptly at 2 p.m., Daylight Time, Oct. 19.

The Chicago Section of the American Welding Society has issued a little booklet, the title of which is "Keep the Guess Work Out of Welding." Copies may be had by addressing the American Welding Society, 608 South Dearborn St., Chicago.

The American Association of Engineers has granted club charters at Leavenworth, Kan.; Santa Cruz, Cal.; Amarillo, Tex.; Montreal, Canada; Wilmette, Ill.; Erie, Pa.; Warren, Ohio; Conneaut, Ohio; and Phillippi, W. Va. A chapter charter has been conferred in Cambridge, Ohio.

The National Executive Committee of the American Association of Engineers has approved the proposed bill for licensing engineers, architects and surveyors in Ohio, as presented by Cecil L. Rood, president of the Ohio Engineering Society and the Ohio Association of Technical Societies, and approved by the Ohio Assembly of A. A. E.

The American Society of Lubrication Engineers was organized recently in Chicago. The newly elected president is Nicholas Griffin, vice president of the Mack International Motor Truck Corp.; the vice presidents are Carver Wood, chief technician of the Wayne Oil Tank and Pump Co., Fort Wayne, and L. A. Stewart, of the Anderson & Gustafson Co., Chicago; the treasurer is J. B. Rathbun, consulting engineer on *Petroleum Magazine;* and the secretary is C. B. O'Hare, formerly with the Sinclair Oil Co.

Individual Members of the American Association of Engineers who are interested in furthering the interests of the Democratic and Republican political parties are organizing engineering Republican and Democratic clubs. They are not connected with the association in any way except that membership in the political clubs is largely made up of members of A. A. E. Members of the association will be allowed to belong to whichever one of these two clubs they wish, and if they like may organize clubs for other political parties.

The Baltimore Chapter of the American Association of Engineers has secured an option on a four-story brick residence at 16 West Chase St., to be used as a clubhouse for the chapter. Stock subscriptions are being taken in a corporation to purchase the property. The purchase price is $40,000 in fee. The chapter plans to occupy the second floor and rent the third and fourth floors to members or others who desire bachelor quarters. The first floor will be occupied by offices. The St. Louis Chapter has had similar but more comprehensive plans in mind for the last six months, but they have not been worked out. The St. Louis plan would not only furnish living quarters for the bachelor members, but would utilize much of the space in its building for a graduate school for older engineers and elementary courses for younger members. It is planned to purchase a building containing a library, lounging room, office, music room, billiard room, assembly room and several committee and class rooms.

Business Items

The Krypton (Ky.) Light and Power Co. has been organized by G. W. Humphres, L. E Wooten and others with a capital of $25,000.

Warren Webster & Co., of Camden, N. J., have established a branch office at 15 East Fayette St., Baltimore, Md. Louis G. Vance is in charge of the office as Baltimore district manager.

The American Engineering Co., of Philadelphia, has opened a new office in Cincinnati for the purpose of extending Taylor Stoker representation and service. M. M. Masson is in charge of this office at 207 Neave Building.

Westinghouse Church Kerr and Co., Inc., and Dwight P. Robinson and Co., Inc., have announced their consolidation under the name of Dwight P. Robinson and Co., Inc. Carl C. Thomas has been appointed Western representative of the new organization. His office is in Los Angeles, Cal.

Trade Catalogs

The Smith Gas Engineering Co, Dayton, Ohio, has issued an advance bulletin describing the latest addition to its line of gas producers. The new gas producer is improved in design, and is made in sizes to handle from 800 to 3,000 lb. of coal per hour.

The Sprague Electric Works of the General Electric Co., New York City, is sending out bulletins of its electric hoists, which are built with capacities of from one quarter of a ton to six tons. The bulletins contain specifications and photographs of typical installations.

Carbon Electrode is the title of a new 18-page catalog just published by the National Carbon Co., Inc., New York. The purpose of the booklet is to place in the hands of those interested in electric-furnace operation suggestions relative to the handling, storage and use of carbon electrodes. The process of manufacture of electrodes by this company is also described. A copy of this booklet can be obtained on request.

The Technical Products Co., dealer in new and used equipment, the latter comprising large purchases from Government munitions plants, has recently issued an attractive folder entitled "The A B C's of Refrigeration," describing under the caption of "The Technical Way," the high-speed vertical single-acting ring-plate valve compressors which it is handling.

"Defend Your Steam," is the title of an attractive book by Austin Bolam, published by the Magnesia Association of America, 721 Bulletin Bldg., Philadelphia, Pa. This book presents the results of four years of original research work by the Magnesia Association of America and the Mellon Institute of Industrial Research. Its eighty pages cover exhaustively every phase of the subject of heat and fuel saving and are profusely illustrated with interesting photographs showing the use of 85 per cent Magnesia pipe and boiler coverings in plants of every kind. The results of tests, experiments and actual experience are given, and tables and data are added for the use of engineers and architects in the preparation of specifications for heat insulation.

New Construction

PROPOSED WORK

Mass., Everett—The Boston Elevated Rwy. Co., 108 Massachusetts Ave., Boston, is having plans prepared for several car repair shops including a steam heating system, here. About $3,000,000. Dwight P. Robinson, 125 East 46th St., New York City, Archt. and Engr.

Mass., Fall River—H. K. Barrows, Archt. and Engr., 6 Beacon St., Boston, is preparing plans for a 35 x 40 ft. municipal pumping station and concrete dam at Watuppa Pond, here. About $150,000.

Mass., Lynn — Goodman & Gordan, Andrew St., plans to build a theater building at Andrew St. and Central Ave. About $500,000. Architect not selected.

Mass., Swampscott (Lynn P. O.)—The Sherburne, Inc., 1 Beacon St., Boston, will soon award the contract for a 3 story theatre building, etc., including a steam heating system, on Main St. here. About $800,000. C. T. McFarland, 162 Newbury St., Boston, Archt.

R. I., Providence—The City will soon award the contracts for a 3 story, 71 x 183 ft. school on Arthur Avenue and the installation of a steam heating system in same. About $500,000. Comnr. of Pub. Bldgs., Archt. and Engr.

N. Y., Buffalo—Wilson Brauer, 265 Hoyt St., is in the market for one 1-hp., 25-cycle, 110-120 volt motor.

N. Y., New York—The Thompson-Starrett Co., 49 Wall St., is in the market for refrigeration machinery for new Providence Biltmore Hotel at Providence, R. I.

N. Y., Rochester — Loews' Enterprises, 1493 B'way, New York City, plans to build a theater here, including steam heating system. About $400,000. T. W. Lamb, 644 8th Ave., New York City, Archt. and Engr.

N. J., Trenton—The Crescent Insulated Wire Co., Olden and Taylor Sts., is having plans prepared for a 1 story, 65 x 100 ft. boiler house. About $15,000. J. O. Hunt, 114 North Montgomery St., Archt.

Pa., Riddlesburg—The Broad Top Powers Co. plans to build a power house. F. R. Weller, Hibbs Bldg., Wash., D C., Archt.

Pa., Williamsport—The Williamsport Hotel Co., c/o W. L. Stoddart, Archt. and Engr., 9 East 40th St., New York City, is having plans prepared for a hotel building including a steam heating system, here. About $1,000,000.

Md., Baltimore—C. L. Reeder, Engr., Park Ave. and Saratoga St., has been engaged to prepare plans for a new heating plant at the City Jail, Madison and Buren Sts.

Md., Catonsville (Baltimore P. O.)—The General German Orphan Asylum, 224-242 Aisquith St., Baltimore, is having plans prepared for several 1 and 2 story asylum buildings including a central power and heating plant on Bloomsburg Ave., here. About $150,000. W. M. Gieske, 65 Gunther Bldg., Baltimore, Archt.

D. C., Washington—The General Pur. Officer of the Panama Canal, will receive bids until Oct. 26 for furnishing at Cristobal or Balboa, Canal Zone, Isthmus of Panama, centrifugal and duplex pumps, motors, etc.

D. C., Washington—The United States Engineer, 305 Southern Bldg., will receive bids until Nov. 10 for furnishing and delivering electrically driven centrifugal pumps, motor generator sets, transformers and switchboards.

Va., Ashland—The Ashland Ice Co. is in the market for a new or used gas engine and gas producer. Rathbourn Jones preferred. C. Boehen, Pur. Agt.

S. C., Ware Shoals—The Ware Shoals Mfg. Co. plans to build several buildings including an ice plant, etc. Jackson & Moreland, 387 Washington St., Boston, Mass., Engrs.

Ga., Atlanta—R. S. Pringle, Archts. and Engrs., Empire Bldg., will soon award the contract for a bank including a steam heating system for the Fulton National Bank. About $300,000.

Ga., Columbus—The Construction Division, War Dept., Wash., D. C., plans to build a refrigeration plant at Camp Bennings here.

Ala., Woodward—The Woodward Iron Co. is in the market for one 100 hp. kerosene engine or semi Deisel engine to drive mine fan of 230 r.p.m. (new or used). J. H. Leonard, Pur. Agt.

O., Akron—Peoples' Savings & Trust Co., Main and Exchange Sts., is having plans prepared for a bank and office building including a steam heating system. About $500,000. John B. Day, 1265 Bway., New York City, Archt. and Engr.

O., Canton—The Bd. Educ. received bid for the installation of a heating system in the proposed 3 story, 135 x 160 ft. school on Belden Ave. from the Witters Co., at $42,600.

O., Cleveland—F. M. Drew and W. T. Campbell, Euclid Ave., plan to build a 20 story theater and office building including steam heating system at East 18th St. and Euclid Ave. About $5,000,000.

O., Cleveland—The Glenville Hospital, 701 Parkwood Drive, is having plans prepared for a 2 story, 40 x 50 ft. addition to the boiler and laundry building including the installation of one 100-hp. boiler. About $40,000. Harlen E. Shimmer, 2031 Euclid Ave., Archt., H. M. Benson, 701 Parkwood Drive, Engr.

O., Cleveland—The Andrew Teller Co., Leader-News Bldg., plans to build a 10 story office building including steam heating system. About $1,000,000.

O., Clintonville—The Bd. Educ., Columbus, is having plans prepared for a 2 story, 100 x 200 ft. grade school including a steam heating plant on North High Street, here. D. Riebel & Sons, New First National Bank Bldg., Columbus, Archts.

Ind., Terre Haute—Hoggson Bros., Archts. and Engrs., 485 5th Ave., New York City, are preparing preliminary plans for a 12 story bank and office building including steam heating system, here, for the Citizen Trust Co., 612 Wabash Ave. About $500,000.

Ill., Chicago—The Kroeschell Bros. Co., 460 West Erie St., is having plans prepared for a 1 and 2 story, 220 x 388 ft. ice-machine factory including a steam heating system, and a power plant on Diversey St. About $800,000. Davidson & Weiss, 53 West Jackson Boulevard, Archt., Neiler Rich & Co., 431 South Dearborn St., Electrical Engrs.

Wis., Jefferson—The St. Coletta Convent Assn. will soon receive bids for a 3 story, 60 x 260 ft. addition to convent and chapel buildings including a steam heating plant on Main St. About $260,000. E. Breilmaier & Sons Co., 432 Bway., Milwaukee, Archts.

Wis., Milwaukee—The Bd. of Industrial Educ., 62 Mason St., will soon award the contract for the foundation of a 7 story, 145 x 268 ft. school on 6th and Prairie Sts. About $1,000,000. Van Ryn & Gelleke, Caswell Blk., Archts. and Engrs.

Wis., Templeton—The Mammoth Springs Canning Co., c/o E. A. Kraemer, Rockfield, will soon award the contract for furnishing 4 boilers, necessary pumps, pipe, belting, etc., for new factory here.

Iowa, Cedar Rapids—The Bd. Educ., K. Materd, Secy., will soon receive bids for a 3 story, 124 x 204 ft. junior high school including a steam heating system. About $400,000. Rugh & Zalesky, 811 Securities Bldg., Archts.

Minn., Chisholm—The Bd. Educ. plans to build a 3 story 150 x 225 ft. vocational school including a steam heating system at 3rd Ave. and Chestnut St. About $250,000. Archt. not selected.

Minn., Currie—The City voted $13,000 bonds for a municipal light plant.

Minn., Owatonna—The City Council plans an electon soon to vote on bonds for a light, power, heating and gas plant.

Mo., St. Louis—The Syndicate, c/o I. A. Hedges, Cupples Station, is having tentative plans prepared for a 3 story 130 x 250 ft. film exchange office building at Olive and Beaumont Sts. About $500,000. Preston J. Bradshaw, International Life Bldg., Archt.

Tex., Dallas—Arthur Marshall, Oklahoma City, Okla., is having plans prepared for a 2 story ice cream factory and milk handling station, here, including a cold storage house and electrically driven equipment. About $100,000.

Tex., Denison—Eric E. Hall, Archt., 123 West Madison St., Chicago, Ill., is preparing preliminary plans for a 5 story, 150 x 150 ft. hotel including a steam heating system, at Woodard and Burnett Sts., here. About $400,000. Owner's name withheld.

Tex., Terrell—The Chmn. of the City Commission will receive bids until Oct. 25 for two 5-in., 2-stage centrifugal pumps 500, 600, 700, 800 gal. per minute capacity against a 200-ft. head, direct connected to 2- or 3-phase, 60-cycle, 2,200-volt electric motors; installation to be made complete, with all wiring, switches and transformers necessary to make currents interchangeable as between 2- or 3-phase. Also as counter proposition, two 5-in., 3-stage centrifugal pumps 500, 600, 700, 800 gal. per minute capacity against a 200-ft. head, belted to two or three 75-hp. oil engines of high compression, ignition type. Bids will also be received for 3 miles of power line.

Ore., Portland—Emanuel Hospital, 212 Stanton St., is having plans prepared for a 6 story hospital, 4 story nurses' home, and a power house at Commercial and Stanton Sts. About $300,000. Ernest Kroner, 301 Spaulding Bldg., Archt.

Que., Coaticook—The Corp. of Coaticook plans to build a power house and dam to include one 600-hp. waterwheel and governor. About $65,000. E. E. Akhurst, Supt.

Ont., London—R. M. McElheran, Secy. of Bd. Educ., Dundas St., will receive bids early in November for a collegiate institute on Dufferin Ave. About $750,000. L. E. Carrothers, c/o Bd. Educ., Archt.

Ont., Wardsville—The Town Council plans to build an electric lighting and power distribution plant. About $15,000. Engrs. from the Ontario Hydro-Power Comn., University Ave., in charge of work.

CONTRACTS AWARDED

Me., Lisbon Falls—The Worumbo Mfg. Co. has awarded the contract for a 2 story 53 x 93 ft. boiler house and a 50 x 63 ft. turbine house to the Turner Constr. Co., 178 Tremont St., Boston, at $50,000.

Mass., Boston—The Natl. Shawmut Bank, 40 Water St., has awarded the contract for an 8 story bank and office building addition including a steam heating system on Devonshire St. to L. P. Soule & Son Co., 80 Boylston St., Boston, at $1,000,000.

Mass., Norwood—The Hollister Mills, Lenox Ave., has awarded the contract for a 2 story, 134 x 287 ft. textile factory and a 40 x 70 ft. boiler house to C. A. Batson, 26 Arlington St., Brockton. About $300,000. Noted September 14.

N. Y., Buffalo—The Amer. Car & Fdry. Co., 370 Babcock St., has awarded the contract for a 1 story, 43 x 100 x 43 ft. boiler house to J. W. Cowper, Fidelity Bldg., at $50,000. Noted July 13.

N. Y., Coney Island (Brooklyn P. O.)—Wm. Fox Associates, 715 Bway., New York City, have awarded the contract for a theater building and bath house including a steam heating system at 20 Surf Ave., to Fred T. Ley, 19 West 44th St., New York City, at $325,000.

Pa., Harrisburg—The Bd. of Commrs. of Public Grounds and Buildings, T. W. Templeton, Supt., has awarded the contract for the installation of a heating system for three temporary office buildings for the State to Eugene Fogarty, 1121 North Front St., at $20,011.

Pa., Philadelphia—The Daniels Motor Co., 3rd St., Reading, has awarded the contract for a 1 and 2 story, 40 x 100 ft., 80 x 125 ft., 80 x 485 ft., office, manufacturing and assembling plant at Westmoreland St. and Huntington Park, here, to Wm. Steele & Sons Co., 16th and Arch Sts. A steam heating system will be installed in same.

Md., Baltimore—The Bd. of Awards has awarded contracts for repairing the heating plant at Bayview Hospital, at $14,753 and for running two new heating lines from Bayview to Sydenham Hospitals, at $7,531.25, to H. A. Kries & Sons Co., 6-8 West Lombard St.

Mich., Detroit—The Bd. Educ., 50 Broadway, has awarded contracts both for the installaton of a heating, plumbing and ventilating system in the Thirkell School addition, at $58,763 and in the Lincoln School addition, at $23,745, to O'Connor Bros., 179 Shelby St.

Mo., Kansas City—The Corn Products Refining Co., 17 Battery Place, New York City, will build a plant including a steam heating system, here. About $500,000. Work will be done by day labor.

Tex., Gonzales—The F. E. Shuler Grain Co. will build a 2 story grain elevator plant including one 40-hp. steam engine. About $50,000. Work will be done by day labor.

Tex., Wichita Falls—The State Bd. of Control, Austin, has awarded the contract for installing a complete steam heating system in the Northwest Texas Insane Asylum, here, to Kinnison Bros., 311-313 North Austin St., Dallas, at $69,860. Noted Sept. 28.

Ont., Midland—The Copeland Flour Mills, Midland Ave., has awarded the contract for a 7 story, 100 x 170 ft. flour mill including the installation of a steam heating plant to McFarlane, Pratt Hanley Co., Waterfront St., at $365,000.

Mass., Brookline—John J. Smith, Archt., 1106 Old South Bldg., Boston, will build two apartment hotels, here, one an 8 story, 136 x 254 ft. building at Beacon and Kent Sts., about $1,250,000, and the other an 8 story, 120 x 238 ft. building at Prang St. and Huntington Ave., about $1,000,000. Contracts for the installation of steam heating systems will be sub-let. Owners' names withheld. Work will be done by day labor.

"SEARCHLIGHT" is the "OPPORTUNITY"
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See Pages 81 to 96

Think "SEARCHLIGHT" *First*
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POWER

Volume 52 New York, October 26, 1920 *Number* 17

An Opportunity To Help the Other Fellow

EVERY power plant executive is keenly alive to the coal situation.

Although present exigencies prevent him from being too discriminating as to quality and price, he is, nevertheless, anxious to know how the other fellow is meeting the problem and what he is paying for similar coal.

Unfortunately, the majority of these men have no organization for the exchange of such information. Therefore, *Power* offers its services to this end.

It is hoped that those interested will fill in the blank on the bottom of page two (advertising section) stating the kind of coal, size, source and basis of purchase (whether contract, open market or spot buying), and prices (at mines or delivered), and mail the blank to *Power* at the earliest opportunity.

If sufficient replies are received, the information will be compiled and printed in an early issue. The source of the information will be regarded as confidential.

Remember that in doing this little thing, you are rendering a service to other engineers and power-plant executives.

Steel Foundations for 30,000-Kilowatt Horizontal Turbo-Generators

BY J. R. JAMES
Engineer, Detroit Edison Company

The use of combination concrete-steel foundations for large units has been initiated at Detroit. Advantages claimed over an entire concrete structure are greater accessibility within the base, more light, a saving of space, reduced weight, a better disposition of structural strength and mass, with greater facility in correcting for settlements A reduction in weight of about 500 tons was effected, the difference in cost is negligible, and operation has shown almost no perceptible vibration.

ORDINARILY, supports for horizontal turbines are such a commonplace detail that mention of them is not often made. However, the steel foundations for the 30,000-kw. horizontal turbo-generators recently installed by the Detroit Edison Co. present some features worthy of mention.

At the Connors Creek power house three 20,000-kw. machines and one 45,000-kw. unit have concrete foundations, which have not proved altogether satisfactory. From the design point of view the arch in the base over the condenser has been the weak point—both in comparison with the strength of the other parts of the base and in consideration of the unusual forces that it has to resist when a unit "goes bad." Take the 45,000-kw. machine, for example. The rotating elements in the turbine and generator weigh over 100 tons, so that when a bucket fails there is a fairly good imitation of a 100-ton steam hammer making 1,200 blows per minute The arch cannot conveniently be made large enough as a concrete member to resist such force. Burying a steel grillage in the concrete, to encircle the turbine exhaust, while apparently solving the problem, is a questionable expedient, for it seems logical that should a small crack develop, due to any one of numerous causes, small particles of dust or sand would act as fulcrums of forces, which, owing to machine vibrations, are always working to enlarge the crack.

The concrete piers that support the structure directly under the machine base may be looked upon, with regard to reducing horizontal vibrations or movement, as

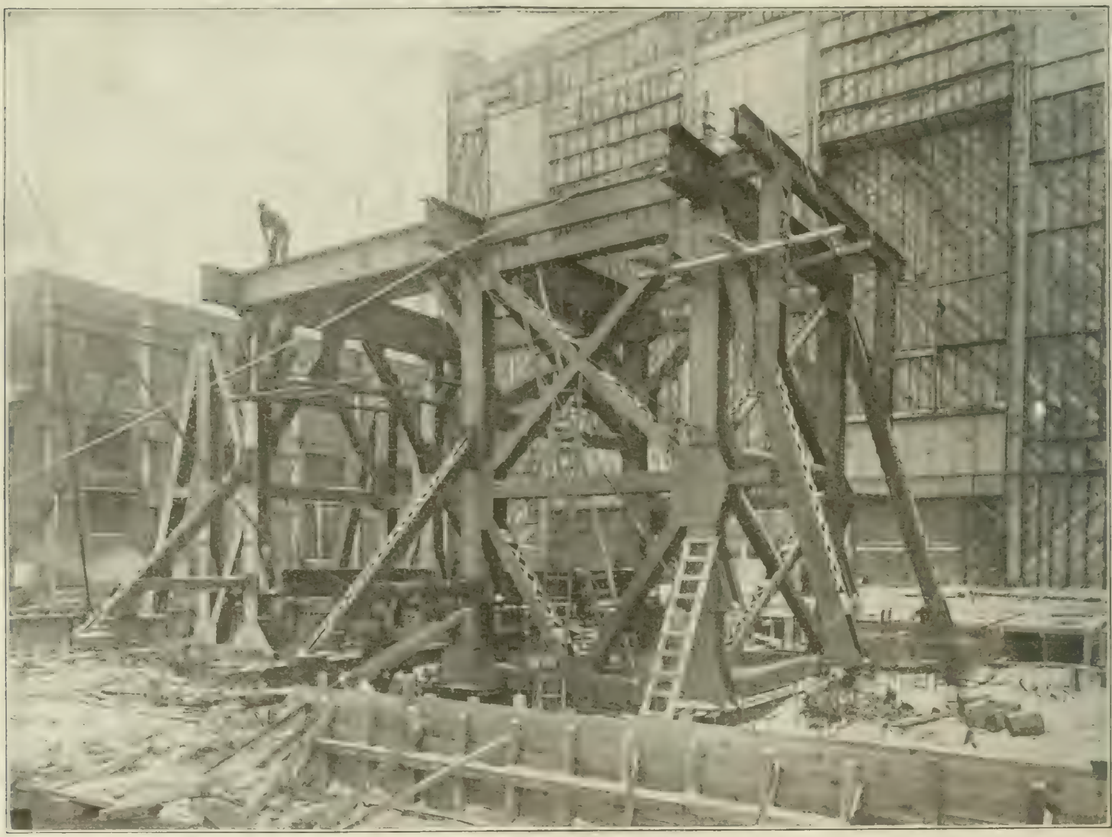


FIG. 1. STEEL BASE FOR 30,000-KW. TURBO-GENERATOR UNDER ERECTION AT CONNORS CREEK STATION

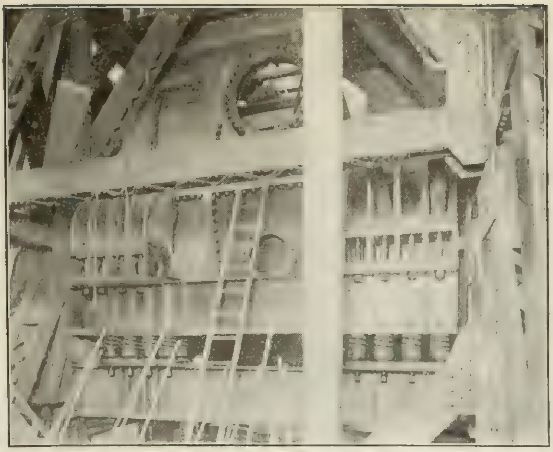


FIG. 2. PROGRESS VIEW AT DELRAY, SHOWING BASE OF CONDENSER

cantilevers with their support at the floor. The great mass of concrete at the floor is therefore used principally to resist an unusually large bending moment when subjected to the severe conditions previously mentioned. For purposes of reducing weight and space, therefore, a steel member at this point would be more efficient. It was such reasoning as this that made a combination concrete-steel structure appear the best suited to fulfill the requirements; namely, greater accessibility within the base, more light, a saving of space, reduced weight, a better disposition of structural strength and mass, with greater facility in correcting for settlements. The reduction of weight was a very important item. For instance, the vertical units in Delray power house No. 2 are to be replaced by horizontal units, and the old mat now supporting the vertical machines would not stand up under a concrete foundation for a 30,000-kw. unit, except with expensive and awkward alterations. The reductions of weight for each of the proposed new units is about 500 tons as between the all-concrete foundation and the composite concrete-steel design.

With these points in mind, therefore, a steel design has been worked out with a concrete slab directly under the turbine and resting on top of a steel base. The top of the steelwork is two feet below the turbine-room floor. It was assumed that the nearer the center of gravity of the concrete mass to the base of the machine, the more effective would be this mass in reducing vibration. The concrete was spread out like the top of a table in respect to the steel foundation and separated one inch from the turbine-room floor along its entire perimeter. Its dimensions are 28 ft. wide by 46 ft. 8 in. long, and the top is tiled flush with the turbine floor proper. One strip 5 ft. wide and 47 ft. long on each side of the mass is 4 ft. thick, the remainder of the mass being 2 ft. thick. The total weight is about 350,000 lb. Such a mass will absorb a considerable force before actually getting in motion, and at the same time it lowers the pitch or tune of the structure as a whole so that it is not so likely to vibrate in synchronism with the turbine itself.

After this concrete cap was poured, steel bearings or sole plates were set at short intervals to the intended elevation of the bottom of the turbine base. These sole plates are about 2 in. thick and 2 ft. long by about 10 in. wide. Irregularities in castings were then made up by placing thin shims on these plates, and the entire base was finally grouted in. Sole plates were considered preferable to wedges, as they make a neater job and save time for the erectors.

The problem of providing for settlements must be met whenever a plant is built upon such subsoil as exists at Detroit The entire city is underlaid with a clay bed varying in thickness from about 70 to 130 ft. and quite soft in proximity to the Detroit River. As both the Connors Creek and Delray plants are along the river, foundation types are somewhat limited. A mat or boat foundation was adopted in both cases. With such a foundation a settlement is expected, and the designer endeavors, so far as he is able, to have this settlement uniform over the entire area. The mat at Delray has settled in the shape of a saucer, and as the turbines are set near one edge of the mat, they come on the edge of the saucer and consequently are subject to an uneven settlement. Usually, this settlement is taken care of in the machine by shimming the main bearings, which, as one might well imagine, is an expensive method—especially so if the baseplate has to be regrouted. This means taking the machine entirely apart and starting over again, as with a new installation.

With the new steel foundations, by leaving the bearing plates of each column and brace accessible, it will be a simple matter actually to raise the entire structure by jacks and maintain the top in a level position should any settlement develop. In case of lowering any particular column the shims can be removed (these have been slotted to avoid conflict with anchor bolts) and vice-versa, shims can be added where an elevation is desired.

In the side elevation of the concrete-steel foundation a good idea is given of the proportion of the structure and of the braces at each end of the machine as well as those at the sides. The main columns of the steel base are about 25 ft. long and made up of two 15-in. channels and 18 x ½-in. plate. They rest on a grillage of six 24-in. I-beams about 24 ft. long, which extend transversely to the unit from one colmun to the other. This spreads the load in a satisfactory manner over a large area of the mat foundation proper, which is 4 ft. 6 in. thick. The largest beams used in the structure are 28-in., 165-lb. I-beams. Stresses were computed for 16,000 lb. per sq.in. For live loads, which are composed of the weight of the turbine and the condenser, 50 per cent impact was allowed. No steel framing is used smaller than a section made up of two 8-in. channels. Gusset plates are of ½-in. metal and amply large, as upon these plates depends the rigidity of the structure. Throughout, ⅞-in. rivets are used. The steel in the base and grillages amounts to about 90 tons. With regard to cost the difference in price between an entire concrete structure and the composite type is small; at least that was the situation for this particular job.

At the end and sides of the structure the braces should be efficient in guarding the main part of the steel base against unusual shocks or jolting, such as are experienced when an accident happens to a turbine. On the other hand, there may be danger of getting the structure too rigid. However, with so many riveted connections it is to be expected that there will be some play in the joints, sufficient, in combination with the elastic deformation of the members themselves, to dissipate the force of any sudden shock the structure might meet. At

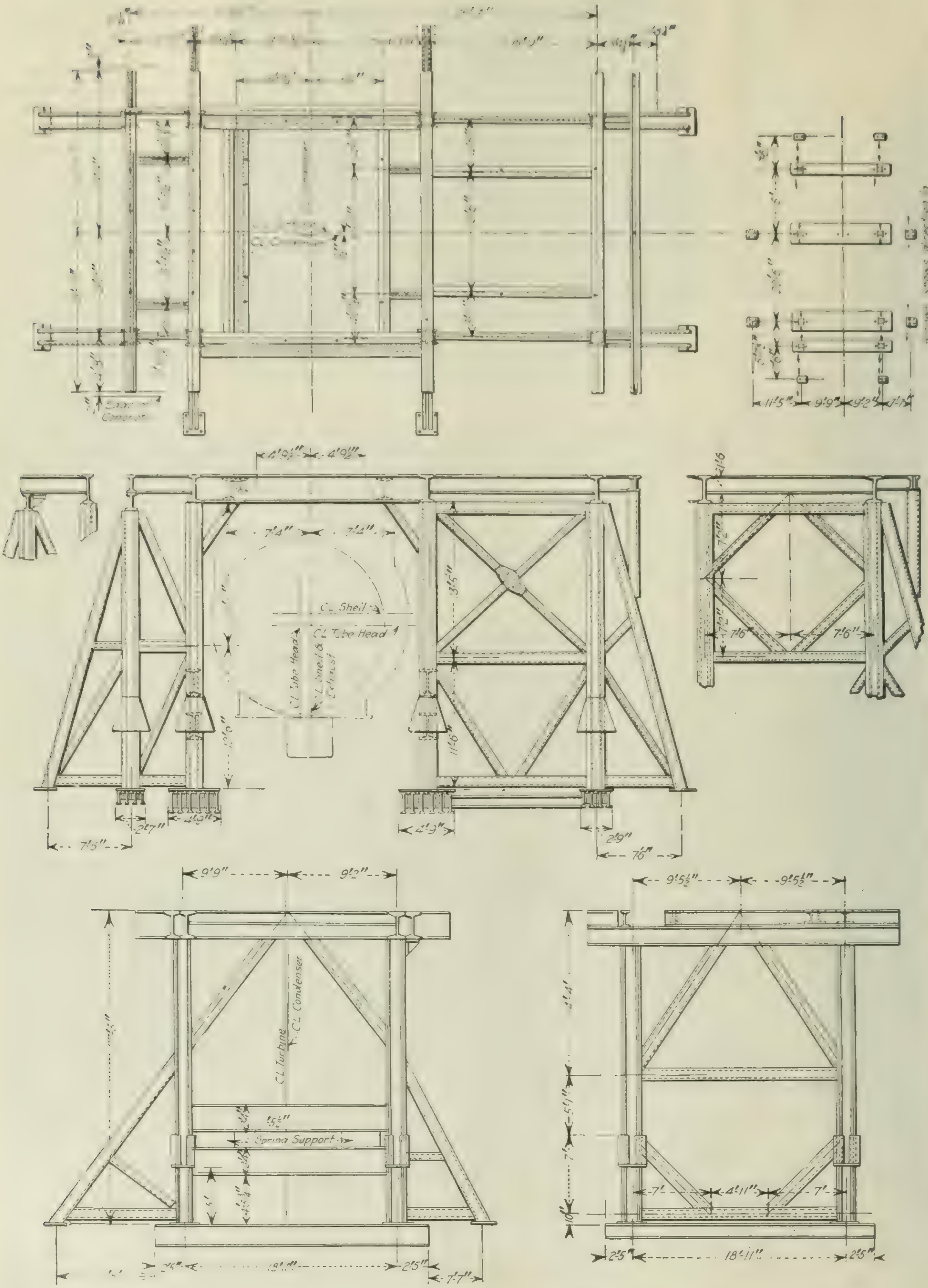


FIG. 3. SHOWING PLAN, ELEVATION AND SECTIONAL VIEWS OF THE STEEL FOUNDATION

least there is a possibility of some "give" to the structure. On the lower part of the columns the "skirts" are made up of plates and angles which are made use of when the structure is to be elevated. A 15-in. I-beam is placed under them and receives the push from a group of jacks.

The reason for the two beams, one over and one under the springs supporting the condenser, is that the condenser heads were transposed, so that the center of gravity no longer would lie midway between the feet of the condenser. Therefore the springs were sandwiched between the two beams in such a position as to take an equal share of the load.

The first of these units has now been operating several months, and its behavior on this foundation has been considered very satisfactory. There is a slight vibration in the end braces on the longitudinal axis. This, however, has not been serious enough to warrant any radical changes. There are several methods available that would probably correct this situation. Possibly, filling the brace with concrete, the additional weight acting as a dampener, or even a rearrangement of the stiffener connecting with the brace, would be the remedy. As an example of how small this vibration is, a tile floor was laid over the exposed concrete cap extending beyond the bedplate of the machine. This tile was successfully laid on a bed of grout 1½ in. thick, while the unit was running with a load of 28,000 kw.

For several weeks the second installation of this type has been operating and is entirely satisfactory. There is almost no perceptible vibration.

PUTTING THE UNITS IN OPERATION

To discuss the steel type of foundation has been the primary object of this article, but a few words concerning the units themselves, with their auxiliaries, may not be out of place. Such a description would not be complete without a few remarks about the conditions under which they were assembled and put in operation.

A 17-stage impulse turbine, developing 40,000 hp. at 1,800 r.p.m., drives the generator, which has a capacity of 33,333 kva. at 12,200 volts. The turbines are designed for steam at 200 lb. gage pressure at the throttle and 200 deg. superheat. The turbine exhausts into a 42,700-sq.ft. double-pass surface condenser containing 8,490 1-in. tubes 18 ft. long. Circulating water is supplied to the condenser by two 36-in. volute pumps driven by variable-speed motors of 440 to 350 hp. To keep the discharge leg of the condenser less than 24 ft. and so make the siphon effect reliable, the level of the overflow canal was raised by means of a weir.

Vacuum is maintained in the condenser by a two-stage dry-vacuum pump, displacing 2,050 cu.ft. of air per minute and driven by a variable-speed motor. Two wet-vacuum pumps are capable of delivering 1,000 gal. per minute of condensate from the hotwell against 100 ft. head.

Electrically, the unit in the Delray plant is remote controlled, the switchboard being some 1,500 ft. from the power house. Control is effected by a signal panel at each building, safeguarded by two independent telephone lines.

What has made the 30,000-kw. unit in the Delray power house and a similar unit in the Connors Creek station of more than ordianry interest to the Construction Engineering Bureau of the Detroit Edison Co., is the fact that immediate installation was imperative for power requirements. Contrary to expectations after the war, the power load on the system continued to increase instead of diminish, which made it difficult to overhaul machinery that had been pushed to the limit for three years.

To hasten construction on the Delray unit, the condenser was erected first and then the steel base built around it and the concrete cap poured. An excellent spirit of co-operation prevailed between the construction men on the job and the erectors, and as a result the turbine was turned over 37 days after the first carload of machinery entered the yard.

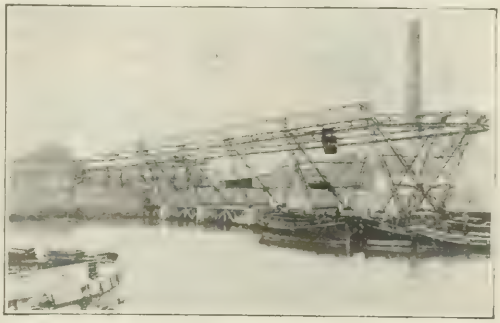
At Connors Creek the unit was installed immediately after the Delray machine. The race for time was even more evident because of a delayed start, due to the breakdown of transportation. The erectors broke their previous record by installing the unit in 30 days, 7 days better than with the first machine.

Fuel in Argentina

BY V. L. HAVENS

The writer lately returned from an extensive visit to South America, and it may be that *Power* readers will be interested in the unusual difficulties that power-house operators have encountered there during the last few years.

The following tables are not for the purpose of indicating exact market values, as the prices changed greatly during any of the late years, but rather to indicate the problem of the power-house executive.



HANDLING COAL IN THE PORT OF BUENOS AIRES

COAL IMPORTS INTO ARGENTINA

Year	Total Imports	From U.S.A.	From Great Britain	Approximate Price
1913	4,046,278	56,206	3,977,650	$9
1917	700,000	400,000	300,000	30
1918	821,974	200,000	600,000	50
1919	1,000,000	500,000	500,000	40
1920				35

APPROXIMATE PRICES PER TON OF SUBSTITUTE FUELS, U. S. DOLLAR

	1913	1917	1918	1920
Quebracho colorado wood	$2 50	$10		$12
Quebracho blanco wood	2 50	10		10
Charcoal			$50	
Petroleum	10 00		55	

Quebracho colorado contains a very large percentage of tanning extract. As the name indicates, this is red. Quebracho blanco is used largely for construction purposes as it is practically permanent as a building material. Both are highly valuable woods and difficult to replace, but their use as fuel has become very necessary.

The war has induced the growth of local industry in many ways, and the demand for fuel, especially for railway use to move the increasing yearly crops, has tended to make the situation more acute. The annual needs of the country may then be assumed to be at least 5,000,000 tons of high-grade fuel for local use and bunkering.

The shortage of three or four million tons has been made up by curtailment of needed power or heat or by the use of wood to a considerable extent, but this has not been the only substitute. Some of the younger power-house superintendents in this country may think they have troubles, but one fifty-kilowatt plant in central Argentine has been running two years on bran and hay. I suppose many an adolescent calf has looked with deep yearning on the fuel pile, but the brave firemen guarded the bins with jealous zeal.

In one of the small gas plants in the state of Entre Rios, in northeastern Argentina, operations have gone on continuously for the last four years with wood gas, enriched after a fashion from such supplies as the local market permitted

Some coal is used in the power houses, supplemented by wood in the larger centers and by wood, corn and bran in the smaller cities, corn, bran and hay in others and, as already noted, bran and hay in a few. The bran is fed with a blower and has produced some extraordinary results, such as scale of glutinous cinder.

On the railways 25 per cent of the fuel was wood in 1913 and 71 per cent in 1916. It is probably higher now. Some interesting facts have been brought out regarding calorific values.

About 2.4 by weight of dry wood, harder than oak, is required to replace the best steam coal. Corn or maize has not been used very much on the railways, but wheat has been used occasionally in the power houses and a great deal of corn has been consumed in this way.

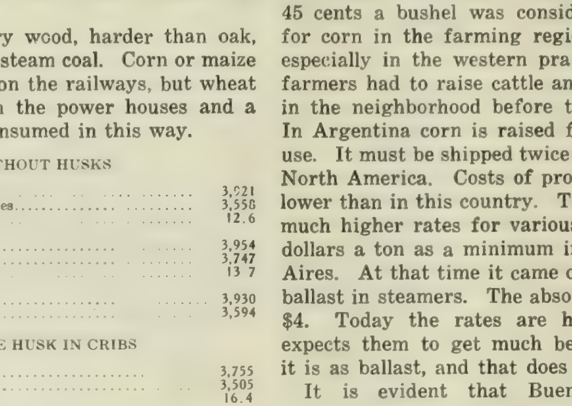
CORN DRIED WITHOUT HUSKS

Shelled corn	
Total calorific value, calories	3,921
Available after evaporating moisture, calories	3,558
Moisture, per cent	12.6
Corncobs:	
Total calorific value, calories	3,954
Net value, calories	3,747
Moisture, per cent	13 7
Corn on cob:	
Total calorific value, calories	3,930
Net value, calories	3,594

CORN DRIED IN THE HUSK IN CRIBS

Shelled corn:	
Total calorific value, calories	3,755
Net value, calories	3,505
Moisture, per cent	16.4
Corn cobs:	
Total calorific value, calories	3,594
Net value, calories	3,125
Moisture, per cent	18 3

The net B.t.u. per pound for corn dried without husks are: Shelled corn, 6,400; corncobs, 6,745; corn on the cob, 6,470. When dried in cribs in the husk, the moisture is greater and the B.t.u. per pound 6,300; corncobs, 5,625. Since only a high quality of steam coal would be shipped abroad, if it could be obtained, these figures could be compared with 14,000 B.t.u. for steam coal. Then dry corn would have a fuel value of about 0.47 of coal, or to substitute corn for coal would mean handling 2.2 the tonnage. The corresponding relation of cobs to good steam coal would be 0.44 heat value, or 2.3 the tonnage. Corn on the cob is about the same as corn. This is no doubt due to the low specific gravity of cobs as compared with corn, but it would appear that one should burn the corn on the cob if the corn is to be burned at all, thereby saving shelling, getting a better draft and avoiding the minor tendency on the part of the corn to coke.



There appears to be no obvious advantage in thinking of burning corn without the cobs, unless it would be to reduce the space requirements in transportation. This, of course, might prove an important item if transportation should be at all difficult, and anyone considering the use of corn would no doubt consider the details of fuel value obtained per cubic measure as well as weight if they were shipping in barges or box cars.

ONE TON OF COAL EQUIVALENT TO SIXTY-FOUR BUSHELS OF CORN

One could hardly expect such a high grade of coal as the export quality in the average district, but might find a good quality. If the coal normally available is about 13,000 B.t.u. quality, and air-dried husked corn on the cob has 6,740 B.t.u., and taking 70 lb. as a bushel of corn on the cob, then 35 lb. of the coal would be equal in fuel value to a bushel of corn. Likewise a ton of coal weighing 2,240 lb. would have the same fuel value as 64 bushels of corn, and each dollar added to the cost of a ton of coal would add 1.5625 cents to the price of a bushel of corn.

It was not so many years ago, as time runs, that 45 cents a bushel was considered a pretty good price for corn in the farming regions of the United States, especially in the western prairie land. Even then the farmers had to raise cattle and hogs and raise the corn in the neighborhood before they could pay that price. In Argentina corn is raised for export as well as local use. It must be shipped twice as far by sea as corn from North America. Costs of production must generally be lower than in this country. Their railways must charge much higher rates for various reasons. Coal cost nine dollars a ton as a minimum in pre-war days in Buenos Aires. At that time it came out in sailing vessels or as ballast in steamers. The absolute minimum freight was $4. Today the rates are high enough, but no one expects them to get much below $10 for years unless it is as ballast, and that does not control general rates.

It is evident that Buenos Aires will not see coal as low as $20 for many moons, and to that must be added the very high freight rates on coal, hauled with the same expensive fuel or its equivalent, to the interior. Therefore in a region distant from the seaboard, capable of raising good corn at a low cost and having nothing but imported coal, it is not such an extraordinary thing when they even think of raising corn to burn, although the idea may at first seem strange to people in the states. The calorific value of corn as given in the table was determined by the Compañia Alemana Transatlántica, of Buenos Aires. The values are shown in large calories per kilogram of fuel.

Application of Induction Motors—I

General Considerations in the Application of Induction Motors Are Outlined—Kind of Load Motor Is To Drive—Motor Ratings—Required Torque for Starting—Starting Under Severe Conditions—How to Determine Length of Period Required for Acceleration

By FRASER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

AS A general rule the importance of the correct application of motors is seldom fully appreciated. Outside the lack of proper care and attention, and incorrect installation, it can broadly be stated that at least 95 per cent of all the troubles experienced in the field can be directly attributed to the fact that the question of application was not fully considered at the time the contracts were awarded. The various points that must be brought out to insure correctness of application are surprisingly numerous, and the most important of them are listed here:

1. What is the motor to drive?
2. Kinds of rating.
3. Will the motor have sufficient torque to start its load?
4. If the starting conditions are severe, how much actual torque is required to start the load?
5. What will be the length of time of period of acceleration?
6. If the motor is of the squirrel-cage type, will excessive line current during the starting period be objectionable?
7. Is the capacity of the system supplying the motor sufficient to take care of the starting period?
8. Will the motor operate at its full rated load?
9. Will the motor be subject to heavy overloads and severe mechanical shocks?
10. Will the motor be "plugged"?
11. Location of motor: Floor mounting or ceiling suspension; outdoors or indoors; dry or wet place; explosive gases; acid fumes, clean or dusty; cool or hot; altitude, etc.?
12. Will motor be direct-connected or belted? If direct-connected, how connected to the load? If belted, what is the pulley size on both the motor and the driven machine and the belt centers? Also in what plane will the belts run, horizontally, vertically, etc.?
13. If power is to be bought, will the power demand meet the local power company's requirements?
14. Will the motor and control meet the local underwriters' requirements?
15. Will the motor be supplied with adequate protection such as overload, low-voltage and the necessary interlocking devices?
16. Would some type of machine other than an induction motor or the motor that is selected be more preferable to meet the existing conditions?

There are other features that will naturally come up relative to the existing local conditions, but the main points are as enumerated.

1. What Is the Motor to Drive?

It is generally understood that induction motors are not suited for individual drive of the general line of machine tools, printing presses, etc., and that speed control within close limits is not possible. If speed control is required, then it is necessary to know the exact speed-torque characteristics of the driven machine. A squirrel-cage motor is unsuited to accelerate machines having a large amount of inertia such as flywheels, cement- and ore-grinding mills, or centrifugal pumps, fans, compressors, etc., which are not unloaded during the starting period.

Knowing what the motor is to drive gives a check, not only on the suitability of the type selected, but also a general idea as to the possible load conditions to be expected.

2. Kinds of Ratings

The rating of the motor used should correspond as nearly as possible to the nature of the service required. Most induction motors can be classified in respect to the kind of rating under the two general headings—Continuous Rating and Short-Time Rating.

A continuous-rated motor should be capable of delivering its full rated output continuously without exceeding the limitations set by temperature, mechanical strength, dielectric strength, etc. Machines rated under these limitations are suited to conditions where the load is more or less constant and such as is found in almost all of the great industrial and manufacturing plants. Motors having short-time ratings are suited to a service requiring full output for limited periods including runs alternating with stops of sufficient duration to insure substantial cooling without exceeding the limitations as to temperature, mechanical strength, etc. Motors of this class are to be found in the operation of elevators, hoists, etc.

3. Will the Motor Have Sufficient Torque To Start Its Load?

Consider a squirrel-cage induction motor starting a centrifugal pump or fan. The speed-torque characteristics of the centrifugal pump or fan are similar, and the horsepower needed to drive them varies as the cube of the speed, while the torque required varies as the square of the speed. This latter is shown by curve *A*, Fig. 1; the speed-torque curve of an induction motor, for full impressed voltage, is represented by curve *B*, while curve *C* shows the same thing for 50 per cent full impressed voltage, such as might be used for starting the load.

A centrifugal pump with the valve in the discharge line fully open, if started up by a squirrel-cage induction motor on an intermediate tap, will usually not come up to full speed on the starting position, but to some such point as *D*, Fig. 1. If the pump is sustaining a high column of water when the motor is thrown from the running to the starting position, the lapse of even a few seconds of time necessary to change over—that is, temporarily disconnect the motor from the starting and connect to the running position—is sufficient to allow the column of water to start downward. A tremendous shock is created when the motor is suddenly thrown to the full running position, thus tending to change instantly the direction of the water. This shock is severe enough to break the piping in cases where the volume of water is large. It tends to create a severe water hammer, and not only is this hard on the pump and on the motor mechanically, but the electrical jolt is also severe and creates a condition unfavorable to the motor and sometimes to the line.

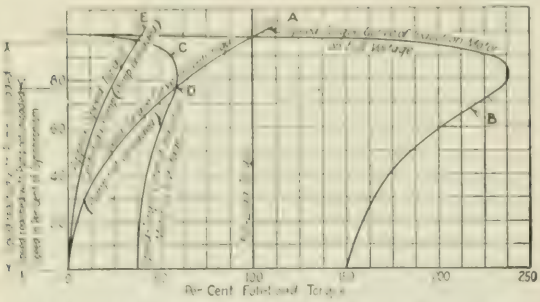


FIG. 1 SPEED-TORQUE CURVES OF CENTRIFUGAL PUMP AND SQUIRREL-CAGE TYPE INDUCTION MOTOR

If, on the other hand, the valve in the discharge line is closed, the torque required at full speed is approximately 40 per cent of the full-load torque and the motor has no trouble in bringing the pump up to practically full speed on the starting tap. This is shown by curve *E*, Fig. 1, it being assumed that the torque under these conditions also varies as the square of the speed. After this, the discharge valve may be opened gradually and the pump will assume its full load. Under these conditions of starting, the pump must always be filled with water, otherwise the clearance strips are likely to be burned out.

CHARACTERISTICS OF SQUIRREL-CAGE TYPE INDUCTION MOTORS

All Motors 440-Volt, 3-Phase, 60-Cycle Squirrel-Cage Type

Hp.	Poles	Synchronous r p m	Full-Load Efficiency	Full-Load Power Factor	Maximum Starting Torque in Per Cent of Normal
150	4	1,800	92.5	93	180
150	6	1,200	92	92	135
150	8	900	91	91	125
150	10	720	91	89	120
150	12	600	90	88	115
150	14	514	90	85	110
150	16	450	90	82	105
150	18	400	89	79	100
150	20	360	87	75	100

Fig. 2 shows the same starting conditions with a slip-ring type motor. Curve *A* is the speed-torque curve of the pump under full head, while curves *B*, *C*, *D*, etc., are the speed-torque curves of the motor on the different positions of the starter. Such a method of starting eliminates the line disturbance prevalent even with the squirrel-cage motor and unloaded pump and gives a smooth, even acceleration. When the slip-ring motor cannot advantageously be used, it is essential except in the smaller-sized units, that all driven machines such as centrifugal pumps, plunger pumps, fans, blowers compressors, etc., be unloaded during the starting period when started by squirrel-cage induction motors.

By referring to the table it is seen that as the number of poles of the motor increases, hence the speed decreases, the starting torque for full impressed voltage of the squirrel-cage motor also decreases. This is an inherent feature of the induction motor and is characteristic of all such machines. Slow-speed machines do not have as good characteristics as to power factor, efficiency, torque, etc., as high-speed machines.

Fig. 3 illustrates the difference in the speed-torque curves of two 60-cycle squirrel-cage motors of equal output, voltage, phase and frequency, but of different speeds, one being a 4-pole and the other a 16-pole motor. These curves show that not only the starting torque, but also the maximum torque, is lower on the slow-speed than the high-speed motor. Therefore great care has to be exercised, not alone in the proper selection of the type of motor, but also as to the nature of the starting conditions, in order to make certain that the speed selected assures a motor with the requisite amount of torque.

4. IF THE STARTING CONDITIONS ARE SEVERE, HOW MUCH ACTUAL TORQUE IS REQUIRED TO START THE LOAD?

In the correct application of the induction motor, the starting- or static-torque features of the load determine to a large extent the use of the squirrel-cage or the slip-ring type. As a general rule the running-load conditions of any given load are well known, usually by direct measurements of power, but the starting-load conditions are totally unknown.

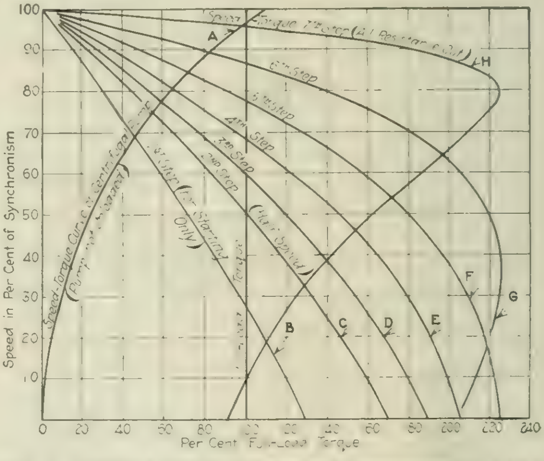


FIG. 2 SPEED-TORQUE CURVES OF CENTRIFUGAL PUMP AND SLIP-RING TYPE INDUCTION MOTOR

A good idea as to the static conditions of a load may be obtained by a spring balance used at a known radius. Suppose it were desired to learn the static conditions of a long length of lineshafting in a factory. A spring balance attached to a rope around a pulley of known diameter or a beam rigidly attached to the shafting will show what is desired. In cases such as this it is always advisable to take a number of readings and under conditions known to be the most unfavorable. For instance, static torque on a lineshaft should be taken, preferably, on a Monday morning before starting up, after the shafting has been idle over Sunday. The readings should also be taken, if possible, at a time when the lowest temperature that is likely to be encountered exists.

When using the beam, Fig. 4, the readings should be taken when the beam is in a horizontal position, then the torque is

$$T = \frac{W - w}{16} \times \frac{L}{12}$$

where T is the torque in pounds at 1 ft. radius, L is the length of beam in inches from center of shaft to point of pull of the spring balance, w is the weight in ounces of the beam when free to rotate about the center O (minus when the measurement is made vertically upward and plus when made vertically downward), and W is the weight in ounces read on spring balance for any load.

When the static torque is known, it can readily be transferred into synchronous horsepower by the formula

$$Hp. = \frac{T \times 2\pi \times r.\,p.\,m.}{33{,}000}$$

where T equals torque in pound at 1 ft. radius, *r.p.m.* equals revolution per minute and *Hp.* equals horsepower. From this the question of one of the important points of correct application is readily determined. As the motor speed is oftentimes different from the driven-machine speed, care should be exercised in the use of this formula. For instance, consider an arrangement as in Fig. 5, where a lineshaft runs at 400 r.p.m. and the motor runs at 1,150 r.p.m. By the use of the beam on the lineshaft the value of T is readily found and the synchronous horsepower is found by the formula for this factor, in which 400 is used for the r.p.m. value. If, on the other hand, the beam is used on the motor shaft, the value of r.p.m. used in the horsepower formula should be 1,150 and not 400. These two methods should closely check each other.

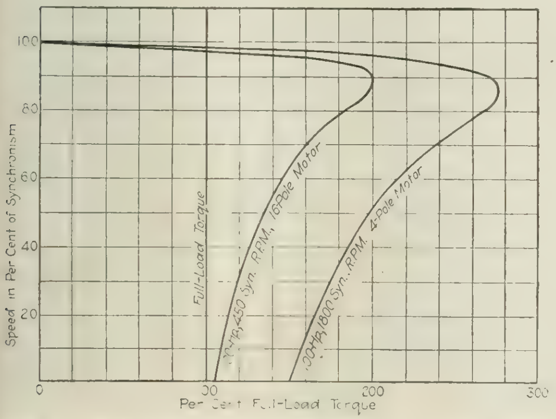
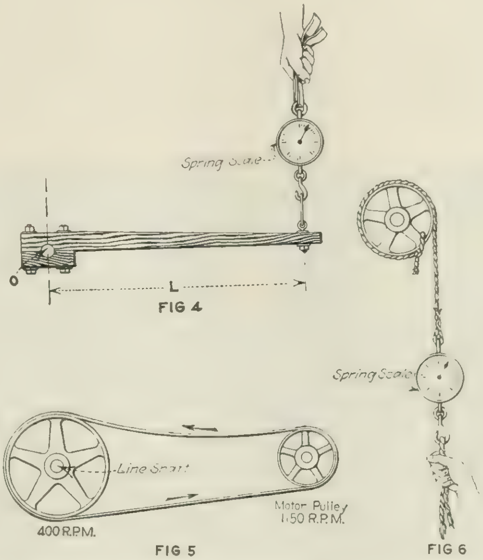


FIG. 7. COMPARISON OF SPEED-TORQUE CURVES OF A HIGH-SPEED AND A LOW SPEED SQUIRREL-CAGE TYPE INDUCTION MOTOR

When using a rope around a pulley as in Fig. 6, the torque formula, while practically the same, considers slightly different conditions as follows:

$$T = \frac{W \pm w}{16} \times \frac{L}{12}$$

where L equals length in inches from center line of pulley to center line of rope; w equals weight in ounces of the free length of rope on spring-balance side and is a plus quantity if the measurements are made in a vertically downward position (if the measurements are made in a vertically upward position, the sign becomes minus); and W equals weight in ounces read on spring balance for any load.



FIGS. 4 TO 6. METHODS OF DETERMINING STATIC TORQUE FOR MOTOR DRIVES

In the case of masses rotated between bearings such as flywheels, motor-generator sets, etc., where the use of the spring balance is frequently not feasible, the power to overcome the bearing friction at the instant of starting may be estimated from the expression,

$$Synchronous\ hp. = 0.3 \times W \times \frac{r}{12} \times \frac{2\pi \times r.\,p.\,m.}{33{,}000}$$

where W is the weight in pounds of rotating parts, r is the radius in inches of shaft in bearings, and *r.p.m.* is the synchronous speed.

In the foregoing, the coefficient of friction is taken as 0.3, but variations in conditions may make it advisable to change this slightly. The value as given is intended to cover starting under average conditions and not under ideal conditions.

5. WHAT WILL BE THE LENGTH OF TIME OF PERIOD OF ACCELERATION?

The question of static torque alone is no criterion of what type of motor to use. A flywheel might have a static torque indicating the use of a squirrel-cage motor, but the stored energy necessary to accelerate the wheel might be sufficient to prohibit absolutely the use of such a driving machine. Static torque and period of acceleration must be considered together. On shafting or machines on which the period of acceleration is in doubt, it is often possible to obtain the necessary data by temporarily connecting a direct-current motor and taking the watts input and time of acceleration. Where such tests are not available, certain data are often obtainable from which a knowledge of the acceleration may be had. Take the following problem:

Problem: Find the power required to start up a shear having a flywheel; where S = speed = 120 r.p.m., D = outside diameter = 11 ft.; W = weight of flywheel rim = 12,000 lb.; and W' = weight of 6 arms of flywheel = 2,250 lb.

Assuming an inside diameter of 8 ft. 6 in. for the rim of the wheel, the moment of inertia,

$$I = \frac{W}{g} \times \tfrac{1}{2}[(r_1)^2 + (r_2)^2]$$

(Foot-pound-second system of units)

$$= \frac{12,000}{32.2} \times \tfrac{1}{2}[(5.5)^2 + (4.25)^2] = 9,000.$$

and

$$(Radius\ of\ gyration)^2 = R^2 = \frac{I}{M} = \frac{9,000}{\left(\frac{12,000}{32.2}\right)} = 24.1,$$

from which

Radius of gyration $R = \sqrt{24.1} = 4.90$ *ft.* *(say 5 feet)*

where r_1 = outside radius of rim in feet; r_2 = inside radius of rim in feet, and g = acceleration due to gravity, equals 32.2.

Therefore, the flywheel effect or WR^2 of the rim equals weight of flywheel rim times radius of gyration squared, in this problem is

$$12,000 \times (5)^2 = 300,000 \textit{ pound-feet},$$

but the rim WR^2 is also

$$\frac{5,870 \times Hp. \times t \times 550}{(120)^2} = 300,000 \textit{ pound-feet}$$

therefore the horsepower-seconds is

$$Hp. \times t = \frac{(120)^2 \times 300,000}{5,870 \times 550} = 1,340$$

If the radius of gyration of the flywheel arms is 2 ft. 6 in., then

$$WR^2 = 2,250 \times (2.5)^2 = 14,050 \textit{ pound-feet}$$

and

$$Hp. \times t = \frac{(120)^2 \times 14,050}{5,870 \times 550} = 62.7$$

Total horsepower-seconds to bring the flywheel from rest to 120 r.p.m.

$$1,340 + 62.7 = 1,402.7$$

Assume that the static friction of the shear and the power required to bring it up to speed is equal to one-half that required for the wheel. Then the approximate total accelerating energy is

$$1,402 + \frac{1,402}{2} = 2,103 \textit{ horsepower-seconds}.$$

If the time of acceleration is limited to 20 sec., then the horsepower required is

$$Hp. = \frac{2,103}{20} = 105.$$

In the foregoing, the WR^2 of the arms is so small that it could be neglected. It is also seen that a general assumption of power required to bring the shear without the flywheel up to speed also has to be made, nevertheless some idea of the period of acceleration can be obtained. In the case of motor-generator sets, flywheels, etc., where data are not available, some such method of calculation has to be resorted to.

For ordinary calculations the radius of gyration of a rim-type spoke flywheel may be taken as equal to 0.4 × external diameter, or for greater accuracy use $0.707\sqrt{(r_1)^2 + (r_2)^2}$ and the weight of the rim as being approximately 60 per cent of the total weight of the wheel.

For solid-disc flywheels the radius of gyration may be taken as equaling 0.707 × radius, and the calculations for stored energy made as stated, the total weight of the disc having to be considered.

[*This is the first of three articles on induction-motor applications. The next article will deal with items 6 to 10 outlined in this article, and the third installment will take up items 11 to 16 inclusive.*—EDITOR.]

Starting an Old Diesel

In visiting oil-engine plants many Diesels ten to fifteen years old are often encountered. The majority of these old engines have never had a reasonable amount of care. Usually, the pistons are so badly worn that the compression is seldom above 300 lb. per square inch. On starting, the air blows down past the pistons so that it is difficult to turn the engine over fast enough to secure ignition.

Many engineers, not realizing the danger, are in the habit of giving the cylinders a shot of gasoline. The gasoline is poured in through the admission valves. The engine, even though just barely turning over, will fire the gasoline in the firing cylinder. There is grave danger in this procedure. The gasoline will quite likely explode early in the compression stroke. If this occurs, something is going to give way. Even if relief valves are fitted to the cylinder heads, they may fail to open. Frequently, admission valve cages are blown out, connecting rods bent and, to the writer's knowledge, in two instances crankshafts were fractured.

There is no disputing the fact that it is extremely difficult to start a badly worn engine. The best way to do it is to set the air starting valve to open after the piston has passed dead center. This will save a lot of air, since the piston will be moving outward when the air strikes it on the second turn. To prevent too much leakage about the pistons a pint of lubricating oil can be poured in on the top of each piston. The oil will effectually seal the clearance and will raise the compression pressure high enough to ignite the fuel when the fuel valve opens. There is no danger of the lubricating oil preigniting. The engine, even though badly worn, will usually fire.

There are extreme cases of engine wear where even the method outlined above fails to secure results. It is possible to block open the admission valves of the firing cylinders and turn the engines over with the starting cylinder until a fairly high angular velocity is attained. Throwing the admission valve into place at this time will invariably secure regular firing. Of course the proper relief is the reboring of the cylinder and the installation of new pistons. It so happens that occasionally the engineer cannot induce the management to do this. Above all else, no Diesel engine should be dosed with gasoline or kerosene.

Diesel Engines in Cement Mills

Oil Engines Are Proving Economical Power Producers Even in Such Industries as Cement Mills, Where Heretofore Waste-Heat Boiler Plants Have Held the Supremacy

WHEN the Lehigh Portland Cement Co. installed Diesel engines in their Iola, Kansas, plant in 1916, the McIntosh & Seymour units purchased were the first 1,000-hp. Diesels to be constructed in the United States. These 1,000-hp. six-cylinder engines were developed along the same lines as the smaller Diesels built by this firm and so represented no radical ideas in Diesel design. That the design was along sane, conservative lines is attested by the uniform success obtained in the operation of this plant. The plant record of continuity of service is probably unequaled by any other oil-engine station.

Originally, three 1,000-hp. engines were installed Each was direct-connected to a 750-kw. Westinghouse direct-current generator delivering 440 volts to the switchboard. In 1919 the fourth engine-generator unit of like capacity was installed, and a fifth engine will probably be in operation by December of this year. The plant will then be the largest Diesel station in America. The units are set in line along the length of the building, as shown in Fig. 1. Space has been left for the fifth engine, the foundation bolts of which appear in Fig. 2 in the foreground. The engine platforms are interconnected, enabling the operators to go from engine to engine without descending to the room floor. The plant is served by a 10-ton Whiting traveling crane. The switchboard is of black slate and is equipped with Westinghouse instruments and switches. The board is set at the end of the building, somewhat out of sight of the operators of all save the adjacent engine.

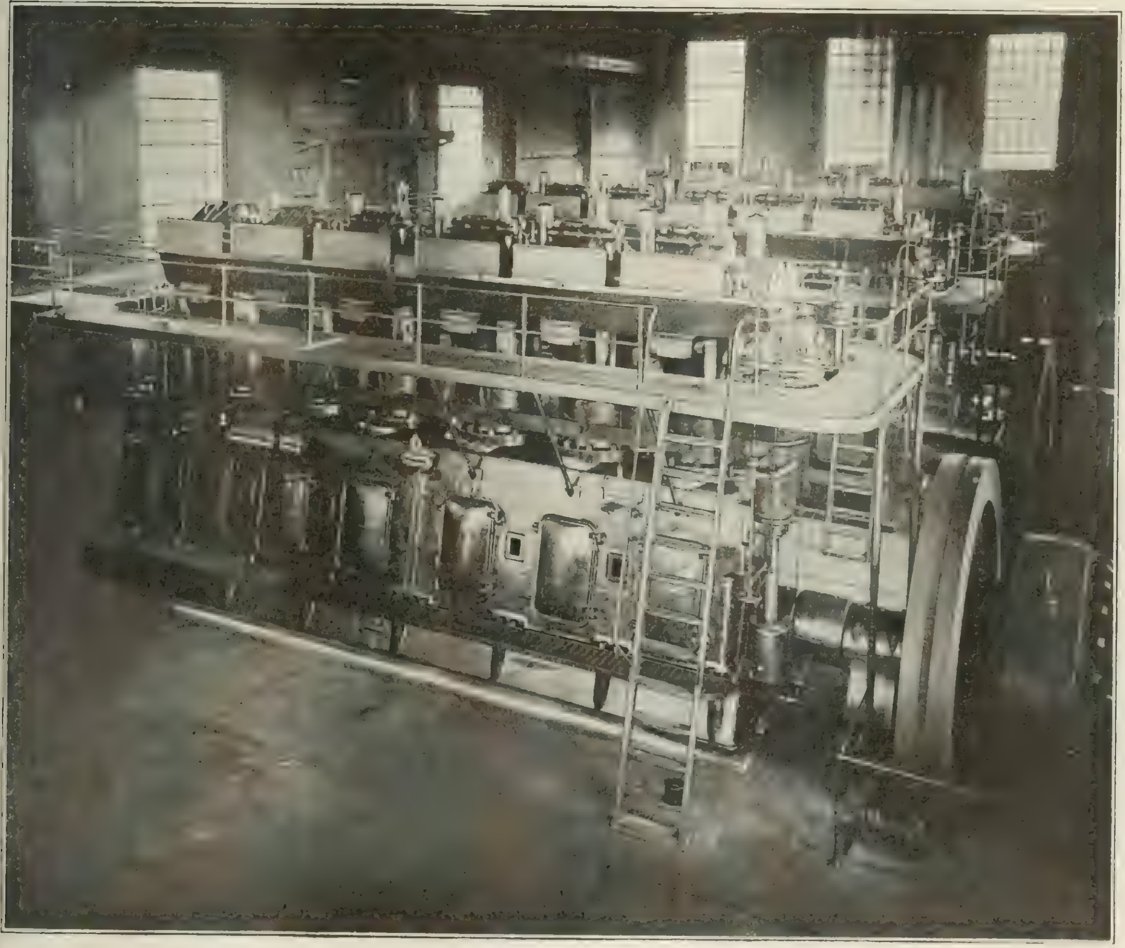


FIG. 1 DIESEL POWER PLANT OF LEHIGH PORTLAND CEMENT CO., IOLA, KANSAS

As has already been mentioned, the record of the plant operation is excellent. One of the units was in constant operation for 417 days, 23 hours and 45 minutes with the exception of a two-hour shutdown at the end of each six month period for the purpose of changing valve cages. Since the fourth Diesel has been installed, it is the practice to change exhaust and admission valves every sixty days. The pistons are pulled after six months' service, although the oil shows no tendency toward ring gumming. The only serious trouble occurred when one of the connecting rods was bent, resulting in a fractured cylinder and liner. The damage was occasioned either by the air-starting valve wedging open or by overpriming of the starting cylinder. If the starting valve failed to seat, starting air at 800 lb. pressure filled the cylinder at the beginning of compression; the connecting rod was not of sufficient strength to withstand the enormous pressure developed as the piston moved upward. The more probable cause was overpriming of the starting cylinder. In the event that any great amount of fuel is admitted into the starting cylinder, preignition will take place on the compression stroke.

TABLE I—STATION COSTS

Total kilowatt-hour output	1,190,100
Total fuel, gals	112,703
Fuel cost per kilowatt-hour at $0.032 per gal	$0.0030
Labor cost per kilowatt-hour	0.0008
Supplies and oil per kilowatt-hour	0.0014
Total	$0.0052
Fuel oil per kilowatt-hour, lb	0.694
Fuel oil per brake horsepower, lb	0.482

TABLE II—POWER COSTS OF A CEMENT MILL

	Diesel Plant	Gas Engine	Steam Power
Fuel cost	$3,608.44	$2,173.25	....
Labor cost	1,806.30	622.32	$784.39
Stores cost	956.20	392.16	....
Total cost	6,370.94	$3,187.73	$784.39
Total power cost			$10,343.06
Total cement, bbl			1,096.86
Power cost per bbl			$0.095

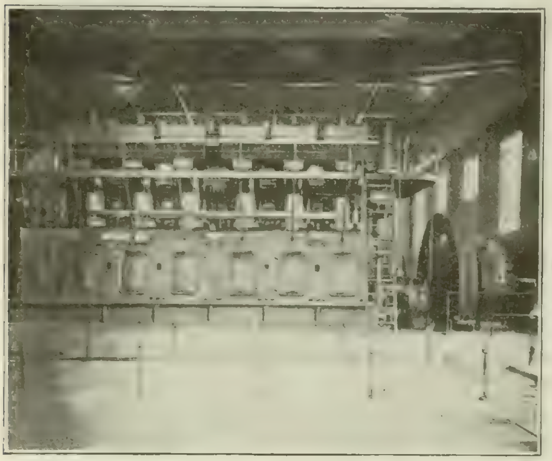


FIG. 2. McINTOSH & SEYMOUR 1,000-HP. DIESEL

In the way of replacements but few parts have developed faults. Some fifty piston rings have been replaced in the four years' operation. This would average eight years of life per ring. The air-compressor valves tend to leak at frequent intervals. This is not difficult to understand when consideration is given to the location of the plant. The engine room is within a hundred feet of the cement mill. The air for blocks is filled with minute cement particles which settle on the building like flour. The engine room, although of concrete construction, has many doors and open windows. The cement dust fills the air within the engine room and is drawn into the air compressors and the working cylinders. It is remarkable that more trouble is not experienced. An engine room in such a location should be sealed and all air drawn in through an air washer and filter.

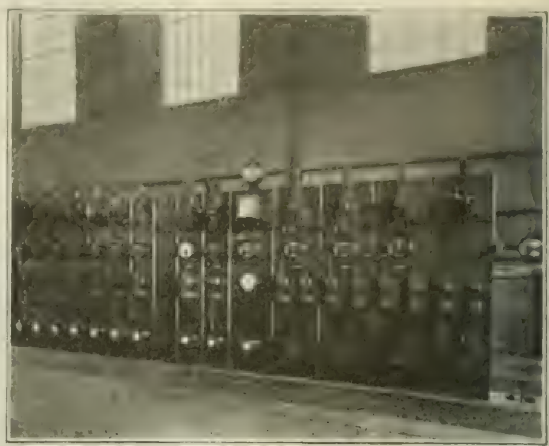


FIG. 3. SWITCHBOARD

The cost per kilowatt-hour appears in Table I. This covers the operating charges, no fixed charge being tabulated. On a basis of an estimated investment of $600,000 and an overhead charge of 12 per cent, the power costs shown would be increased by 6 mills per kilowatt-hour.

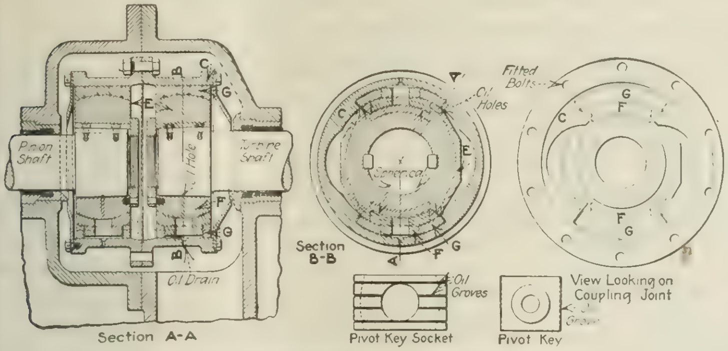
The cement plant also has a gas engine which drives a portion of the mill and a small steam plant for the heating and fire-pump requirements. In Table II are shown the total operating costs of the power plant for January, 1920. The heating and fire-pump costs are shown as totals

The Robertson-Fairfield Flexible Expansion Coupling

The Robertson-Fairfield coupling was designed primarily for use with geared turbines installed on shipboard.

As reported in *The Engineer*, London, the coupling consists of a casing, or shell, *C* made in halves, which are bolted together when the coupling is assembled. The inner surface of this shell has two gaps, or slots, machined in it, and in these gaps are fitted the blocks *G*, which have been named by the designers "pivot-key sockets," one of which is represented separately. These pivot-key sockets transmit the drive to the casing by coming into contact with the ends of their slots, and at the same time any relative axial motion between the drivers and the driving shaft is provided for by the sliding of these blocks along their slots in the shell *C*. The drive of the turbine shaft is transmitted to the two pivot-key sockets *G* by means of pivot keys *F*, of which one is shown separately; others can be seen in place in the illustrations.

A pin, or boss, which is turned on the convex face of these pivot keys, fits into a corresponding hole in the pivot-key sockets. The abutting surfaces of the pivot keys and the pivot-key sockets are spherical, as is also the inner face of each pivot key. Each pivot key fits into a slot cut in a block *E* secured to the end of the driving or the driven shaft. These slots are machined to fit the spherical face of the inner surfaces of the pivot keys. These keys, therefore, can slide over their seats should the coupled shafts get out of alignment, and an angular displacement at right angles to that thus secured is provided for by a slight rotation of the pivot-key sockets on their pins.



DETAILS OF FLEXIBLE EXPANSION COUPLING

The coupling is lubricated by the oil that flows from the adjacent bearings. The oil is caught by the end-plates shown and, after passing between the moving surfaces of the coupling, escapes through small drain holes. The coupling runs drowned in oil, and gutters are machined to the internal parts of the coupling for the purpose of insuring a thorough distribution of the lubricant.

The upper half of the first sketch is a bastard section taken along the radius lettered *A* in the second one. The pressures on the bearing surface are quite definite, being free from the indeterminateness that exists in the case of multiple-claw couplings; as a consequence somewhat higher bearing pressures are permissible, the figures adjusted being from 500 to 750 lb. per square inch.

The coupling is already being applied to geared marine turbines aggregating over 300,000 shaft-horsepower. The working of the patent has been taken over by Michell Bearings, Ltd., of 3, Central Buildings, London, S.W. 1.

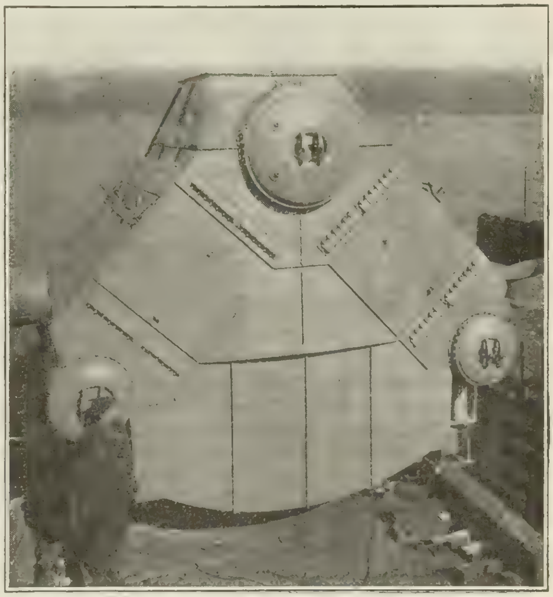
Ludlum Water-Tube Marine Boiler for Naval Experimental Station

The boiler here illustrated, built for the Naval Experimental station at Annapolis, Md., is of special interest because of its large size and the extremely high pressure carried. It is 15 ft. high, 17½ ft. wide and 12 ft. deep, with a furnace of approximately 500 cu.ft. in volume. Its weight is 85,000 lb. complete. It was built for a working steam pressure of 350 lb. and tested to 550 lb. hydraulic pressure. The steam drum is 48 in. by 12 ft., with a tube sheet 1⅜ in. thick. The water drums are 30 in. by 12 ft., with tube sheets 1⅜ in. thick. All drums have double butt-strap and double-riveted joints.

The tubes are of cold-drawn seamless steel, No. 10 gage, 1⅝ in. outside diameter. The casing is of No. 10 gage steel plate backed with asbestos millboard and 2 in. of high-tempered special insulating material. The combustion chamber has a 9-in. firebrick lining backed up with the same insulating material. The bottom of the furnace is shaped on the arc of a circle to allow for the proper expansion of the brick lining.

The unit is equipped with cleaning openings for each bank of tubes and also with Ludlum automatic soot blowers, the latter being operated by a chain pull. They automatically dispose of water of condensation in the piping and also shut off the steam automatically after cleaning is completed.

This boiler was too large to be shipped by rail, and it was therefore transported on a barge, completely assembled, as here illustrated. On arrival at the Naval Station it was necessary only to set it on its foundation and connect up the piping and smokestack. No mason work or boiler setting was required. This equipment was built in the shops of the New York Engineering Co. at Yonkers, New York. This company is now at work on a battery of boilers of this same type for the United States Navy, each unit of which will be much larger than the one here described. They will be installed in one of the new battleships now under construction.



MARINE BOILER DESIGNED FOR 350 POUNDS PRESSURE

Pipe bends for taking up expansion and contraction should be made so that they are shorter face to face than the cold dimension of piping and should be pulled into position.

A large receiver separator pays for itself by delivering dry steam to the engine at a constant pressure, independent of loads.

Maintenance of Welding Machines and Selection of Types To Be Used

Chief Problem of Maintenance Is with Portable-Type Machines—Careful Inspection of Equipment Before Being Put Into Service Is Essential—In the Selection of a Machine, First Cost and Reliability, Electrical Efficiency, Rating and Portability Should Be Considered

By L. W. WEBB
Master Electrician, United States Navy Yard, Norfolk, Virginia

TOO little attention is frequently given to the maintenance of welding machines and equipment, especially those of the portable type. For this reason it is believed that some of the following points can be noted to good advantage.

Where the machines are of the permanently installed type in protected locations such as shops, substations, etc., the usual maintenance procedure can be followed as with ordinary types of motor-generators, etc. This procedure consists principally of seeing that the machine is protected from dirt, dust, water, etc.; that bearings do not heat up, are kept properly filled at all times, and oil renewed or cleaned out systematically; that the commutator is watched and checked to see that the brushes are properly set, fitted and not sparking, and that the commutator is kept cleaned at all times. A periodical visit and inspection by the maintenance man usually suffices to keep the machine in good operating condition, and its upkeep presents nothing unusual and soon becomes a part of the regular shop or plant routine.

INSPECTION AND WORKING TEST OF NEW MACHINE

With portable-type machines which are being continually shifted from one location to another in all conditions of weather, and for which it is often almost impossible to provide adequate protection against dust and rain, the treatment usually received is very severe, and consequently the maintenance and upkeep of these present problems not common with the ordinary run of electrical equipment, especially permanently installed machines. The following points can be applied to good advantage in connection with these machines:

When the equipment is purchased, and before being put to use and sent out to work, a careful inspection should be made and the machine given a thorough working test in the shop under normal conditions of load, etc., and run for a sufficient length of time to see that bearings do not heat up or other defects exist. If this is a new-type machine, with which the operators have had no previous experience, it is desirable to instruct each operator who may be assigned to it at some future time on its use before it leaves the shop. This will prevent delays at the work which would occur if the operator were assigned with no previous experience in the machine's operation.

When the machine is sent out of the shop to the work, see that all necessary auxiliary equipment, such as welding leads, electrode holders, etc., goes along with it, and is in good condition. This will save any delay in getting the machine connected up and operating after it reaches the work; and if possible all preliminary arrangements as to connections should be made before the machine arrives at the work point.

INSTRUCTIONS FOR REGULATION AND OPERATION

Be sure that proper instructions are issued as to regulation and operation. If possible these instructions should be framed and attached to the machine in a conspicuous place, where they can be easily read yet will be protected from damage. See that the operator thoroughly understands operation before starting him to work if possible to do so, as the extra time spent on this will usually be repaid by better quality and more work produced.

Have the machine at the work point fully protected against dust, rain, etc. Make periodic inspection to see that the bearings are running cool and are properly lubricated.

When the job is finished, and unless another piece of work is immediately available, it is desirable to return the machine and equipment to the shop or central-storage place for inspection, minor repairs and adjustments if necessary, and everything should then be made ready for the next trip. This may look as if too much time were being spent on the machine's upkeep, but where there is available a central-storage space, properly fitted up, only a fraction of an hour need be consumed in doing this and the cost will be negligible. Of course, unless there are several welding machines available it will not be possible to follow this procedure very efficiently, but where there are a number of machines such a practice will prove a great saving. The central storage space, if possible, should be so located that the mechanic detailed to look after it has other routine duties to perform in connection with upkeep and maintenance of other shop or plant equipment. With proper maintenance the machine is always available to send out on a job in first-class operating condition and there is no danger of finding out that something is wrong after arriving at the work and making all preparations to start welding.

REPLACEMENT PARTS SHOULD BE KEPT IN STOCK

In order to systematize the care and maintenance of these machines and at the same time insure quick repairs or replacements of worn-out or defective parts it is essential that a complete stock of spare replacement parts be kept on hand at all times. To avoid needless expense in this connection, all machines should if possible be of the same type and manufacture, so that the parts of the different machines will be interchangeable. On the basis of two to twelve machines maximum, the following spare parts can be carried to good advantage: One complete armature (motor, generator and exciter); one complete set of brush holders; two complete sets of bearings; two complete sets of brushes; one field coil of each kind; one set miscellaneous parts on starter and generator panels.

However, since the cost of these parts approaches very closely that of a complete welding set, it is considered more desirable, if possible, to carry an additional machine as a reserve unit and thus always have one ready when trouble happens at the work point. Of course the tendency to use all available equipment at all times makes it very hard to keep a spare unit available and ready when needed and not at use at some other point. For this reason spare parts are often carried as being a cheaper first-cost proposition, as well as an assurance of rapid repairs when all available equipment is being worked.

SOME POINTS THAT SHOULD BE CONSIDERED IN SELECTING A MACHINE

In the selection of the type of machine to be used the following points should be considered: (a) First cost and reliability; (b) electrical efficiency; (c) rating; (d) portability; (e) summary for the ideal machine.

(a) Too often machines are purchased because of the low first cost, and this frequently results in finding out later that the extra maintenance required to keep them in first-class working condition and the time lost while repairs are being made make them much more expensive in the long run than higher first-cost machines. Selection on the basis of lowest first cost is usually made through misinformation, but sometimes, unfortunately, through lack of finances. To illustrate the point, assume that ten portable machines are to be purchased and offers of $11,000 and $10,000 are made. Certain purchasers would immediately accept the lower offer of $10,000 and congratulate themselves upon the saving of $1,000, or sufficient to purchase an additional machine, not even considering whether the cheaper machines would in the course of a few years cost more than this amount and possibly require complete renewal. Suppose the higher offer was for machines that could produce 5 per cent more work than those of the lower offer and required very little maintenance? It can be readily seen that under such conditions the higher offer would be the more advantageous to accept. Therefore, the first cost of equipment should be the last consideration in the purchase of machines.

(b) One manufacturer offers a machine of 60 per cent over-all efficiency and another one of 50 per cent. On the basis of electricity at 5c. per kw-hr., 4 kw. output from each machine, we have the cost per hour per machine operation as follows, if figured on normal continuous output rating basis:

(1) $\frac{4 \times 5}{0.60} = 33\frac{1}{3}$ cents per hour.

(2) $\frac{4 \times 5}{0.50} = 40$ cents per hour.

However, the work-duty cycle would not be over 60 per cent of normal rating when due allowance is made for time lost changing electrodes, fatigue of operator, etc. Then the total cost per hour for power on this basis would be:

(1) $33\frac{1}{3} \times 0.60 = 20$ cents.

(2) $40 \times 0.60 = 24$ cents.

This is a difference of only 4c. per hour. Figured on the basis of an eight-hour day and 312 workings days, the yearly difference would be $0.04 \times 8 \times 312 = \$99.84$, which would be a considerable saving if that alone figured in the total cost of operation. Now suppose the other machine, although 10 per cent less efficient, could produce 5 per cent more work; then the comparison for each machine on yearly basis total cost (assuming $1 per hour for operator) would be cost of power, plus operators' pay multiplied by unit of work:

(1) $(0.20 \times 8 \times 312) + (1.00 \times 8 \times 312) \times 1 = \$2,995.20$

(2) $(0.24 \times 8 \times 312) + (1.00 \times 8 \times 312) \times 0.95 = \$2,845.44$

or a difference of $149.76, which more than balances the extra cost of $99.84 for power, as shown in the foregoing. Assuming the cost of work produced to be worth twice the cost of power and labor, the amount would increase to $\$149.76 \times 2 = \$299.52$, which is a material saving indeed. Therefore it can be seen the electrical efficiency should not be given too serious consideration in the selection of a machine.

RATINGS OFTEN CONFUSING

(c) The rating of a machine is often very incompletely understood. One manufacturer offers a 200-ampere machine that will stand a continuous load of 200 amperes at 25 volts without exceeding safe allowable temperatures. Another offers a 200-ampere machine that will stand a load of 200 amperes at 25 volts for one-half hour, and another offers a machine that is rated for 200 amperes at 25 volts on the basis of current on so many minutes and off so many minutes, or on a so-called welding-duty cycle. The purchaser is often confused, as each manufacturer has offered a machine rated at 200 amperes, while in reality one machine is capable of doing more work than the other.

The one best to purchase under these conditions depends upon the nature of the work and whether the full load capacity of 200 amperes will be required continuously or intermittently.

(d) Portable means capable of being easily carried, and portability, as applied to machines, means those that are easily transported from place to place. The fact that one machine is more compact and self-contained than another, and consequently more portable, does not necessarily mean that it is best adapted for the use intended. Value of portability should be gaged by the ability to get the machine to work points easily, and machines satisfying these conditions meet all the essential requirements of portability.

(e) Summing up the foregoing would show that the ideal machine should be reliable and require very small maintenance expense rather than low first-cost at the expense of reliability and added maintenance. It should have high work efficiency or capacity for producing output rather than high electrical efficiency. It should have continuous-load-duty cycle rating if it will be required to produce work at maximum load conditions for extended periods of time, and should be sufficiently portable so that it can be easily transported to any location desired at a reasonable cost.

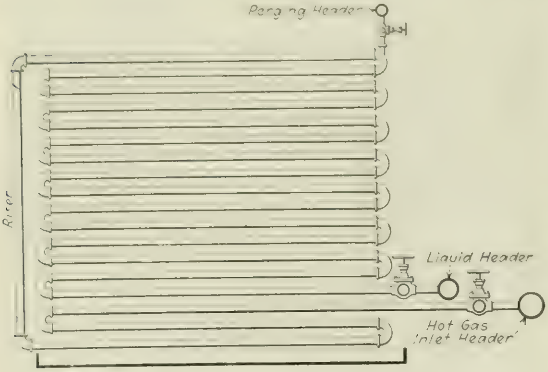
Modern practice tends more and more toward the use of centrifugal pumps in place of the reciprocating type where large quantities of feed water have to be dealt with. The points in their favor are low initial cost, low running cost, small space occupied, light weight and inexpensive foundations, flexibility in operation, smooth running, and they can be direct-coupled to a turbine or high-speed motor.

Ammonia Condensers as the Operating Man Sees Them

By B. E. HILL
Field Refrigerating Engineer with Swift & Company

THERE are a number of types of ammonia condensers, ranging in ratio of lineal feet of 2-in. pipe to tons of refrigeration, to from 20 to 65 ft.; that is, a one-ton condenser of one style may have 20 ft. of 2-in. pipe per ton of refrigeration, while another will have 28 or 30 ft., and still another will be made up with 50 to 65 ft. to take care of the same one-ton machine.

The temperature of the water and the amount available have all to do with the amount of pipe or condensation surface necessary to furnish liquid for the required tonnage and at the same time hold the condensing pressure down to the minimum. The water used for condensing ammonia should be as cold as it is possible to obtain, but as an ample supply is not always available it is up to the engineer or designer of the plant to use what he can get. It may be that to get a suitable and adequate supply of water would be prohibited by cost; or, if not this, it may be that the amount required is not available, in which case a cooling tower would be necessary and the amount of water required would depend on the style or type of tower, locality and weather conditions.



SEMI-COUNTER-CURRENT AMMONIA CONDENSER

One point must be borne in mind by the engineer with respect to the later types and improvements of ammonia condensers—to cut down on the condensation surface the final temperature of the water must be raised or the volume of water increased.

For example, assume that a condenser having 60 lin.ft. of 2-in. pipe per ton of refrigeration requires 2 gal. of water per minute per ton of refrigeration, with a final rise in temperature of 10 deg. F. Suppose, now, that this condenser was replaced with one of the later types having only 30 lin.ft. of 2-in. pipe per ton of refrigeration to do the same work. The same two gallons per minute per ton would be required on the condenser having 30 ft. as on the one having 60 ft. if the final temperature of 10 deg. F. is assumed in each case. But the volume of water flowing over the surface in the latter case would be twice that in the former, as the surface is but half the former; also, the velocity of gas in the latter is twice that in the former.

To reduce the water supply the final temperature must be raised, the initial temperature reduced, or both, as the water supply to the ammonia condenser must absorb every unit of heat taken out of the products, together with all heat leaks due to opening and closing of cooler doors and radiation. The condensing water is the final heat conveyor which delivers the heat units to the final dump, and if the supply is small, the load of heat units must be heavy, and if the supply is large, the heat load will be less.

THE PARALLEL-FLOW CONDENSER

The old-style "parallel-flow" atmospheric ammonia condenser is made to take the hot gas in at the top pipe and discharge the liquid at the bottom. The cooling water is showered over the pipes from top to bottom, absorbing the heat as it runs over them.

The objection to this type of condenser is that the coldest water is in contact with the hottest gas, and as the water flows down over the pipes, absorbing heat as it goes, the warmest water is in contact with the cool ammonia liquid, which liquid is delivered to the receiver at a temperature ranging from 8 to 10 deg. F. above the final temperature of the water. Now, as this liquid has to be cooled to the temperature of the liquid in the evaporating coils before it can do effective work, there is more or less loss, depending on the boiling point of the liquid in the evaporating coils. The points in favor of these condensers are that the liquid flows *down* and will deliver a steady flow of liquid with no intermittent action, regardless of whether the system is fully charged or not; also, when this type of condenser is used there will be a decrease in condensing pressure when there is a shortage of ammonia, as there is a larger condensing surface than the later types and the condensation medium is all on the outside of the pipes. This old type of ammonia condenser also has the advantage of being nearer foolproof than any other type made; but it is being rapidly replaced with the later types.

If it were possible to use this old-type condenser allowing the hot gas to enter the top and, with a current of air or otherwise, pass a finely atomized quantity of condensing water from the bottom coils up to the top, we would have a condenser that would have all the advantages of the atmospheric type, would use less water per ton of refrigeration and would not require any argument to prove that the liquid ammonia runs up hill without any additional cost, as is the case with all bottom-inlet or so-called flooded condensers.

THE COUNTER-CURRENT PRINCIPLE

The counter-current principle is to discharge the hot gas into the bottom pipe, where it meets the effect of the warmest water, and as the gas flows upward, the sensible and latent heat is removed, leaving the liquid to be raised a part of the remaining distance by pressure of the incoming gas at the bottom. It is claimed that, owing to the coolest water being delivered at the top where the liquid is leaving, there is a slight reduction of pressure which pulls or lifts the liquid to the top. Some persons go so far as to say that, theoretically, there is a difference in pressure of something like 40 lb. between the inlet and outlet end of the ammonia condenser.

The real counter-current principle is the double-pipe condenser, where the hot ammonia gas enters the top pipe and the liquid ammonia leaves at the bottom, while the cold condensing water enters the bottom pipe and leaves at the top. The objection to this type, however, is that the design is necessarily complicated and expensive; also, it has the disadvantage of not being able to bring the condensation surface in contact with the evaporating effect of the atmosphere.

THE SEMI-COUNTER-CURRENT CONDENSER

Semi-Counter-Current condensers are designed to take the hot gas in the coils at a point ranging from one to five pipes from the bottom. The illustration shows this type of condenser taking the hot gas in at the third pipe from the bottom and circulating the ammonia through these coils first, and at the end of the coil opposite the hot-gas inlet the ammonia is carried to the top pipes through risers and circulated through the top portion of the coils; this liquefies the gas and discharges it into the liquid header, as shown. The object of this type of condenser is to take out the sensible heat, or heat that can be measured with a thermometer, and also to reduce the final temperature of the liquid ammonia leaving the condenser. The bottom three or five pipes are intended to take out the sensible heat only; but in practice there is an accumulation of liquid, which shows that a part of the latent heat is removed also, although this fact does not necessarily mean that *all* the sensible heat is removed, as the liquid will lie in the bottoms of the pipes, allowing the ammonia gas to pass over the top, up through the riser and into the upper part of the condenser to complete the removal of both the remaining sensible and latent heats.

ACCUMULATION OF LIQUID IN BOTTOM PIPES

The trouble with this type of condenser, especially if the system is not fully charged, is an accumulation of liquid in the bottom three or five pipes until they are filled or partly filled to such an extent that the flow of gas is stopped. When enough of them are filled to a point where the total area is reduced to such an extent that there is a rise in pressure sufficient to force the liquid up through the riser to the upper part of the condenser, then the same process starts all over again in the same or some other set of coils.

The coils that are filling with liquid can be detected by inspection of the risers, which will cool off considerably below the temperature of the coils that are working, all of which can be easily detected by touch. While inspection is being made, a chalk mark is placed on the cold risers. It will be found after an hour or two that all or a part of the marked risers will be warm and working well and that another set or other sets will be cold, which is caused by liquid filling in and stopping the flow, as already explained.

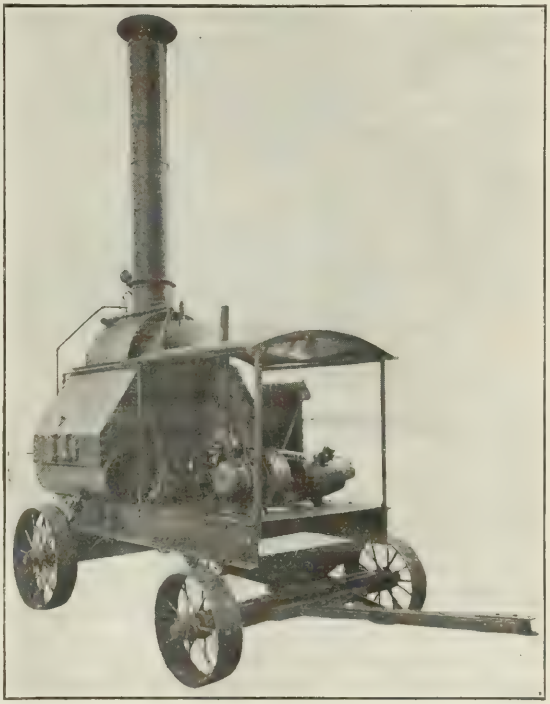
This intermittent or irregular supply of liquid ammonia causes a "long" supply one minute and a short supply the next, which is sure to make more or less trouble with temperatures. The only right and proper thing to do in this, or in any any other case for that matter, is to keep the system charged to the limit so that the receiver will not run dry of its irregular supply from one charge to the next.

The supply can be made to flow through these types of condensers a little more regularly by partly closing the inlet valves to each coil on the hot gas header, but the writer would not advise this being done unless at a time when the suction pressure is at the maximum, and then it should be carefully watched.

Ludlum Dynamobile

This new mobile power unit was designed and built by the New York Engineering Co., 2 Rector St., New York City, for driving the small portable conveyors used in certain classes of mining in South Africa.

The dynamobile consists of a special type of Ludlum water-tube marine boiler, a steam turbo-generator unit, switchboard, boiler-feed pump, feed-water heater, condenser and, where the highest economy is sought, a superheater—all mounted on a steel frame carried on wheels. It is simple in construction and operation.



NEW MOBILE POWER UNIT

The outfit can be furnished for burning any kind of fuel. The combustion chamber is surrounded by the water-filled steam-generating parts of the boiler, thus doing away with all firebrick lining—a good feature, as transportation over rough roads would break or dislodge in firebrick furnace lining.

The high efficiency of the boiler and turbo-generator set and its compactness and light weight make the Dynamobile a most economical and desirable unit for portable power purposes, as it can be located near its source of fuel and its power electrically transmitted to any reasonable distance with minimum loss.

The outfit illustrated is of 10-kw. capacity, but larger units up to 200-kw. are furnished.

The Air Compressor in the Power Plant—II

By SNOWDON B. REDFIELD
Engineer in Charge, Engineering Department, Ingersoll-Rand Company, Easton, Pennsylvania

ALTHOUGH the fact is not always appreciated, it is true that the building of a high-grade air compressor is just as much of an art as the building of a steam engine or turbine. In fact, the compressor builder has a far wider range of variables than the builder of engines and turbines; the latter has but a limited range of pressures, superheats and vacuums, and he usually aims to develop a certain limited range of mean effective pressures, while the compressor builder's pressures alone range from the highest vacuum obtainable by a dry vacuum pump to as high as 4,000 lb. per sq.in. Also, compressors are built not only for air, but for gases—natural gas, city gas, oxygen, acetylene, hydrogen, nitrous oxide, carbon dioxide, sulphur dioxide and ammonia—and there are many hundreds of compressors used for the purpose of "squeezing" out gasoline from the casinghead gas of oil wells.

Just as the builders of high-grade engines and turbines strive to turn out a machine that will do the most work for the least expenditure of steam, so the compressor builder aims to produce a machine that will compress the most air or gas for the least expenditure of power. When standard compressor units run into the thousands of horsepower each, it will be appreciated that ecomony is highly essential. Such considerations lead to various refinements of valve mechanism, single-stage, two-stage and three- and four-stage compression, with highly efficient cooling devices in cylinder walls, and especially between stages of compression.

It is always best to follow the builders' drawings when installing compressors. The latest compressors use the plate and feather types of valves instead of the Corliss type formerly used. Belted compressors are more common than gear-driven. Accumulated carbon should regularly be cleaned from the valves to avoid leakage. Defective valves are invariably hotter than sound valves when the compressor is in operation and therefore easy to detect.

In cases of new installation the foundation and piping schemes must, of course, be planned ahead of time. The builders furnish plans that show foundation and pipe connections for steam, air and water, and it is always well to follow these as closely as possible because they are based upon thought and experience with this class of machinery. Of course the ground for the foundation must be firm, or else the foundation extra deep.

DIFFERENT TYPES OF STEAM-VALVE GEAR

In the past, when rotative speeds were lower than they are today, the Corliss steam-valve gear was considered the best for highly economical steam-driven compressors. This type is so well-known and understood by power-plant engineers that it needs only to be mentioned here. In these machines the air-pressure governor changes the cutoff to control the speed and air quantity. The governor may control only the high-pressure side of a compound engine or it may control both cylinders. In the former case the steam-receiver pressure will change with the cutoff and so the proportion of load will vary between the two cylinders. In the latter case the steam-receiver pressure will remain constant and so will the division of load.

In an air compressor the mean effective pressure in the cylinders remains so nearly constant throughout a wide range of speeds that there is but slight difference of cutoff from full speed to slow speed, so that the refinement of having the governor control the cutoff in both steam cylinders of a compound unit is not usually resorted to. The low-pressure cutoff is generally adjustable by hand to secure a proper average steam-receiver pressure and distribution of load.

It should be needless to say that with a Corliss steam gear the throttle should be wide open while running, to secure economy. Observation, however, reveals that too often this practice is not followed.

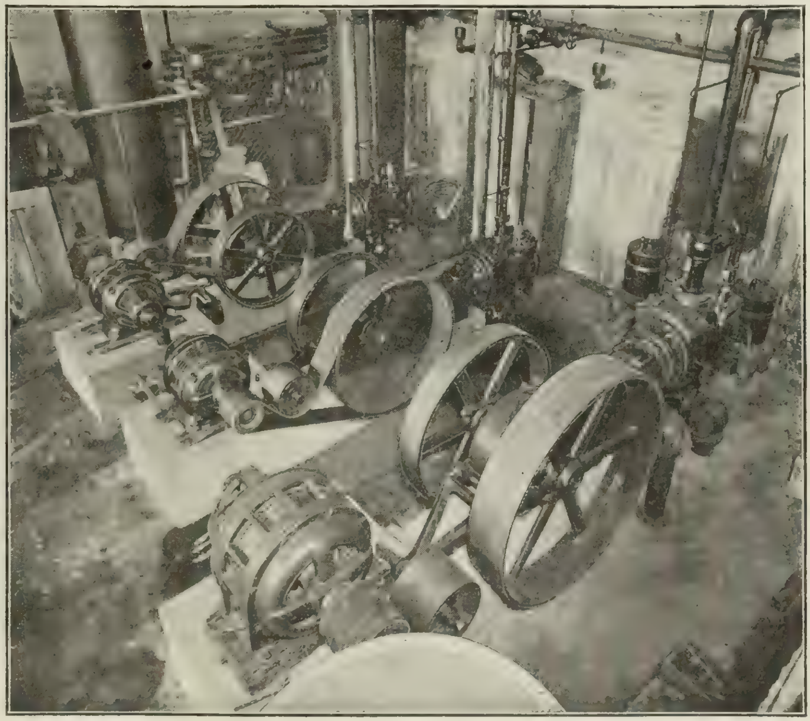
Another form of steam-valve gear which was quite universally popular fifteen years ago was the Meyer cutoff. As mentioned, the mean effective pressure is so nearly constant in an air compressor that this form of cutoff could be used to secure good economy, for when the valve was once properly set it needed little adjustment. The fact was, however, that it was so much easier to start a compressor with a long cutoff, few operators took the trouble to adjust the valve to short cutoff. The result was that the Meyer cutoff was more of a "selling point" than one of practical value.

Since the day of the Meyer valve there have been designed some compressors that really do obtain the high economy of the short cutoff. These machines use the well-known balanced piston valve, and some are single valves controlled by a flywheel governor, similar to the automatic cutoff, high-speed steam engine, while others employ the Meyer principle of a concentric cutoff valve within the hollow main piston valve. The cutoff valve is then under the direct control of the air governor and the obtaining of the high economy of the short cutoff does not depend upon the necessity of adjusting the rider valve by hand. The action is then just as automatic as a Corliss gear, with the added advantage of higher speeds and ability to use higher superheats.

With the former type a 75-hp. unit running on 100 lb. steam pressure, non-condensing, may have a steam consumption one-fourth less than the ordinary throttle governor and fixed cutoff. With the more elaborate form having Meyer cutoff controlled automatically by the air pressure, steam economies equal to Corliss steam gear are attained and sometimes exceeded.

With any of these machines employing governor-controlled automatic cutoff, it is essential to economy that the compressor be run with throttle wide open. For electric-driven small compressors the belted unit is most usual. Gear drives are not so universally satisfactory for compressors, no doubt because of the uneven turning moment; as an improvement upon the disadvantages of gear drive some compressors are regularly built with a belt idler attachment. By this means the compressor and motor may be set almost as close together as if they were gear-connected and yet not have the troubles and noise of gearing. At the same time the idler enables much greater belt contact surface to be obtained and so makes it possible to cut down belt tension, with its attendant bearing friction and wear.

For larger electric-driven units the motor is usually mounted directly upon the compressor shaft in the same manner as engine-generator units. With these machines it usually is customary to furnish a synchronous motor. Such a device may be adjusted by over-excitation so as to improve the power factor of the electric line, which is most desirable. By adding a good-sized synchronous motor of this type to an electric system, less generator capacity may be required than with any other type, and also a cheaper unit rate for current often is obtainable from power companies. In purchasing such a unit, it should be determined in advance whether or not it is to act as a "rotary condenser" of this sort, and the purchase should be made accordingly. This is a study for the electrical men of the plant. If, however, the machine is simply to run at "unity power factor," the exciter rheostat is adjusted until the compressor motor draws the least main-line current.



BELT-DRIVEN AIR COMPRESSORS USING IDLERS

The synchronous motors furnished on these direct-connected units are of the self-starting type. The windings are so arranged that under light torque the motor will start as an induction motor and when at nearly full speed the throwing of the exciter switch puts it into "step" and the motor then operates in synchronism with the generators.

To start with light torque, some form of starting unloader must be provided. After having turned on the cooling water in preparing to start the compressor, it is important to see that this regulator is set in the light-load position before throwing the switch. If this is not done, either the circuit breaker will be thrown open or some injury may be done to the motor.

In the high-economy compressor the type of air valve used plays a most important part. A few years ago most air-compressing cylinders were provided with Corliss or, rather, rotary air valves moved by eccentrics, and usually the discharge valves were of the poppet type.

With valves of this kind the rotative speed of the compressor was limited, not only on account of the excessive noise of the poppet valves, but the valves being relatively heavy, the severe pounding they received made them specially liable to breakage. Also, the speed at which the rocking Corliss inlet valves could be operated was limited, as the inertia of the valve parts and the consequent strains on the parts became quite severe especially when acute angles were employed in order to get quick opening movements. Since the best days of poppet and Corliss air valves there is a marked preference among practically all compressor builders to use some form of so-called "plate valve." These are of many kinds, being made out of thin plates of steel. Some are circular one-piece perforated plates, some are strips, and some are in the form of rings. All these valves are assembled to some form of seat which is put into the cylinder casting and held there by bolts.

The advantages of plate valves are principally the ability to run at high rotative speed, absence of noise and especially economy of power. The high rotative speed not only gives large capacity from a machine of a given size, but also means a much cheaper motor for a given horsepower when of the direct-connected, shaft-mounted kind. Absence of noise is of secondary importance, but is much appreciated by the operators in the power house, while the saving in driving power per cubic foot of actual air delivered, which is quite material, is a feature that appeals strongly to the man who is responsible for the coal or power bill.

In these plate valves the form of guide to the moving plate is an important matter affecting wear, and with it, tightness against leakage. To insure tightness, it is essential that the side play of the valve should be a minimum, so that it will always seat in the same place. The metal surfaces of the seat and of the valve then become exactly fitted to each other by the continued pounding in the same spot. To secure this condition the plate valves furnished by the Ingersoll-Rand Co. are guided, not by sliding on lugs or pins, but by the flexibility of the valve itself, part of the flexible arms being bolted directly to the seat. Thus the guiding and absence of side play cannot be affected by the wear of any sliding parts.

Valves of the plate type are also automatic in their action, being operated only by the air. Thus they are free from the possibility of wrong setting, which may occur with a mechanically moved or Corliss inlet valve.

This brings to mind an erroneous idea which was sometimes taken to indicate high volumetric efficiency. Every air cylinder must have some clearance or waste volume between the piston and cylinder head and under the valves, and at the beginning of the suction stroke this air must expand. If allowed to expand completely before the inlet valve is opened, it will do useful work upon the piston and assist in the driving. This may be shown by the re-expansion on curves of indicator diagrams. If, however, the inlet valves are made to open at the beginning of the suction stroke, this air trapped in the clearance space will simply "puff" out to atmosphere and the useful work that it might have performed is lost.

EFFECT OF PREMATURE OPENING OF INLET VALVES

The effect of this premature opening of the inlet valves will be to show a perpendicular drop in the line of the indicator diagram, and as this has been sometimes erroneously taken to show that the clearance is small and so the quantity of air trapped therein small also, it has been claimed that it showed high volumetric efficiency. As a matter of fact, the amount of air trapped in the clearance space, instead of being discharged, is exactly the same whether the clearance air is allowed to expand or not, so this premature opening of the inlet valves not only does not truly show more air handled, but it also is a direct waste of power in not giving up its useful energy by being allowed to expand behind and help the piston.

With plate valves automatically operated by the air, they cannot open until clearance expansion is completed, so that the energy of the air is usefully employed in assisting the piston during this part of the stroke.

In the care of air valves it is good practice to inspect and clean off the accumulated carbon at regular intervals. Carbon may cause leakage, and leakage certainly causes carbon. A leaking valve becomes hot from the passage of the heated air back through it, and this heat forms carbon from the lubricating oil. This carbon in turn may make worse leakage and worse heat, resulting in an overheated and warped valve, which becomes worse with continued use.

Valve trouble may be located in several ways. In a compound compressor, if any of the low-pressure valves are out of order, the intercooler pressure will be below normal because the low-pressure cylinder will not be furnishing enough air to keep the intercooler pressure up to what it should be. Trouble with valves in the high-pressure cylinder will be indicated by a rise in intercooler pressure above normal. This is because the high-pressure cylinder will not be taking the air away from the intercooler fast enough to prevent the abnormal building up of the pressure.

The foregoing statements as to the effect of the valves upon intercooler pressure apply equally well to inlet or discharge valves. Any particular defective valve may be located by its being hotter than the others. This is especially true of the intake valves.

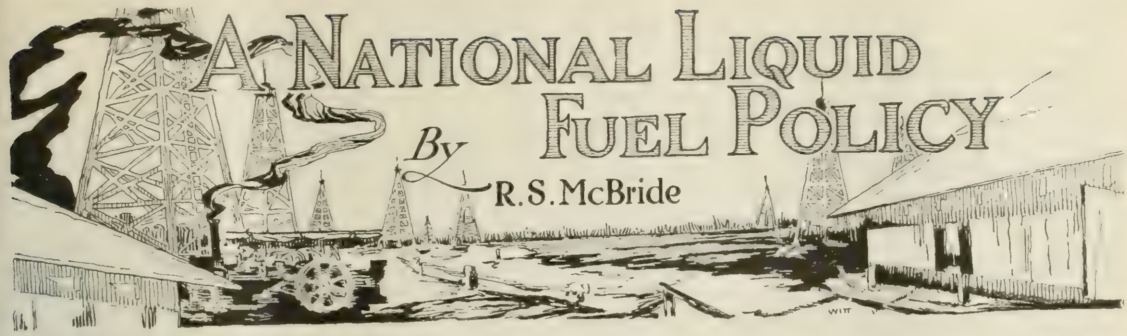
MEASUREMENT OF COMPRESSED AIR

Mention should be made that at present it is possible to measure compressed air by means of a nozzle. The only difficulty is that during the measurement, if accurate figures are to be obtained, the air must be discharged to atmosphere.

In this measurement the compressor discharges at its rated pressure into the main air receiver. From here the air is bled through a globe valve into a second receiver, in which is a nozzle of such size that it will pass all the air from the compressor at a pressure not greatly exceeding atmospheric. This pressure may be obtained with a water or mercury column, and knowing the temperature of the flowing air and the barometer reading, the flow may be calculated. By using a nozzle with a well-rounded entrance, the friction and eddy losses are so slight that the actual flow is within one or two per cent of the theoretical. This has been proved experimentally many times and has become a standard method of measuring air flow. Many engineers' handbooks give the formulas by which the air quantity may be calculated.

The old method of estimating the volumetric efficiency of a compressor by measuring the length of the intake line shown by the indicator diagram has now been discarded as inaccurate and deceiving. This method assumes that the air shown to be in the cylinder is at intake temperature and that there is neither piston nor valve leakage. With some types of machine the incoming air is greatly heated before getting into the cylinder, and this reduces the actual amount of air delivered to the work in the same way as described under the subject of "intake duct." The loss from these sources may cause the actual delivery of the compressor to be from 3 to 15 per cent less than the so-called "indicator-card volumetric efficiency" would show. This loss is vitally connected with the design of the compressor and is therefore a most important point.

Work in connection with the Aura power station, Norway, was begun in April, 1914. Many difficulties were encountered during the years of war, and work was finally stopped, but is now to be resumed, according to *The Electrical Review*, London. It was originally estimated that the whole of the Aura works would involve an expenditure of 38,000,000 kroner ($9,500,000). The idea was first to utilize the Lilledal watercourse so as to obtain 90,000 hp. by the end of 1921, and to increase this power to 300,000 hp. by the further use of the Aura River. So far, however, only one-third of the work is well under way and this has required 20,000,000 kroner ($5,000,000). The first installment, which is to develop 44,000 hp., is not yet completed, and additional capital is required for the purpose. In the case of the Ranasfoss, the work is progressing rapidly and is expected to be finished next autumn. This fall is to develop 72,000 hp.; 15,000,000 kroner ($3,750,000) has already been expended on the development, which is to be completed at a cost of 41,000,000 ($10,250,000) as contrasted with the original estimate of 18,000,000 kroner ($4,500,000).



A National Liquid Fuel Policy

By R. S. McBride

How Can the Maximum Petroleum Production and Delivery to Market Be Secured? What Substitutes or Supplements in Liquid-Fuel Supply Can Be Produced and in What Quantities? How Can the Available Supplies Be Best Distributed Among the Various Classes of Users When the Total Demand Exceeds the Available Supplies?

ONE day we read of the curtailment of Mexican oil supplies by a new revolution and the domination of the world petroleum markets by Great Britain. The next day we read that the petroleum interests in Mexico are to be fully protected by the provisional government and that Great Britain would not think of interfering with United States petroleum development or attempt any of the unreasonable things which are charged. As a consequence there has been a most uncertain state of mind developed with respect to the imminence of the liquid-fuel shortages which we know must ultimately confront this country. It is not worth while to speculate as to the merit of these claims as to Great Britain, Mexico, Persia or any of the rest, for at best it would be speculation. It *is* worth while, however, to raise the more important question, What is going to be the policy of the United States with respect to the future of liquid fuels?

When the need of a national policy is suggested, it is not meant that the Government should enter the petroleum business to direct or interfere. The industry must serve itself, but it must do this along national lines and intelligently. Paternalism is not a successful stimulant; it is rather a prop for weak industries.

Factors That Must Be Considered

The needed national policy must consider three things: (1) How can we secure the maximum petroleum production and delivery to markets and what will this maximum be? (2) What substitutes or supplements in liquid-fuel supply can be produced, and in what quantities? (3) How can the available supplies be best distributed among the various classes of users, when the total demand exceeds the available supply?

These three questions would each justify extended discussion, but here they can be treated only briefly to show the need of further consideration on a broad basis.

One need not worry as to details or exact figures regarding petroleum resources or consumption of the next few years. It makes little difference, indeed, as to whose figures or interpretation of figures is used; there are at least three outstanding facts that are undisputed: (1) The United States still produces more than half of the oil marketed in the world, (2) at the same time it uses about 80 per cent of the world's output, and (3) it has approximately 10 to 15 per cent of the total known oil reserves of the world. These three facts are generally accepted, and almost any interpreter of them will agree that we are as prodigal in this line as elsewhere and have rapidly built up so-called "essential" uses beyond our means of supply.

We can accept any of the several estimates of petroleum reserves, and then may use any particular system of estimating the rate at which consumption is going to increase, either gradually or by continually progressing steps as in the past, and we have the same result. The best we can make of the situation when production and consumption figures are set side by side is to admit that with petroleum alone we cannot maintain the present pace. David White in a recent statement summarizes the situation as follows:

> The recoverable oil in this country, according to the conservative estimate, would probably be practically exhausted in 17 years if the 1919 rate (nearly 380 million barrels) of production could be maintained for so long, while a reserve of seven billion barrels, at moderately liberal estimates, would disappear in 18½ years.

Whether we agree with this part of his statement exactly or not, we cannot deny his later statement as follows:

> The production of natural petroleum in the United States must pass its peak at an early date—probably within five years and possibly within three years—though the long sagging production curve may be carried out beyond the century. . . . The output of oil in 1919 could only with great difficulty be made to increase abreast of the increase of consumption in 1919, and that possibly within three years and very probably within seven years, the production of this country would pass its climax, notwithstanding the growing deficiency as compared with the needs of the country.

Even the most sanguine, therefore, will have to agree that we are doomed either to reduce our liquid-fuel consumption or to seek new sources.

Supplementary Supplies and Substitutes

The second question in national policy demands consideration of the substitutes and supplementary supplies of liquid fuel. Most discussions of this subject have given principal consideration to only one or two of the several possibilities. As a matter of fact all means for supplementing existing liquid-fuel supplies are needed. Even taken all together, they are not enough to really satisfy the total liquid-fuel demands of the country.

The most obvious means of augmenting liquid-fuel supplies is, of course, increasing domestic production. An increasing import of foreign production, or what is equivalent, a decreasing export would work to the same end. The less obvious but equally effective method of increasing the efficiency of use, thereby decreasing demand, also requires consideration. These three considerations taken together afford the major means of supplementing the petroleum supply.

The question of substitutes is, however, quite a different one. Shale oil will in time become available in tremendous quantities in this country. It has afforded, therefore, a basis for the most spectacular prophecy of new resources to substitute for petroleum. Alcohol and benzol from sources such as fermentation, coking of coal and others offer promise on a smaller scale as substitutes for certain petroleum fractions, particularly gasoline. None of these suggestions, however, rivals shale oil in available quantities nor in general applicability.

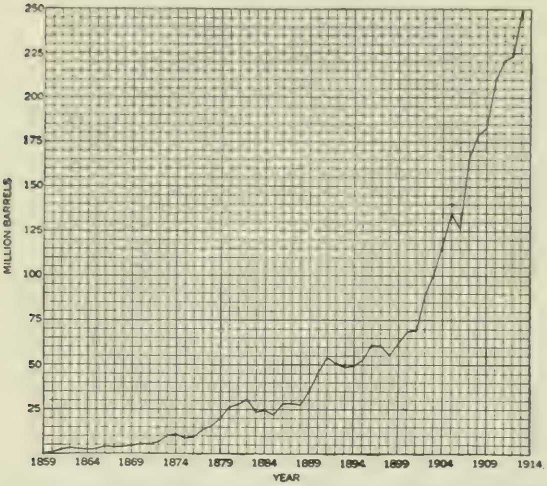


FIG. 1. PETROLEUM PRODUCTION IN THE UNITED STATES

A third group of what may be termed petroleum substitutes is found in a field foreign to liquid fuels. Materials in this class are powdered coal, coal-oil mixtures, byproduct gas, and even electricity. These sources of heat, light and power would, of course, readily lend themselves to many of the purposes for which petroleum is now applied. In any general discussion, therefore, the possibilities in these directions must be considered carefully.

Present Applications of Petroleum

An extended discussion might be developed of all these varieties of supplementary or substitute materials. For the present article, however, they cannot be considered in detail. As pointed out previously, all materials and methods taken together are not enough to bring the present supply up to the total demand. For this reason it is more profitable for the present to turn to the third national question as to how the available supplies can be used to best effect during such period of inadequacy.

It is not practicable to give any exact statement of the present uses of petroleum, but an excellent idea of the principal applications is obtained from the Bureau of Mines' figures of refinery output in this country during 1919. The important points in this summary are as follows:

Product	Output Million of Gallon
Gasoline	3,958
Kerosene	2,311
Gas and fuel oil	7,657
Lubricants	847
Miscellaneous	1,279
	16,053

The gasoline, of course, goes principally into automotive and other internal-engine uses. The kerosene is to some extent used for internal-combustion engines, but primarily is an illuminant. Lubricating oils, of course, have obvious application. The gas and fuel oils go into naval and marine-engine and power-plant applications, to the water-gas and oil-gas manufacturer, for a wide variety of industrial heating and steam raising, and to some extent to industrial chemical applications. The miscellaneous output is made up of specialized products which are applied in many fields, partly as fuels but also largely for other uses, such as inks, medicinal products, paints, road oils, etc.

A still more significant method of classifying the present distribution of petroleum was used by the United States Geological Survey in its study of the fuel- and gas-oil requirements. This bureau summarizes some of the major demands in this field from official sources as follows:

	Barrels
Shipping board—for merchant marine, 1920	40,000,000
Shipping board—for merchant marine, 1921	60,000,000
Navy requirements, 1918-19	5,500,000
Navy requirements, 1920-21	8,000,000
Railroads, 1918	36,700,000
Gas manufacture	25,000,000
Other public utilities	11,000,000
Crude oil used on leases	5,700,000
Total accounted for, 1920 (approximate)	150,000,000

This tabulation is by no means a complete representation of fuel-oil demands, but it indicates the order of magnitude of the requirements of some of the principal users that have been conspicuously in the market during recent months. They, indeed, represent over 60 per cent of the United States fuel-oil requirements at present, it appears. The notable increase in the requirement of the merchant marine and Navy is a point that should be particularly considered in this connection.

Not all users of petroleum products are in competition with each other for their supply, because certain of the products are available only for a limited variety of uses. It is undoubtedly worth while, therefore, to consider the relative importance of the various demands for these materials. As a result we can gain at least some measure of the economic justification of these applications and establish what might be termed an economic priority list for petroleum.

A Petroleum Priority List

During recent years we have had a variety of bases for determining priorities. During the war period priority commonly was granted to a specific individual or firm in order that a particular job on hand might be accomplished expeditiously. Then, too, we had priority classes for fuel in which the character of the institution served or the nature of the work to be done by the fuel user determined his position in the list, as, for example, the relatively high placing of public institutions, hospitals, etc., the intermediate ranking of public utilities, and the superior ranking of war industries over those termed "non-essential." Still more recently, in the case of coal transportation, another class of priority has been granted by the Interstate Commerce Commission; that is, according to geographical subdivision. This was done to provide that New England and the Northwest would not freeze or be threatened with idle industries during the coming winter season. However, none of these priority systems serves for the present purpose. What is needed rather is a scale by which we may judge the relative social service performed and thereby establish the economic justification for priority.

It is realized that any effort to this end cannot expect to command general concurrence with every detail; in fact, there will perhaps be as many priority lists established as there are investigators in this field. However, there are certain principles to which practically all will agree, and these justify careful consideration in the hope that at least we may establish some basis to guide the industrial thought for the immediate future.

In the following discussion of such priority it is intended to take rather a middle ground between what can be our everyday practice this year and what might be termed an ideal future practice toward which to work. As a result the suggestions of the following sections are a recommendation toward which it is believed we can immediately turn with the expectation of realizing the relationships suggested within a few years. Still further development beyond that period will also be needed. However, it is impossible for anyone to say now just how each of the several interests that must be regarded as competitive today will develop or to prejudge their proper rank for periods of the more distant future. This limited applicability over relatively few years should be carefully borne in mind in order to avoid a misunderstanding of the rather high position given to some uses of petroleum that cannot be recognized as worthy of such preference permanently.

THE INFLUENCE OF PRICE IN DETERMINING PRIORITY

In the final analysis the laws of supply and demand, if unrestricted by artificial legislation, fix petroleum prices properly in reference to trade conditions. He who can still afford to pay the price thus fixed can expect to remain in the market as a successful purchaser; he who can least afford to pay the prices thus established will soonest be eliminated. This perhaps is the law of the jungle, but it is almost inevitable that it shall rule. A further consideration of some of the aspects of this principle, however, is worth while.

Liquid fuels are for most uses simply competitors of gas, coal and electricity as sources of heat, light and power. So long as liquid fuels afford to the purchaser an attraction superior to these other energy supplies, the purchaser will continue to use the liquid fuel if it be available. Price is, to be sure, only one of the elements in determination of the relative suitability of liquid and other fuel supplies. Convenience of use as compared with solid fuel, ease of storage as compared with gas, and other similar factors enter. However, in the last analysis the purchaser buys the one that gives him for the least expenditure of money and effort the desired operating result.

Under these circumstances as soon as the petroleum becomes decidedly more expensive per unit of service rendered than coal, let us say for heating, then the use of liquid fuel for this purpose will promptly cease. It is likely that price will thus establish a more or less sound basis for determining industrial priority especially if unaffected by governmental restriction. Indeed, one might say that such a priority list established by ability to pay the price will ultimately be identical with a list established solely on the basis of the economic justification for use of the liquid fuel. Nevertheless, it is worth while to consider these problems from a little broader point of view. To this end let us consider a dozen of the principal applications of petroleum.

LUBRICATION, ILLUMINATION AND SPECIAL DEMANDS

Probably nearly a unanimous opinion can be expected with respect to the first on the priority list; for a general agreement certainly can be looked for with the thought that lubrication is the most important and most nearly irreplaceable application of all petroleum products. One is safe, therefore, in placing this requirement at the head of an economic priority list.

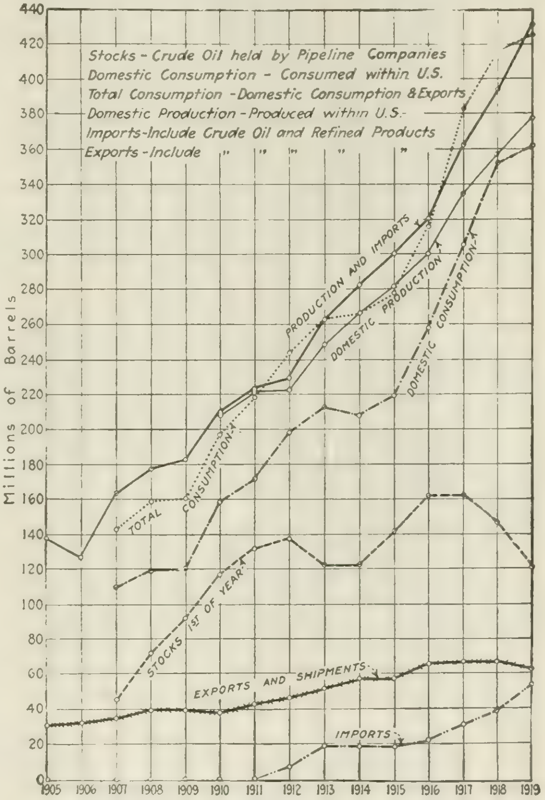


FIG. 2. PETROLEUM CONSUMPTION, IMPORTS AND EXPORTS

Next in order one must probably place either illumination or the special chemical requirements for miscellaneous petroleum fractions. Of these two uses the former draws upon rather a different group of oils from the latter. It, therefore, makes little difference which is placed second and which third in our list. Kerosene, as an illuminant for districts where city gas, electric current or acetylene is not available for lighting, certainly serves a fundamental social function that is hard to care for otherwise. Moreover, this use of kerosene calls for only a portion of the illuminating oils which can be manufactured from the available petroleum resources that will be handled if demands in other lines are met. There seems some ground, therefore, for placing illumination as number two in the schedule.

Numerous chemical processes require the use of liquid fuels, but these do not draw very heavily upon our petroleum supplies. To the extent that neither gas nor solid fuel seems quite as well adapted to the processes in question, so far are we justified in giving distinct preference to this requirement.

Within the chemical industry there is also a highly specialized requirement of petroleum fractions which are used not for fuels, but rather for other purposes. Ink oils, medicinal oils, petrolatum, paint oils and similar petroleum products are conspicuous examples. These demands represent applications that certainly justify encouragement. And fortunately, this encouragement can be given without any particular burden upon other uses, as the quantities needed are very small indeed compared with other requirements.

Within the group of chemical requirements there is, also, a peculiar class that is rather the result of the existence of products not readily adaptable to other uses. To the extent that these relatively inferior products can be efficiently applied in chemical industry, we would give great encouragement to such use. All these so-called "chemical" uses are grouped together and placed as third in the economic priority schedule proposed.

AUTOMOTIVE FUEL REQUIREMENTS

The requirement of petroleum fractions for automotive fuels is peculiar in that the fraction commonly needed is not largely in demand for any other use. Gasoline is, in fact, almost synonymous with automotive fuel. Practically all gasoline can be given to automotive requirements and this use placed as number four in a priority list without giving rise to any serious objection.

The only sense in which automotive requirements are in conflict with other demands for petroleum is that fuel-oil fractions are now being used to a considerable extent for the production of gasoline by cracking. In placing automotive requirements as number four, it is not intended to include with them this indirect production of gasoline; this rank of four is confined to the gasoline produced by the older methods of distillation.

It is well known that all the gasoline that can be made by present-day plant practice is quickly absorbed by the markets. The competition or priority with respect to gasoline, if such were undertaken, would therefore require a very different type of classification from that which we are now discussing. It would require, in fact, a discrimination between uses of greater and lesser economic justification; in other words, a contrast between essential, desirable and purely luxury applications. To enter a discussion of that question is, for the present purposes, wholly unnecessary.

COMPETITORS FOR GAS AND FUEL OILS

After recording the first four entries on a priority list, a more difficult problem is met, for at this stage one must decide as between those who require substantially the same fractions of petroleum. There are eight groups of gas-oil and fuel-oil uses that must be so judged and ranked. These applications are: Gas manufacture, gasoline manufacture, internal-combustion (Diesel) engine use, navy fuel, merchant-marine fuel, locomotive fuel, steam power-plant fuel, and fuel for heating plants.

In this group gas manufacture is set apart because it represents a distinct type of fuel-oil application. Other public-utility fuel users would also require special treatment were it not for the fact that their oil requirements fall within the scope of the remaining groups mentioned. For example, these other public-utility uses are in Diesel engine, power plant, or heating plant; and for present purposes these need not be distinguished from similar demands by other users.

GAS AND GASOLINE MANUFACTURE

It is a general principle in our census of manufactures that a measure of industrial development is the value added by manufacture. For this purpose value of raw materials compared with value of products and the difference taken by the census as of economic significance. Proceeding upon the same theory here, we can place gas manufacture and gasoline manufacture somewhat ahead of other demands for fuel oil. In these applications the oil is not consumed, but rather is converted into a material available for application in a superior class.

If it were possible quickly to substitute coal-gas plants for existing oil-gas and carburetted water-gas installations, there would be no particular need to regard the city-gas manufacturer as entitled to serious consideration for high place in a priority list for fuel oils. However, such quick change of gas-making process is not possible. The machinery and materials needed for installation of coal-gas or coke-oven plants cannot be made available for a considerable period, nor can the funds required for so large a change in investment be secured by utility companies at present. Gas represents an essential of modern city life. For the present and a considerable number of years to come, therefore, preference must be given to gas manufacture over other fuel-oil requirements to such extent as will permit uninterrupted adequate gas supply.

This situation may continue longer than at first seems likely, for natural-gas supplies are now continuously decreasing in quantity, and manufactured gas must inevitably ultimately replace them. Much new construction of coal-gas and coke-oven plants will doubtless, therefore, be directed to extension of gas-making facilities in such districts of the country. Municipal growth and extension of gas supply into suburban territory also tend to limit gas-works construction to that which can be regarded as extension of present plants. Thus, for many years to come an important fuel-oil demand for water-gas making will be met.

Gasoline production from fuel-oil fractions, when it can be efficiently practiced, raises the petroleum production from a lesser to a greater usefulness. To the extent that equipment is available for this conversion to gasoline, preference will doubtless be given for such use by the petroleum refiners. This will be not only a matter of good business judgment on their part, but also, for the reason cited, an economically justifiable procedure. On the other hand, Diesel-engine use is so much more efficient than most gasoline-engine use that there is no ground for encouraging conversion of fuel-oil to gasoline for work which the Diesel engine can do. Therefore, as Diesel-engine demand develops, this new factor will enter to offset the present tendency toward cracking to make "gas."

OIL FOR FUEL AND POWER

Having disposed of gas-making and gasoline manufacture, there remain only power and fuel uses for consideration. Because of the greater efficiency of petroleum use in internal-combustion engines as contrasted with boilers of any type, we certainly must give preference to this use. As a matter of fact, this, for the immediate present, is not of large commercial significance because the internal-combustion engine (limiting ourselves here to the non-automotive type) does not demand any large percentage of our fuel-oil supplies. Nevertheless, with increasing costs of liquid fuels we may look forward to great increases in this more efficient method of fuel-oil utilization; and as these uses develop, we probably shall continue to place them at this point in any priority schedule that may be evolved.

The remaining users of fuel oil burn it under a boiler or for direct heating purposes. Of these users the naval requirement unquestionably comes first. Following this, most would doubtless agree that the merchant-marine demand should be met before other use can be justified. That this merchant-marine demand is going to increase continuously in the next few years cannot be questioned. Not only are the estimates from the United States Shipping Board good evidence of this, but also there is extensive development of oil-fired shipping by the British. In fact, the "Olympic" and "Aquitania," two great Cunarders, only recently made their maiden voyages as oil-burning vessels with very gratifying results.

After these marine uses we can probably give the locomotive boiler next position. The large advantage of liquid fuel for such mobile power plants is well recognized. To the extent, therefore, that the locomotive cannot be electrified, we can justify oil burning in preference to the use of oil for stationary power or heating-boiler use. This preference is also supported by the critical state of the transportation demands of the country at the present.

It is to be anticipated that this preference for locomotive use will not continue long except in certain limited portions of the country where liquid fuels are much more readily available than solid fuels. Oil for locomotives is rapidly becoming prohibitive in cost or wholly unavailable.

As a matter of fact, by the time we reach this stage it makes little difference to whom we give priority; for if the higher classes of use are satisfied, there is no oil left to distribute. Nevertheless, one may as well continue to theorize through to the end, and discriminate between the steam-power plant and the heating plant. It appears that the former should be given preference over the latter, for a greater increase in efficiency is doubtless generally obtained in power production through oil firing as compared with solid-fuel firing, than can be found in contrasting liquid-fuel and solid-fuel use for heating purposes. Thus we would place steam-power-plant use ahead of heating-plant application, the latter being the last of the twelve items in the schedule.

As a result of the foregoing discussion one obtains a priority list for liquid fuels as follows:

Character of Use	Kind of Oil Applied
1. Lubrication	Lubricants (fuel oil)
2. Illumination	Kerosene
3. Chemical processes	Miscellaneous
4. Automotive engines	Gasoline
5. Gas manufacture	Fuel oil
6. Gasoline manufacture	Fuel oil
7. Internal-combustion engines	Fuel oil
8. Navy	Fuel oil
9. Merchant marine	Fuel oil
10. Locomotive firing	Fuel oil
11. Steam-power plants	Fuel oil
12. Heating	Fuel oil

This schedule will doubtless wholly meet the ideas of few, but it represents the application of a relatively new principle in national-resource thought, and as such it should be generally considered. In any event, whether one agrees with it or not, it represents a starting point for the consideration of a still more important engineering problem, namely: What attention must be given to petroleum substitutes in order that all these industrial needs for liquid fuels may most effectively be met? This latter question requires separate discussion.

Diesel Central-Station Costs

In 1916 the Texas Power and Light Co. installed three 500-hp. McIntosh & Seymour Diesel engines in the Paris, Texas, station. These Diesels are direct-connected to alternators and are delivering power into a 100-kv. transmission line in parallel with a steam-turbine plant at Waco, over one hundred miles away. It is of interest to engineers to learn that these Diesels deliver a kilowatt-hour at a total cost well under the cost at the Waco steam-turbine plant.

At the time the plant was installed, very exhaustive tests were made on the units. The maximum efficiency secured during these tests was 0.603 lb. of fuel per kilowatt-hour. In the report appearing here, the average consumption is 0.657, showing less than a 10 per cent increase over the full-load test values.

It is more or less a mooted question as to the continued efficiency of a Diesel engine. Many engineers are under the impression that the low fuel consumption is secured for only a few months at best. To the contrary, if the oil engine is maintained in first-class condition, the fuel consumption remains practically constant over a long period of operation. Probably no form of prime mover experiences a smaller drop in efficiency

PRODUCTION COSTS, PARIS, TEXAS, DIESEL STATION

	1919	Sept. 1—Dec. 31, 1916
Engine hours	24,047	
Gross kw.-hr	7,580,130	
Net kw.-hr	7,507,940	1,565,000
Station factor	93	51
Fuel oil, lb.	4,988,120	149,072
Fuel oil per kw.-hr., lb.	0.657	0.672
B.t.u. per kw.-hr.	12,700	13,100
Labor per kw.-hr., mills	1.577	1.44
Fuel per kw.-hr., mills	3.130	3.07
Water per kw.-hr., mills	0.0503	0.09
Lubrication per kw.-hr., mills	0.1748	0.04
Miscellaneous supplies per kw.-hr., mills	0.235	0.10
Building repairs per kw.-hr., mills	0.0945	0.05
Engine repairs per kw.-hr., mills	0.51	0.04
Auxiliary repairs per kw.-hr., mills	0.0103	0.15
Electrical equipment repairs per kw.-hr., mills	0.0873	
Miscellaneous station repairs per kw.-hr., mills	0.0167	
Total production cost, mills	5.99	4.98
Overhead, per kw.-hr., mills	4.85	4.85
Total cost, per kw.-hr., mills	10.84	9.83

from wear and tear than does the Diesel. The increased costs in old engines is due almost entirely to higher maintenance charges.

In the table shown, the production costs are given for the four months from Sept. 1 to Dec. 31, 1916, and for the entire year of 1919. It will be noticed that the fuel consumption per kilowatt-hour has decreased. This is due to the increased station factor. The increase in the labor charge follows the rise in wages experienced during 1919. All the several maintenance items show an increase. With the entire equipment requiring more repairs, as is but natural, and with increasing costs, these items are very low. The record of 24,047 engine hours in 1919 shows that the three engines were in operation for over 90 per cent of the time, which compares favorably with the performance of a steam plant of like size.

If the overhead charges are assumed to remain at the same figures as were used in estimating the total power costs in 1919—namely, 4.85 mills—the present total cost per kilowatt-hour is 10.84 mills, or an increase of one mill per kilowatt-hour over the 1916 costs.

The operating procedure has had an important influence over the fuel and repair costs. The engines are usually run slightly below the normal horsepower rating. On Sunday one unit is shut down and necessary adjustments are made. At this time, the valves from one cylinder are removed, an extra set replacing them; the valves are cleaned during the week. Each set of valves then, is removed and cleaned every three months, while bearing adjustments, etc., are made every three weeks. A unit is out of service from two to ten hours at this adjustment period.

The station force is much smaller than for a steam plant of like capacity. There is a chief engineer in charge of the plant, and on each shift there are one watch engineer, one helper and a switchboard operator, or ten in all.

Jones Spur-Gear Speed Reducers

The Jones spur-gear reducer, manufactured by the W. A. Jones Foundry and Machine Co., of Chicago, has been made in its present form for the last three years. Its possible uses are numerous—in fact, with any machine that it is desirable to operate at a considerable reduction in speed from that of the driving motor.

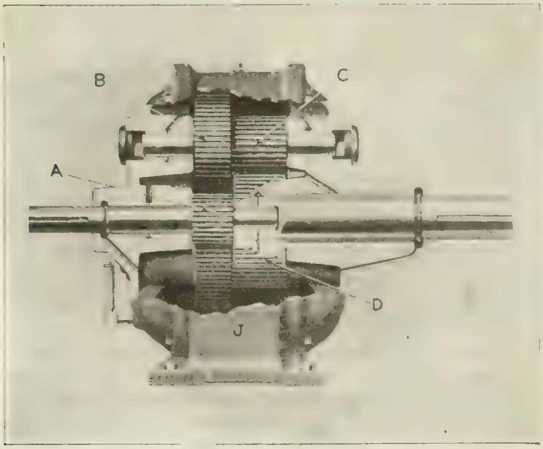


FIG. 1. SINGLE-TYPE JONES REDUCER FOR REDUCTIONS UP TO 15 TO 1

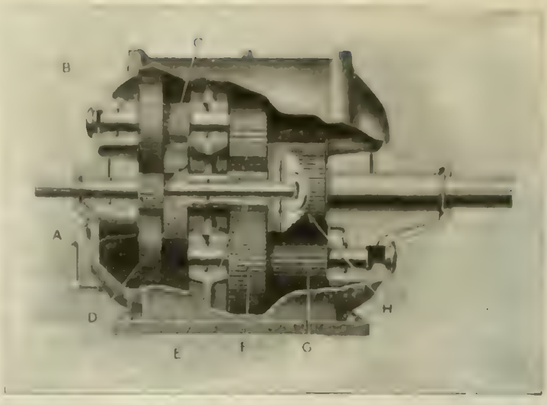


FIG. 2. DOUBLE-TYPE REDUCER USED FOR RATIOS OF FROM 15 TO 1 UP TO 200 TO 1

The reducer is an inclosed spur-gear drive with the high- and slow-speed shafts concentric and having the same direction of rotation. Connection to the machine on either side is made by means of flexible couplings.

All reductions are accomplished by means of plain spur gears, the tooth form employed being the involute stub with a 20-deg. pressure angle.

Fig. 1 is a sectional view of the single-type reducer, which is generally used for reductions up to 15 to 1. The double-type reducer shown in Fig. 2 is used for ratios of from 15 to 1 up to 200 to 1 or over if desired; its construction details do not differ materially from the single-type, except that a total of four reductions is accomplished instead of two, the housing being increased in width to accommodate the necessary gears. Reference to the illustrations will show that the pinion *A* meshes with and drives the three gears *B*, which are mounted integral with the three pinions *C*, these in turn meshing with and driving the slow-speed gear *D*. The gears *B* and pinions *C* are equally spaced around the high- and slow-speed pinion and gear at angles of 120 deg., thus relieving both the high- and slow-speed shafts and bearings of transverse loads due to tooth thrust. The pinion *A* is supported in correct alignment at one end by the bronze-bushed bearing in the reducer housing and on the other end by the slow-speed shaft extension, which carries a bushed bearing as shown in the illustration.

In the double-type reducer, Fig. 2, the gear *D* which corresponds to the slow-speed gear in the single-type model, is keyed to a sleeve that is integral with the pinion E. This sleeve is bronze-bushed and rotates on and in the same direction as the high-speed shaft. The extreme end of this high-speed shaft journals in the bronze-bushed bearing located in the end of the slow-speed shaft, the same as in the single-type reducer. The intermediate pinion *E* meshes with and drives the three gears *F*, which are mounted integral with the three pinions *G*, these in turn meshing with and driving the slow-speed gear and shaft *H*. The back gears and pinions are equally spaced at 120 deg. as in the single-type reducer, but the set on the slow-speed end are located intermediate, or 60 deg. from those on the high-speed end.

Standard reducers suitable for all motor speeds are made, ranging from 1 hp. up to 200 hp. and almost unlimited reduction can be obtained.

EDITORIALS

Application of Induction Motors

THE problem in the application of motors to the driving of any piece of machinery is to select one that will have sufficient torque to start and accelerate the load within the period that may be imposed by the particular condition and do this with a reasonable value of current from the line. It must also have sufficient capacity to drive this load for the required period, as well as a reasonable overload, without overheating. Where necessary, the motor must lend itself to speed adjustment to meet the requirements of the drive. With the exception of applications requiring wide ranges of speed adjustment, induction motors can successfully meet these requirements. However, the foregoing covers considerably more than might at first thought indicate, and in general the importance of correct motor application is not fully appreciated.

Improper applications of motors in practically all cases cause the maintenance costs to be higher, not infrequently increase the power consumption of the motor, and in the case of induction motors may create conditions that will increase the losses in, and reduce the useful capacity of, all generating, transforming and transmission equipment. To this must also be added the losses due to reduced production from the machine the motor is driving and not infrequently the loss due to an inferior product. Once a motor and controller are incorrectly applied to a drive, unless the defect is too serious it is allowed to continue and the losses due to misapplication pile up each year without corrective measures being taken. A frequent occurrence in the application of motors is selecting one of either too great or too small a capacity for the load. Of the two it is better to have the motor too large. If the motor is overloaded, burnouts will be frequent and a loss of production from the driven machine will result. With an underloaded direct-current motor about the only objection that can be raised is the increased first cost and slightly decreased efficiency. However, with an induction motor, in addition to the foregoing the power factor will be low, with its many deleterious effects on the whole power system. Besides, if power is purchased a penalty in the form of an increased rate may be imposed for poor power factor.

To select a motor of the proper horsepower rating for a given load frequently requires a very careful study of the characteristics of the load; especially is this true if the load is intermittent. If a motor is selected with a continuous horsepower rating equal to the maximum load, it may be operating for considerable periods at only partial loads. In such applications it will frequently be found that a motor rated on a one- or two-hour basis will do the work and give better satisfaction all around, at a considerable saving in first cost and in power consumption after installation. Or by selecting a motor of the proper characteristics and using a flywheel, a considerable saving can be made in the size of the machine as well as improving its service.

The proper application of motors is no longer a matter of guesswork, as shown by Frazer Jeffrey in three articles on the "Application of Induction Motors," the first of which appears in this issue. In these articles Mr. Jeffrey has outlined sixteen general features to be considered in the application of motors. Although these do not cover all features of application, since there are points that will naturally arise due to peculiar local conditions, nevertheless if a motor is selected for a given condition to meet the sixteen features outlined, it will in a large percentage of cases be highly satisfactory.

The British Coal Strike

THE coal miners of the British Isles have at last taken the grave step they have for a long time been threatening. On the surface they are striking for a few more shillings a day. Their real purpose is the nationalization of the coal mines. What railroad brotherhoods in the United States would do under the Plum Plan, the British coal miners would do for their industry.

As this is written, they are storming Downing Street in an effort to reach the Prime Minister's residence. They give the police an ugly fight. And this is, perhaps, indicative of their temper in this matter. Of course these miners will leave nothing undone to get the other great unions in the fundamental industries to join them and thus more completely disjoint the life of the British Isles. It is impossible to forecast accurately whether they will or will not get such co-operation. Our guess is that they will not. It is not so long ago that Englishmen turned to and operated the railroads when the workers went out for a cause not supported by public opinion; it has recently been demonstrated again and again that a strike not supported by public opinion must fail. The British coal strike seems, at this distance, to be in this class.

But the strike may continue for some time, and it is this that immediately concerns us in the United States. A strike of such magnitude in such a basic product as coal, and occurring in a country which exports so much of it, brings precipitous panic to the coal markets of the world. The first move of the British government was to stop the export of fuel. Immediately there will follow a great increase in exported coal from the United States. This will in all likelihood force up prices to consumers at home. If the strike continues for long, we in America will pay our share of the cost.

It is not a bit too soon for the United States Government to act to prevent a flood of coal for export. Exporters know that if they can deliver the coal they can get their price, whatever it may be. The profiteering side of the situation is not the worst side; the abominable part of it all is that we at home, next door to the coal mines, the mines of the United States, must bid against the panic-striken buyers of Europe, who will pay any price for our coal.

The power-plant men of the country, who consume about forty-two per cent of the coal mined will watch with deep concern for such action by the Government as the conditions may warrant to insure the full measure of protection to consumers here at home.

Safety-Valve Openings

THE Boiler Code of the American Society of Mechanical Engineers provides that a boiler shall have sufficient safety-valve capacity to discharge all the steam that it can generate without allowing the pressure to rise more than six per cent.

While numerous methods of determining the maximum generating capacity of a boiler are suggested, it is stipulated that the total relieving capacity for all other types of power boilers than the water-tube shall not be less than five pounds of steam per hour, per square foot of heating surface for pressures above one hundred pounds.

When the steam to be discharged exceeds 2,000 pounds per hour, two or more safety valves must be used. Each safety valve must be stamped with the maker's name or trade mark, the pressure at which it is set to blow, the number of pounds of steam that it will discharge per hour at that pressure, and "A.S.M.E. Std."

A boiler manufacturer took an order for some 72-in. by 18-ft. horizontal return-tubular boilers for one hundred and fifty pounds pressure. These are listed by the maker at one-hundred-and-fifty horsepower, and said to contain 1,436 square feet of heating surface, which, at five pounds per foot, would require a relieving capacity of the safety valves of 7,180 pounds of steam per hour.

The order called for "one four-inch (or larger to comply with the ratio for grate surface) reinforcement riveted on top of shell for safety valves."

The "ratio for grate surface" refers to a provision of the rules of the Industrial Commission of Ohio, into which state the boilers were going, in which safety-valve area is made dependent upon the grate surface.

The boiler maker, in accepting the order, explained that since the capacity exceeded two thousand pounds per hour, he would be obliged to provide openings for two smaller valves instead of for the single four-inch valve called for.

In this he was right, in a way, although if he had built the boilers with the four-inch nozzles or reinforcements, as the customer wanted them, the customer could have complied with the Code by using two valves on a yoke or Y mounted upon that opening. The maker, however, instead of providing nozzles or reinforcements for some such combination as one three-inch and one two-and-a-half-inch valve, which would hardly provide the required capacity with a pop safety valve of the usual design at a medium lift, simply tapped a hole into the shell for a one-and-a-half-inch valve and put on a reinforcement pad for a two-inch.

This was pretty small for a seventy-two-inch boiler, but there are valves upon the market which, by virtue of their high lift, are guaranteed to relieve over 8,600 pounds per hour in these dimensions and at this pressure. Equipped with such valves, the boiler would comply with the Code so far as safety-valve relieving capacity is concerned, and having fixed it so that it could be equipped with such valves, the builder felt that he had built a Code boiler.

But the customer, knowing nothing of high lifts and relieving capacities, went out and bought ordinary pop safety valves such as were common in his market, to fit the holes that the builder had made in his boiler, just as ninety people out of one hundred would have done.

And then comes the boiler inspector, who refuses to pass the boiler because it has not sufficiently large safety valves—which, of course, it has not.

Here is a costly and disagreeable situation. Who is at fault, the Boiler Code, the boiler builder, the customer or the inspector, and what is to be done about it?

The Petroleum Situation

EVERY *Power* subscriber should turn to page 665 and read R. S. McBride's discussion on the condition of the petroleum supply. The public at large has always discounted prophecies of exhaustion of natural resources, and its attitude on the liquid-fuel situation will probably be likewise. It then becomes the duty of the engineering world to recognize present-day conditions and attempt some solution of this question.

Usually, with diminishing resources the law of supply and demand tends to enforce the practice of economy, thereby lessening the danger of total extinction of the particular commodity. Unfortunately, conditions in the petroleum industry preclude the successful operation of this law. The greatest market for petroleum is the automobile industry, where the actual consumption of gasoline per individual purchaser is comparatively low. A rise in price would then have but small influence toward a decrease in demand If the demand for gasoline could be reduced, the "cracking" of heavy oils and the mixing of kerosene and casing-head gasoline would decrease. This would release more heavy oils to those users who are practicing economy.

Some procedure that will lessen the petroleum demand must be instituted. A priority list is suggested by Mr. McBride as a solution. As a further step, undoubtedly a method of distribution where supplies would be available to those who extract the greatest possible percentage of the heat in the fuel would be eminently fair.

A local chapter of one of the engineering societies has inaugurated a move to ascertain and classify the personal qualifications of its members with a view to more intelligent committee assignments. Inquiries are being addressed to the members, asking them to name those among their associates who can make a good address of welcome, those who have musical ability, are able to tell a good story, are interested in athletics, etc. The idea is an excellent one. Every society contains many men capable of doing good work along these lines, but often they are either overlooked or put on work for which they are poorly fitted. The more active members a society has the healthier it will be and the more rapid its growth.

On several occasions during the present political campaign the American Association of Engineers has seized the opportunity of questioning candidates on matters directly concerning the engineering fraternity; not with a view of committing the association to any one party, but in order that its members may more intelligently judge for themselves. This is admittedly a new departure for an engineering association and seems to have startled some of the conservative members of the profession, but if the effort accomplishes nothing more than to help put engineers on the map, it will not have been in vain.

CORRESPONDENCE

Correct Height of Return-Tubular Boiler

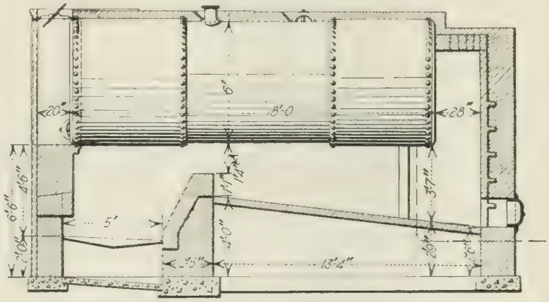
Mr. Misostow, in his article on page 1034 of the June 29 issue of *Power*, I believe, has defined the proper relation of setting a horizontal return-tubular boiler and hand-fired grate in his brief statement, "We must set the boiler as close to the source of heat, which is the fire, as possible and still have a furnace which will allow perfect commercial combustion in the presence of the boiler at the predetermined distance."

This is a proper definition of the correct setting of any boiler and it must be appreciated, as stated in the article, with particular reference to the horizontal return-tubular boiler, that it is of advantage to distill the volatile of the coal at as uniform a rate as practical, rather than cause the distillation to approach the flash or explosion phenomenon by maintaining a furnace temperature that is too high. When we consider what I believe to be the basic principles of a good and complete combustion, the advantages of slow distillation are evident. For proper combustion there must be an intimate mixture of air and combustible gases with sufficient air to supply combustion, and this mixture must be maintained at a temperature high enough to cause the ignition of the combustible gases while they are mixing or being mixed with the air.

The particular advantage that we see in the removal of the arches and brickwork, referred to in Mr. Misostow's article, is in allowing the absorption of heat by the boiler through radiation from the fire and flame and the great reduction in furnace-temperature resulting, with correspondingly slower distillation of the volatiles and lower flue-gas temperature, and also in a majority of cases the formation of less clinker.

I do not believe that the reduction in the height of the setting, referred to by Mr. Misostow, would have any appreciable effect on the heat transfer by radiation. My analysis of the improvements resulting from the furnace changes described in the article would be to attribute them entirely to the removal of the brickwork under the boiler shell, and I would not credit any improvement to lowering the boiler. The removal of this brickwork allows the absorption of more heat by radiation and also increases the amount of combustion space. The installation, in the final setting, of deflecting pier and wing walls in the combustion chamber acknowledges the necessity of thoroughly mixing the combustion gases with the air and at the same time keeping them at as high a temperature as is practical, this being accomplished through the heat in the brickwork of the wing walls and deflecting pier.

I would take exception to the statement that the temperature in a hand-fired furnace seldom exceeds 1,800 deg. F. However, at such a temperature I am not able to check the figure of 52 cu.ft. of gas to the pound of coal. Rough calculations of the volume of gas at 1,800 deg. F. per pound of coal, with a combustion producing 20 lb. of gas per pound of coal, give approximately 1,050 cu.ft. of gas for every pound of coal burned. Using the velocity of 20 ft. per second for gases over the bridge wall, as given by Mr. Misostow, and the correct volume of these gases, I calculate an area of 43.8 sq.ft., as compared to 2.17 sq.ft. given in the article. Following the method used in the article to determine the setting height, there results the height of 44 ft. 9½ in. from grate to boiler shell. Evidently, therefore, the stated velocity is in great error.



BOILER SET FOUR FEET ABOVE GRATES

Just what velocity should be used is a question, but it appears that since experience has proved wing walls and deflecting piers in the combustion chamber to be unsatisfactory from the maintenance standpoint, it is well to increase the velocity of gas passing over the bridge wall to such a point as to pass through the critical velocity—that velocity where the stream-line flow ceases and eddying begins—and proportion the combustion chamber beyond the bridge wall, so as to permit a slowing down of the gases. This will produce the mixing effects desired under temperature conditions supporting combustion.

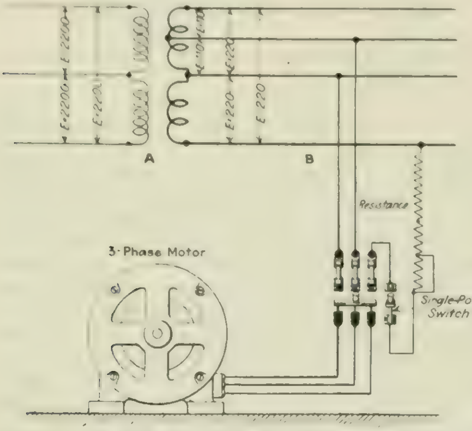
This idea is expressed in the setting shown, wherein the dimension 1 ft. 4 in. from top of the bridge wall to the boiler shell is considered a minimum and is subject to variation in individual installations. Analyses of many existing installations show that the old practice of low setting is not so advantageous as a distance of 4 to 4½ ft. from the grates to the boiler shell.

Cleveland, Ohio. M. K. BRYAN.

Operating Three-Phase Motor on Single-Phase Circuit

One of our customers had a three-phase 110-volt induction motor, that he desired to use on premises where the only current available was a four-wire service of 110-220 volt single-phase and three-phase 220-volts, as at *A* in the figure.

The motor was examined and found to be single-series star-connected, which made it impossible to adjust the connections for running it on 220 volts without rewinding. It was decided to try running it as a single-phase machine if the load to be carried was not too heavy. As is well known, a three-phase induction motor will operate satisfactorily, once started, if the load to be carried as a single-phase machine does not exceed 40 per cent of the three-phase output. The motor was installed, started by hand and tried out on the load to be carried, and found to be satisfactory.



CONNECTIONS FOR STARTING A THREE-PHASE MOTOR AS A SINGLE-PHASE MACHINE

No phase-splitting devices being immediately available, it was decided to use the other leg of the three-phase 220-volt supply for starting, simply inserting a resistance in the circuit with the third wire to cut down the impressed voltage. The motor was one horsepower rating, therefore the three-phase starting current was assumed to be about nine amperes. After starting, the current would drop to about three amperes as the speed came up to normal. To use a resistance just the right size for the starting current would endanger the motor from overvoltage when the current decreased, as the drop in the resistance would be reduced as the current decreased. Resistance enough to maintain balanced voltage at three amperes would necessarily cut down the starting torque, but this was considered preferable to endangering the motor. This gave the resistance equal volts divided by amperes, or $110 \div 3 = 37$ ohms. Heating elements from two 550-watt 110-volt flatirons were mounted on an asbestos base and connected in series. This gave 44 ohms, and after shunting one-half of one element, 33 ohms was obtained, which was close enough. Connections as used are shown at *B*. Two of the motor leads are connected across the 110-volt supply and the other, in series with the single-pole switch and the resistance, to the other phase of the supply.

The motor is started by closing both switches, and when full speed is reached the single-pole switch is opened, leaving the machine running as a single-phase machine. The device is giving perfect satisfaction, cost less than a standard phase-splitter, and saved time by not causing delay while a standard starter was obtained.

Eddyville, Iowa. HENRY H. BRUNNER.

Behavior of a Semi-Diesel Oil Engine

I am operating two 100-hp. vertical semi-Diesels of the dry type direct-connected to alternators. The load conditions are bad; for fourteen hours there isn't enough load to show on the meters, and then it jumps to 16 amperes per phase.

One night my operator called me on account of the engine stopping. I tried to start it, but found one of the pistons was seized. When I finally got the engine up to speed, it would start to slow down and finally stop. I had to repeat the starting two or three times. When it finally did start, everything was all right and no more trouble occurred for some time. I carry the cooling water at 155 deg. F. on light load and at 120 deg. on full load. What causes this sticking of the piston?

The engine has a pound which I cannot locate. When I start it up there is no noise, but after about fifteen minutes the pounding begins and keeps up. I have all the bearings very snug. Where does the pound come from? Four cylinders have cracked at the exhaust end air port bridges. What causes this?

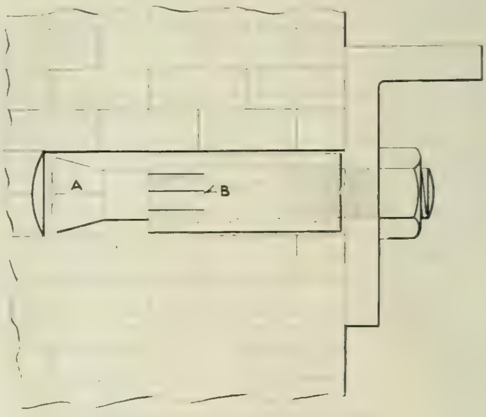
Bracketsville, Tex. JOHN M. TONEY.

[Possibly some of *Power's* readers who have operated similar engines can answer Mr. Toney's questions.—Editor.]

Easily Made Expansion Bolt

When expansion bolts are required, it pays to buy the factory-made article. However, very often a bolt is wanted in a hurry, and the plant may be situated at considerable distance from any source of supply.

Different emergency bolts have been described, more or less difficult to make. The one shown is easy to make by taking an ordinary bolt and filing the head tapered as shown at *A*. Then take a short piece of lead pipe and with an ordinary handsaw cut several slots in one end as shown at *B*. Place the pipe over the bolt and as the nut is tightened on the bolt, the tapered head is drawn into the lead pipe, thus expanding it.



EMERGENCY EXPANSION BOLT

Portsmouth, Ont. JAMES E. NOBLE.

Faulty Valve Adjustment Caused Loss

The diagrams shown in Fig. 1 were taken from a $14\frac{1}{2}$ x 30-in. slide-valve engine. Diagram *A* shows the condition of the valve adjustments as found. Diagram *B* shows the condition after advancing the eccentric 22 deg. The average steam consumption per horsepower-hour calculated from diagram *A* is 75.3 lb.; that from diagram *B* is 40.7 lb., a decrease of 34.6 lb. of steam per horsepower hour. For one year this would mean a saving of about 225 tons of coal, which at $14 per ton, the present price, would amount to $3,150.

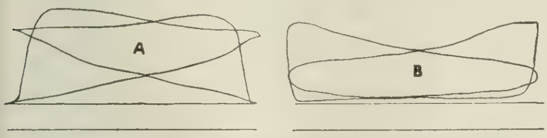


FIG. 1. BEFORE AND AFTER MOVING ECCENTRIC

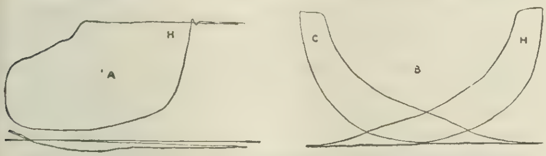


FIG. 2. ANOTHER CASE OF MOVING THE ECCENTRIC

The diagrams shown in Fig. 2 were taken from a 14 x 16-in. center-crank engine fitted with an automatic flywheel governor. The engine had for some time been giving trouble and was gradually getting worse. Diagram *A* shows the condition of the valve adjustment as I found it upon first indicating. The crank end showed a negative m.e.p. of 2 lb., caused by a slide-valve not opening during any period of the stroke. The head end was doing all the work, admission occurring when the crank end had completed 63 per cent of its stroke. The trouble was caused by the valve being screwed too far into the valve slides.

The steam consumption per horsepower-hour calculated from diagram *A* is 38.64 lb., and that calculated from diagram *B* is 20.09 lb., a decrease of 18.5 lb. per horsepower-hour, which made a saving of 123 tons of coal per year, which at $14 per ton would mean a saving of $1,722 per year. C. J. HALLORAN.

Avoca, Pa.

Boiler Drum Pitted

I recently made an examination of a water-tube boiler consisting of six drums, three below and three above. The feed water enters the rear lower drum through the side, and I found that this drum was pitted and corroded to a depth of from $\frac{1}{8}$ to $\frac{1}{4}$ in. In the other drums there was not even a sign of pitting.

My theory is that, as the feed water entered the rear drum and as it was not passed through a feed-water heater, there was more chemical action taking place in the rear lower drum than in the others. If I am not right, I should be glad to have someone give me his opinion.

I also found that the short circulation tubes extending from one drum to another were only about halfway through the sheet. I considered that these tubes should have been properly flared or belled, which would have prevented this condition.

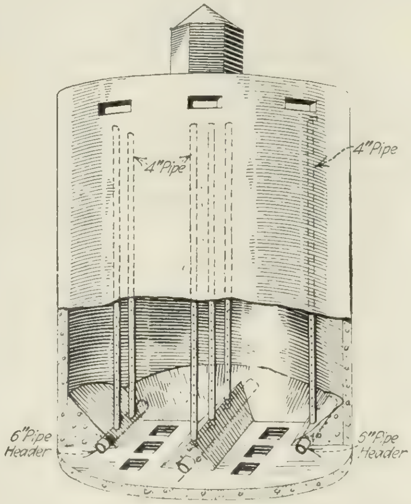
I had quite a lengthy discussion regarding the pressure in the different drums, with an inspector who had had over twenty years' experience. We could not agree, and we would like to have the opinions of *Power* readers. In the boiler mentioned this inspector claimed that the rear lower drum was not subjected to the same pressure as the others, and I contended that inasmuch as the pressure parts are all one unit, there is just as much pressure on the rear drum as on any of the others. CHARLES W. CARTER, JR.

Olean, N. Y.

Spontaneous Combustion of Coal in Storage

In the Sept. 14 issue, page 428, there is an article headed, "Spontaneous Combustion of Coal in Silo Bunkers." Coal is entirely too scarce to have such losses. One of my neighbors, several years ago, had trouble with spontaneous combustion of coal stocked in the open in a pile about fifteen feet in depth. It was necessary to remove it at great expense, as the fire could not be put out, although vast amounts of water were directed on it by the local fire department.

He avoided the trouble the following year by laying square wooden troughs on the ground with frequent hollow wooden columns connected vertically. These column had holes chipped in the corners every few feet. In this way free circulation of air was had through the coal and this prevented spontaneous combustion.



VENTILATING PIPES FOR SILO COAL BUNKER

If the silo bunker under discussion were equipped with 6-in. iron pipe headers across the bottom and protruding through the sides to the atmosphere with a number of 4 in. vertical pipes, 8 ft. center to center connections with the header, with sufficiently large holes cut in them at frequent intervals and wire-shielded to prevent filling and obstructing a free circulation of air spontaneous combustion should be prevented. There should be a constant draft from the outside atmosphere through the piping R. L. BEARE

Jackson, Tenn.

Pounding in Semi-Diesel Oil Engines

In the Sept. 28 issue of *Power* A. S. Gabler describes the action of his 25-hp. oil engine. I had the same trouble with a 100-hp. and a 75-hp. semi-Diesel oil engine, both in a light plant. I am unable to answer all his questions, but can tell him how I got around the difficulty.

The builders of the engine advocate a temperature of 120 to 160 deg. for the cooling water. The temperature inside the cylinder is much higher. On a heavy load the heat produced by the combustion of the fuel is not carried away fast enough. We lowered the temperature to 100 to 110 deg. during peak load and used a medium-heavy grade of Diesel lubricating oil. This ended the trouble.

A. W. GRATKE.

Strawberry Point, Iowa.

Mr. Gabler's engine trouble is largely due to overload. However, it is probable that the exhaust ports and possible that the air ports in the cylinder have filled up with carbon, due to excessive amounts of lubricating oil used in the cylinder.

It is not likely that the fuel pump is causing trouble, unless from the governor. If the governor "slams," or pounds against its stop, the pump will take a full stroke several times and then cut out for a few revolutions of the flywheel, causing the engine to run very irregularly. This can be remedied by tightening up on the governor friction, which makes the governor less sensitive.

The air intake valve into the crankcase may be clogged, especially if the air is piped in from outside the building.

As a last resort, and not at all to be recommended, a hole can be tapped into the air passage, between the crankcase and the cylinder, a check valve and small pipe line run from the water supply to this tapped opening and a small amount of water fed into the cylinder. This water, mixing with the scavenging air, will prevent preignition on heavy loads. The use of water is not advisable in this engine, but neither is an overload advisable. Nevertheless, in a pinch the water is useful and will do no harm other than increasing cylinder wear.

Versailles, Mo. R. MOSER.

In reference to the letter of A. S. Gabler I have this to say for his information and assistance;

It is characteristic of the dry type of engine to pound when loaded at or near its capacity and to "die down" when overloaded. The pounding is due to two conditions as a rule. One is early injection of the fuel, particularly with a light fuel, and the other is the fact that this is a dry engine—that is, one having no spray water injected into the cylinder to absorb the excess heat and consequently soften the pounding due to the first condition. As the engine approaches its load capacity, it is unable to get rid of the excess heat through the exhaust and the cylinder jacket water with the result that the piston becomes overheated and expands to the point where it binds the walls of the cylinder, resulting in additional pounding, in the wristpin and crankpin bearings. The engine then slows down, the governor opens up the pump stroke to care for this and makes matters worse by injecting an excess of fuel just when it is not wanted, creating more heat: Then, as something has to happen, the engine "dies down."

While the operator is getting his torch ready, this excess heat is being radiated through the jackets and to the air from the piston. This does not take very long; the piston is soon free again and easy to move, and the engine goes on as if nothing were out of the way.

The only real and lasting solution of Mr. Gabler's problem is to stop overloading the engine, but since I am going through with the same condition, I know that is a practical impossibility unless he can get another engine for his plant. The next suggestion is that he shorten his fuel-pump stroke to the point where his engine will just maintain full speed under normal load and then allow the load to govern it when overloaded. Of course, this will cause the lights to be dim, but that cannot be avoided with an overloaded engine of this type, and I find that the public would rather have dim lights continuously than intermittent lights.

He will find that this adjustment will cut down some of the excess heat and carbon deposits and lessen the frequency of his exhaust-pot burnouts. It will also help if he will clean out the exhaust ports frequently.

The extra lubrication seems to help the engine because it serves to carry off some of the excess heat from the piston and consequently delays the expansion of the piston to the binding point.

F. C. WILLIAMS.

Ranger, Texas.

Having experienced "grief" similar to that of Mr. Gabler, I am sure his trouble with the 25-hp. semi-Diesel engine lies in overheating. While overheating may be caused in this engine by late fuel injection, the symptoms described by Mr. Gabler would rather indicate insufficient circulation of the cooling water or scale-coated cooling surface. Smoky exhaust will result from overcharge of fuel, but the pounding and dying down seem to indicate overheating.

It will be readily understood that when the cylinder is very hot the first part of the air charge expands and fills the combustion chamber with a very light charge of thin air, which does not contain enough oxygen for complete combustion of a full charge of fuel; therefore the unburned fuel leaves the exhaust in the form of smoke rather than in the form of the products of good combustion.

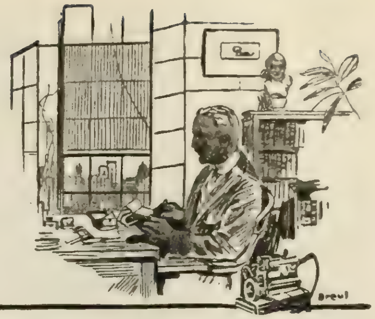
The pounding is caused by the charge being *exploded* by the excessive heat, whereas under a normal ignition temperature a more gradual and more complete combustion takes place.

I would suggest that the water jacket be thoroughly scaled and the lubricator slowed down to normal, for over-lubrication will cause a carbon deposit and aggravate the overheating, although a copious supply of lubricant will temporarily help by forming a seal between the piston and the cylinder wall, especially if the cylinder be worn or the rings "set" by a carbon deposit.

Olden, Tex. GEORGE B. MCCLELLEN.

Coal for power generation will be replaced so far as possible by the use of peat in the electrification of railroads in the vicinity of the large German cities, according to *Electric Traction*. Great hopes are being placed on the new Theissen 10,000 hp. vertical gas turbine, two of which have been ordered for use on the German railways. It is hoped that they will be able to replace the coal-burning locomotives. The peat bogs at Osnabruck will furnish the fuel.

INQUIRIES OF GENERAL INTEREST



Water in Crankcase of Semi-Diesel Engine—What causes water in the crankcase of a vertical semi-Diesel oil engine? B. R.

If the water enters the air passage, some will drip down into the crankcase. Often on vertical engines, heavy charges of water will, in this manner, flow down along the piston.

Inclination for Horizontal Return-Tubular Boiler—How much should a horizontal return-tubular boiler be set lower at the rear than the front end? W. L.

To facilitate drainage to the blowoff and insure submergence of the tubes at the rear end, the boiler should be set with a pitch of about $\frac{1}{16}$ in. per foot toward the rear end.

Benefit of Heavy Flywheel—What effect has the weight of a flywheel on the speed regulation of an engine? R. M.

The main purpose of a flywheel is to regulate the speed of an engine during one cycle by controlling the minor fluctuations due to uneven effort or resistance, and a heavy flywheel materially assists the governor in speed regulation by retarding the fluctuations in mean speed and giving the governor time to act.

Disadvantage of High Vacuum for Reciprocating Engine—Why is it not economical to try to maintain a high vacuum, say 29 in., for operation of a reciprocating engine? J. H. V.

In addition to the increased cost of operation, particularly from leakage due to greater difference of pressure on opposite sides of valves and piston, and increase of air leaks in the condenser connections, a very high vacuum is objectionable, as it increases cylinder cooling, causing greater loss from condensation that must be made up by supplying the engine with additional steam. The increase in operating cost becomes greater than the benefit obtained by reduction of back pressure.

Use of Double-Ported Valves—What is the object of a double-ported valve? C. D. F.

A double-ported valve is employed for the purpose of obtaining the desired area of port opening with small movement of the valve. Cylinders of large size require ports of considerable width, and with single port openings, the necessary travel of the valve becomes excessive. Other things being equal, the work required to actuate the valve varies directly as the travel. The double-ported valve gives twice the steam opening of an ordinary valve with the same travel and therefore is much used for large cylinders. For Corliss engines, large and quick port openings are needed where the engines are operated at the highest speeds, particularly for long range of cutoff, and to meet the requirements double-ported valves are used.

Economy of Direct-Acting Steam Pump—Why are direct-acting steam pumps, such as used for boiler feeding, so much less economical of steam required per horsepower-hour than most types of steam engines? L. K.

In pumps of this kind the load is constant during the whole stroke and it is impracticable to obtain the benefit of expansion of the steam by cutting off. With cutoff there is an excess of energy during the first half of the stroke and a deficiency during the latter half of the stroke, requiring storage and redistribution of the energy, as by employment of a flywheel. The piston of a direct-acting pump without any such device would stop the moment the steam was cut off, except, perhaps, in fast-running pumps with heavy reciprocating parts, where it may be possible to operate with cutoff a short distance from the end of the stroke, depending on the momentum of the reciprocating parts to carry the piston to the end. But in ordinary pumps for general service, this is not practical, and steam must be admitted the full length of the stroke and exhausted into the atmosphere or condenser at high pressure with great waste of steam.

Steam Discharged to Atmosphere Through Three-eighths-inch Orifice—What quantity of steam at 90 lb. gage would be discharged to the atmosphere, per hour, through an orifice $\frac{3}{8}$ in. diameter? P. G.

When the final absolute pressure is less than 0.58 of the initial, the discharge given by Napier's formula is accurate enough for most calculations; namely:

$$w = \frac{p \times a}{70}$$

where w = flow in pounds per second; p = initial absolute pressure of the steam, pounds per sq. in., and a = area of the smallest section of the nozzle or orifice in square inches. Having an initial pressure of 90 lb. gage, or $90 + 14.7 = 104.7$ lb. per sq.in. absolute, and area of orifice equal to $\frac{3}{8} \times \frac{3}{8} \times 0.7854 = 0.11045$ sq.in., by substitution the formula becomes,

$$w = \frac{104.7 \times 0.11045}{70} = 0.1651 \textit{ lb. per sec.},$$

or a discharge of $0.1651 \times 60 \times 60 = 594.36$ lb. of steam per hour.

Relative Steam for In-Stroke and Out-Stroke—Which stroke of an engine should be supplied with more steam? F. S. B.

In an engine without a tail rod, the volume of piston displacement and the effective area of the crank side of the piston are less than for the other side on account of the presence of the piston rod. For the same work a higher mean effective pressure will be required for the stroke from the crank end, requiring somewhat longer period of admission, although with other conditions equal, for the same work, each end will require practically the same quantity of steam. But on account of the angularity of the connecting rod, more degrees of rotation of the shaft are accomplished while the piston is in the crank-end half of the cylinder, and the work in performance of rotation will be more uniformly distributed by admission of more steam for the stroke from the crank end than from the head end of the cylinder. With a vertical engine, more steam should be admitted on the up-stroke to compensate for lifting the weight of the piston and attached reciprocating parts, in addition to the quantity admitted for more uniform distribution of the rotative effect.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Low-Temperature Distillation of Coal in Rotating Coke Oven*

By DIREKTOR DR. ING. E. ROSER

IN PRODUCER-GAS plants gasifying coal, the temperatures in the different zones do not remain constant. The producer frequently has to be stoked, unequal size of coal causes rim firing, parts of undistilled coals enter the gasification and even combustion zones, before being distilled or gasified. All these circumstances make it impossible to produce light carbureted hydrogens in producer-gas plants, even if they are run slow and cold. The great increase in the output of tar at low-distillation temperatures points also to the fact that, when distilling in a gas producer, the yield of tar depends to a great extent on the temperatures prevailing in the distillation zone. The output of tar is much lower when distilling the coal in a gas producer than when treating it in the rotary oven at low temperatures.

To make almost entirely available the bitumen contained in the coal in its primary condition, the author of this report started to commercially develop the process of separated distillation and gasification in two separate apparatus. After a number of trials a distillation oven in form of a rotating oven, such as shown and used for the manufacture of cement, was designed, constructed and installed by Thyssen & Co., A. G. Maschinenfabrik. The rotating oven was chosen on account of the favorable experiences with the produced half-coke, which proved well suited for the gasification in gas producers. This first trial plant with an output of 50 tons has been continuously working since the middle of 1919. The simplicity of the rotating coke oven in design, construction and running conditions has proved to be the best solution in every respect. The use of the rotating coke oven for the distilling of carboniferous materials is in principle well known.

The coal is distilled in a rotating oven similar to those used in cement mills. The low-temperature tar is reported to yield 90 per cent of the bitumens in the coal as against 50 per cent under present methods. The "half-coke" residue is said to be suitable for use on mechanical stokers. Experiments show that so far about 8.5 per cent more electrical energy may be obtained by using gas engines or gas turbines as well as oil engines and by thoroughly using the byproducts, than is obtained by direct coal firing and steam-turbine service.

RESULTS OBTAINED IN A ROTATING COKE OVEN

When distilling one ton of raw gas coal of the Gewerkschaft Friedrich Thyssen, Lohberg, in the rotating coke oven, the output was on an average:

Tar free from water (10 per cent), 100 kg. (220 lb.).

Uncleaned light oils extracted from the distillation gases evaporating up to 200 deg. C. (392 deg. F.), (3.0 per cent), 30 kg. (66 lb.).

Distillation gases up to 9,000 cal.

Lower heating value, in the average about 7,000 cal.[1] of the following composition:

CO_2	C_nH_m	O_2	CO	H_2	CH_4	N_2
Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
6.3	10.6	2.0	4.6	0	64.6	11.9

about = 150 cu.m. Half-coke, after deducting the amount of heat necessary for heating and rotating coke oven, about 650 kg. (1,430 lb.).

HEAT BALANCE OF THE LOW-TEMPERATURE DISTILLATION IN THE ROTATING OVEN

1 ton of raw gas coal of the Gewerkschaft Friedrich Thyssen contains about	6,800,000 kg. per cal. (26,928,000 B.t.u.)

After deducting the amount of heat necessary for the heating of the oven, the following amounts of heat, chemically bound, are carried away with:

150 cu.m. (5,296.5 cu.ft.) of distillation gas (7,000 cal. (27,720 B.t.u.) per 0 deg.), about .	1,050,000 kg. per cal.
100 kg. (3,531 cu.ft.) of low-temperature tar (8,600 cal. per kg.), (31,680 B.t.u.), about	860,000 kg. per cal.
650 kg. (1,430 lb.) half coke (6,000 cal. per kg.), about.. .	3,900,000 kg. per cal.
30 kg. (66 lb.) light oil (10,000 cal. per kg.), about	300,000 kg. per cal.
Total calories of heat chemically bound, about	6,110,000 kg. per cal.

Thermal efficiency of a low-temperature gas plant—

$$\frac{6,110,000}{6,800,000} \times 100 = 90 \text{ per cent approximately}$$

The half-coke can be gasified in gas producers as well as burned on stepped grates under boilers. The briquets made from the half-coke will be welcomed in households. The half-coke can well be briquetted. Pitch needs much less to be added than is required for briquetting slack coal.

Dr. Wittfield proposed to gasify all coal required by the state railway in Prussia, which in 1913 amounted to 11,000,000 tons, in the whole of Germany to 17,000,000 tons.

The briquetted half-coke could be burned in locomotives and the oil utilized in oil engines. By doing this the heat and coal efficiency in the railway service would be a much better one, the supply of illuminating gas to the cities and towns more reliable than up to now. The railways are bound to have their coals, as the traffic has to be carried on. If the whole amount of coal used by the railways should be distilled in this way, illuminating gas for about 25,000,000 people would be obtained, and in consequence, the consumption of coal by the gas works would be correspondingly less.

When distilling fuel of less value, coal dust, etc., the rotating coke oven would be a suitable apparatus on account of its simplicity and reliability.

HALF-COKE AND DISTILLED GAS FOR POWER PURPOSES

Even more than in 1918 the sentence is still valid that "power engines without being connected to a byproduct recovery plant, cannot any more be considered, according to the actual state of the technique, as being the most advantageously and economically working power machines." In addition to this there is to be considered the fact that the price of coal will again be raised shortly.

The cost of production of a kilowatt-hour will be considerably less when distilling the coal in the rotating coke oven and afterward burning or gasifying the half-coke or burning the briquets made in gas producers or under boilers, as compared with gasifying the coal or burning it directly. It is also of importance that even the small manufacturer will be able to distill in a rotating coke oven the coal required and so recover the tar before burning the coal under boilers.

The following tabulation shows that there is no higher consumption of coal when recovering the byproducts, gasifying the half-coke and using the gas in gas-engine or turbine power plants. In the power service of large industrials, owing to the use of gas engines or gas turbines as well as oil engines, and through entirely utilizing the byproducts, 1,392 kw. against 1,280 kw. are obtained by direct coal firing and steam-turbine service; that is to say,

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*Abstract of a paper by the author in *Stahl und Eisen*, Düsseldorf, Germany.

[1] The B.t.u. equivalent of the kilogram-centigrade calorie is 3.96. The large or kilogram-centigrade calorie is the heat necessary to raise 1 kg. of water 1 deg. C. The kilogram equals 2.2 lb. and one degree centigrade equals 1.8 deg. F., therefore 1 × 2.2 × 1.8 = 3.96.

about 8.5 per cent more kilowatt-hours can be generated from one ton of coal.

When in steam power work the steam boilers are fired by gas from gas producers, and when the distillation gas, free from tar, is added to the producer gas, then, out of one ton of coal about 25 per cent less kw.-hr. will be produced than by direct coal firing. The exploitation of such products as grease, paraffin and pitch when making use of the rotating coke-oven process, is not here considered.

UTILIZATION OF COAL IN POWER WORKS

Steam-power installation: Out of one ton of gas coal of the Friedrich Thyssen-Gewerkschaft can be produced in modern power plants with steam turbines at full load:

By direct firing of the coal under the boiler:

$\frac{1000 \quad 7000}{5450}$ = ... 1,280 kw.-hr.

Value of byproducts. 0

By gas firing after distillation and gasification of the coal and firing of the recovered half-coke gas and the distillation gas under the boiler:

650 kg. (1,430 lb.) half-coke	3,300,000 cal. (13,068,000 B.t.u.) in the half-coke gas.
150 cu.m. (5,290 cu.ft.) distillation gas	1,050,000 cal. in the distillation gas
	4,350,000

$\frac{4,350,000}{5,300}$ = 820 kw.-hr.

Available from the waste heat of the gasificator. . . . . 35 kw.-hr.

Besides this the following valuable byproducts are recovered:

About 30 kg. (66 lb.) of light oil in oil engines. 75 kw.-hr.
About 30 kw. of driving oil in oil engines. . . . . 67 kw.-hr.
About 20 kg. (44 lb.) of lubrication oil and paraffin.
About 35 kg. (77 lb.) of pitch and coal dust.

Gas Power Works: Out of one ton of gas coal of 7,000 cal. (12,500 B.t.u. per lb.) after deducting the heat required by the rotating coke oven, the following products are available:

650 kg. (1,430 lb.) half-coke 6,000 cal. These give: 3.9 × 650 = 2,540 cu. m. gas of 1,300 × 2,540=3,300,000 cal. in gas power engines $\frac{3,300,000}{3,570}$ = ... 920 kw.-hr.

Waste heat of the gasificator. . . . . 35 kw.-hr

About 150 cu.m. (5,295 cu.ft.) distillation gas of about 7,000 cal. (12,500 B.t.u. per lb.) = ... 1,050,000

Cal. in gas power engines . . . . $\frac{1,050,000}{3,570}$ = 295 kw.-hr

About 30 kg. (66 lb.) light oil evaporating up to 200 deg. in mobil light oil power engines $\frac{30,000}{400}$ = ... 75 kw.-hr.

About 30 kg. (66 lb.) driving oil evaporating above 200 deg. in heavy oil power engines $\frac{30,000}{450}$ = ... 67 kw.-hr.

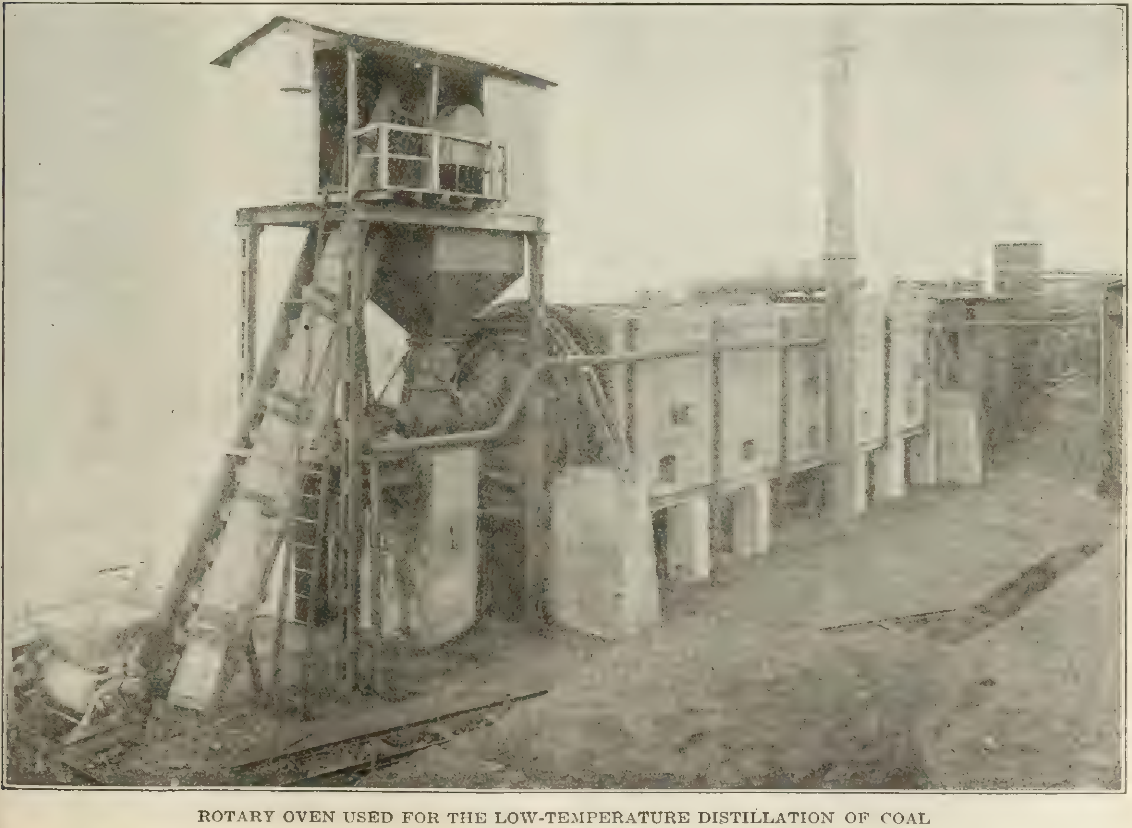
Total. . . . . 1,392 kw.-hr.

Besides this the following products are recovered:

About 20 kg. (44 lb.) lubricating oil and paraffin; about 35 kg. (77 lb.) pitch and coal dust.

The low-temperature tars and, in consequence, the still richer rotating coke-oven tars have become valuable, since our demand for oil depends to a great extent upon the production of tar. The want of coal and the difficulties of traffic have, in connection with the low value of the mark contributed much to the increase of the tar value. American coals imported into Germany cost at present 3,000 marks per ton. American engine oil is not to be had under 1,000 marks per 100 kg. The recovery of the byproducts from a ton of coal gasified by the new process is much higher than by the processes known up to the present. Ammoniac is not sought in the rotary oven process.

[The men engaged in the development of the low-temperature distillation referred to in this abstract are, besides Dr. Roser, Hans Holzwarth and Dr. Heckel, all well known in America.—Editor.]



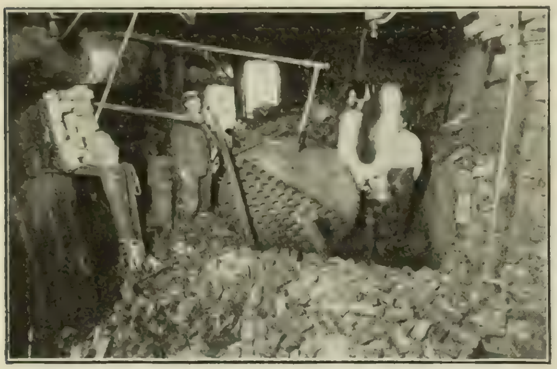
ROTARY OVEN USED FOR THE LOW-TEMPERATURE DISTILLATION OF COAL

A Typical Low-Water Boiler Explosion

At 6:57 a.m. Oct. 5, a boiler exploded at the plant of the Wellington Machine Co., Wellington, Ohio, killing two and injuring one, four others having a narrow escape. The property loss was from seven to ten thousand dollars.

The boiler was a three-ring horizontal return-tubular type of lap-joint construction, 72 in. in diameter by 16 ft. long, having 80 four-inch tubes. It was built in 1904. On Jan. 25, 1920, when the last internal inspection was made by a qualified inspector, the boiler was found in good condition and granted a certificate for 100 lb. working steam pressure.

About 5:20 on the morning of the explosion the engineer, Fred Burton, who had carried a third-class Ohio license since 1905, arrived at the plant and broke down his fire, which had been banked from the night before. Together with several other employees, he fired the boiler for some thirty minutes without any apparent results toward getting up steam, the gage registering only a few pounds. He, then, as the result of an afterthought, looked at his water glass and discovered that his water was gone. He next attempted to start the boiler-feed pump, but owing to the low pressure in the boiler, it was very sluggish. He then returned to the front of the boiler and started to get his scraper to pull the fire. At this moment one of the factory employees who was in the boiler room noticed the pointer on the steam gage rise to about 80 lb. and started to remark that everything was all right, he now had plenty of steam; but as he started to say "steam," the explosion occurred, the result of which tore down the boiler setting and moved the rear of the boiler about four feet and the front six feet to the right, tore out a brick wall between the boiler room and the factory and generally wrecked the adjoining brick walls. The rest of the factory was not injured to any great extent.


BOILER ROOM SHORTLY AFTER EXPLOSION

At the time of the explosion there were seven men in the room, which was not very large and contained not only the boiler, but also the engine, pump and heater. The engineer was buried under the boiler front and some brick work and although still alive when removed, died on the way to the hospital. George Whitney, was standing in the passage way between the engine and boiler wall and was buried beneath the boiler and brickwork and literally roasted alive by the brickwork and hot boiler. Frank Rowell received a fractured leg, and the others escaped with a few slight scratches and bruises, and were able to be at work the next day.

Fred Edwards, master mechanic of the Wellington Machine Co., made the statement that upon arriving at the plant about twenty minutes after the explosion, he found the boiler and boiler tubes still red-hot.

All the information herein was gathered from records and interviews with the survivors.

As the result of an inspection of the exploded boiler, the following facts were gathered: The entire shell exposed to the fire and all the tubes showed that they had been red-hot, all soot and other matter having been burned from them, giving the metal the well-known appearance which results from overheating. The initial rupture was about six feet long, extending the length of the middle course a little to the left of the bottom. The edges of the sheet were reduced to almost a knife edge, due to the pulling apart of the metal, which had been heated until quite soft. The girth joint between the first and second courses was opened up about three feet, but no rivets had been sheared, the sheet having pulled away from rivet shanks. There was also a little to the right of the large rupture another opening in the shell about four inches long, and extending for several feet to each end of this the sheet was drawn almost in two, indicating that if the boiler had not opened up where it did, it would have opened at this point.

An inspection of the wreckage confirms the belief that the explosion was the result of the fallibility of man. Had the engineer learned and applied the first duty of an engineer upon entering a boiler room (ascertain the condition of the water in the boiler), this accident would not have occurred. Another fact was brought out by this accident, and that is that had the boiler been provided with a fusible plug as is always recommended by the Ohio Boiler Inspection Department, but not required on boilers installed previous to the enactment of the boiler inspection law, the accident would not have occurred, for in that case the melting of the fusible plug would have given warning to the engineer and would have relieved the pressure to such an extent that the pump would not have responded at all.

The object of this report is not to criticize the engineer or any other person concerned either directly or indirectly, but to put forth the facts which may at some future time save the destruction of life and property.

The Inspiring Outlook for American Engineering*

By Morris Llewellyn Cooke

The hour of opportunity for the engineering profession really seems to have arrived. All the problems of our common life have come to be recognized as of a size and complexity requiring basic solution. On the one hand we see indications that the public is beginning to lose faith in short cuts and political expediency and will more and more demand social and economic readjustments based on a full understanding of all the facts and a thorough-going orientation of all the elements in any given situation. On the other hand, there is clearly discernible throughout our profession a growing sense that somehow the engineering approach is what is needed if ordered progress is to be the watchword for a civilization in the agonizing process of seeking new levels. Every day sees us ready to broaden our definition of engineering. To the fields of design and construction we are adding operation with ever-increasing emphasis. No one has stated this expansion in the scope of the field of our profession in a more illuminating fashion than Herbert Hoover, when, in speaking of the engineer, he said:

> Unlike the doctor, his is not the struggle to save the weak. Unlike the soldier, destruction is not his prime function. Unlike the lawyer, quarrels are not his daily bread. Engineering is the profession of creation and of construction, of stimulation of human effort and accomplishment.

Such a job is certainly there to be done. Even if we have not been officially tagged or designated to do it, we must admit that there is no other agency or division of society competing with us for the opportunity to do it. It therefore comes down to the question of our capacity to embrace an opportunity as splendid as it is obvious. Are we ready for it? And what must we do further to prepare for it?

In the first place, our efforts must be coördinated, first into societies, then into a national unit, and ultimately throughout the world. We have long had our engineering

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*Abstract of a noonday luncheon talk before *The Philadelphia Engineers'* Club, Oct. 19, 1920.

societies, and we have been revamping them and developing them in recent years. We are now organizing our Federated American Engineering Societies, which form the national unit. The international aspect of the case is part of our future problem. The development of engineering solidarity will be impossible, however, except as we break down the distinctions between men practicing in different branches of the profession. This will require a high spirit of broadmindedness and co-operation.

Our current schemes of organization of engineering bodies—our management, administrative and directive methods—are all very crude, permit much duplication of effort and anxiety over non-essentials. In the light of historical development perhaps it could not be otherwise. But in view of the fact that management and its allied activities are now a recognized part of engineering, it behooves us to study the problems of our own organization. We should be a model in this respect for other social agencies.

CULTIVATION OF IMAGINATION

Perhaps the highest attribute of an engineer is imagination; and yet you will look in vain for a course in engineering where a conscious effort is made to cultivate the imagination of the student. Fortunately, however, those in charge of technical and engineering education have come to understand this, and the trend of the times is to devote a little more attention to humanistics and the engineering of men.

In a world where nothing but moral values really count, we must introduce something akin to spiritual values into engineering. Any possible difficulty in the way of working out a satisfactory code of ethics for engineers is removed when as in the new draft of the American Society of Mechanical Engineers and in the constitution of the Federated American Engineering Societies the public interest is recognized as the supreme test of professional conduct. If a given act is not, broadly speaking, conducive to the public welfare, it is no longer good engineering. Thus the master step has already been taken.

Nothing can be truly great unless it is beautiful. The cultivation of esthetics as a feature in every branch of engineering must be insisted upon. Sometimes we associate noise and ugliness and even filth with accomplishment—with "getting things done," as we say. This is wrong. Largely because we need the influence of their love of the beautiful, we should try to get closer and closer to the architects so that ultimately we may find ourselves one profession.

SPIRIT OF DEMOCRACY MUST BE DEVELOPED

Last but most important of our needs is the development of the spirit of democracy in every nook and cranny of our organization. We must not discriminate against the young man simply because he is young. We must adjust ourselves to the entrance of women into full participation in public affairs. We must further develop the idea of engineering home-rule; even the national organization will profit by strong, even self-assertive local units. Finally, nothing promotes genuine democracy so effectively as publicity. Hence we should be grateful to the sponsors of the new Federation who provided in Article X of its Constitution: "This organization shall stand for the principle of publicity and open meetings." This puts our profession clearly in advance of all others on this very important point. It is significant that, recently, two engineering organizations numbering over 30,000 members published at the head of the correspondence columns in their official publication a pledge to publish in whole or in abstract any communication contributed by a member. Let us study the technique of reaching the people through non-technical publications, and throw open our engineering laboratories, libraries and halls to the widest possible public use. Let us seek to have engineering grow up, as it were, out of the necessities and desires and life of the people.

These are the steps by which alone we shall be able to fulfill our obligations to science and to humanity. In Mr. Cooke's own words, "It is to the largest possible fulfillment of this inspiring task that we dedicate our lives."

Hartford Section of A. S. M. E. Discusses the Superstation

The Hartford Section of the American Society of Mechanical Engineers held its first meeting of the season on Monday, Oct. 18, the subject being The Superstation, and the speaker being John A. Stevens, of Lowell, Mass. Mr. Stevens in his opening remarks complimented Hartford as being the first American city in which a steam turbine of any considerable size was installed, the city in which the first boiler-insurance company was organized, the city in which group insurance was conceived, the city in which the first turbine to be driven by mercury vapor is being installed, and the first city to call a meeting for the specific purpose of discussing the superpower station. He reviewed the advantages of a system of inter-connected stations, such as is in contemplation for New England and the Middle States, and predicted the time when the power of New England would be concentrated in five great stations. He pleaded the bigger view and larger vision which would lead to the consideration of the power problem as a whole, and the avoidance of the many diversities of practice as to voltages, frequencies, etc., which led away from unification. A large part of his address was devoted to a description of the superstation designed in panels of 30,000 kw. capacity by himself and his associates, and described in recent issues of *Power*.

Mr. Stevens' remarks were listened to with evident interest by an audience which completely filled the auditorium of the City Club, and his pressing invitation to discuss the merits of the plan proposed, and beat it if possible, led to an interesting discussion which took, however, rather the nature of a quest for further information than of specific criticisms of the plan advanced. Without attempting to particularize the individual speakers, the discussion brought out that the feeling of insecurity which purchasers of power had had when depending upon a distant source of power was being dispelled by the generally satisfactory character of the service. Mr. Stevens said that one of his own plants takes power from a source 75 miles away. Asked about auxiliaries, Mr. Stevens said that he preferred such a combination of electrical and turbine-driven auxiliaries as would permit enough of the steam-driven units to be operated to preserve the heat balance. Another inquiry brought forth that the estimated coal consumption of the proposed superstation was 1.11 lb. of coal having a thermal value of 14,000 B.t.u. per kw.-hr., which could be reduced to 1.085 by preheating the air and other modifications. This with a power factor of 80 per cent. In reply to an inquiry as to whether preheating the air was likely to work an injury to the stokers, the speaker replied that it was contemplated to raise the temperature of the air to only about 170 deg. instead of to the high temperatures in use abroad with the Howden and other systems. The smaller amount of heating would produce an additional economy of 2.35 per cent.

As regards the use of steam-driven stations as standbys, or as major sources of power, in connection with hydroelectric developments, Mr. Stevens believed that all the water available should be used all the time. It is essential that every possible pound of coal should be saved. Bleeder turbines should be used in the central station only for heating feed water, but it had a wide use in industrial plants in furnishing steam for heating and manufacturing processes. One should not, however, go crazy on that score and put a power plant into a church for the purpose of getting exhaust steam to heat it once a week.

The question of tying existing isolated plants into central station distributing lines was discussed, and Mr. Stevens said that this was done successfully in some places. In St. Louis 65 or 70 such plants were tied into the central station system, which furnished such plants with power in the summer when there was no use for exhaust steam, while in the winter they were operated at capacity, supplying exhaust steam for heating and surplus power to the system.

Hiram P. Maxim, of Silencer fame, who had been industriously figuring during the discussion, said that he had produced some figures that astonished him. A station of

250,000 kw. capacity would use, even at the rate of 1 lb. of coal per kw.-hr., 125 tons of coal per hr., or 3,000 tons per day. This would amount to 1,095,000 tons a year, or 91,250 tons of coal a month, and the five stations, if run at capacity, and at this rate of consumption, would require 456,250 tons of coal a month, which would require the bringing into New England for this purpose alone of 22,812 loaded coal cars, assuming each car to carry 20 tons. A member pointed out, however, that the gondola cars now in use carry 50 tons. Mr. Maxim asked Mr. Stevens if this was what he thought we were coming to, and Mr. Stevens replied, "Not next year, but in the future."

Mr. Maxim wanted to know if it were possible to get away from the transportation of all this coal by the use of Diesel engines, and Mr. Stevens said that this was one of the "ifs," but that the oil fuel should be reserved for marine purposes. There are 300,000 kw. installed capacity within a radius of 50 miles of Newburyport. A great deal of coal is used by the railroads themselves in transporting the coal and other freight. He had been told within a day or two by an eminent railroad engineer that the railroads will be electrified in and near the cities within a short time, but that he doubted if it would ever come for trans-continental traffic. In seventeen years all the oil will be exhausted. For power generation it is coal.

Mr. Jeter, of the Hartford Steam Boiler Inspection and Insurance Co., always with an eye to accident prevention, said that it was a good thing to get away from the use of oil. Only a few years ago the papers were full of accidents from the explosion of kerosene lamps. Today one never hears of them.

A member inquired whether this wasteful transportation of coal could not be avoided by locating the superpower plants at the coal mines and using cooling ponds or towers for condensing water. Mr. Stevens replied that for work of this magnitude it was out of the question. The sacrifice of the high vacuum, unattainable by artificial cooling, and the cost of pumping and maintenance, is prohibitive. One case which he had investigated would have required a cooling pond 2,600 ft. long and 180 ft. wide. It would have fogged the country for miles around, and have required a good-sized brook for makeup water. Samuel Ferguson, president of the Hartford Electric Light Co., said that the station in Hartford requires at the present time four times as much water as is used by the city itself.

At the next meeting of the Section on Nov. 5 Prof. Arthur M. Greene, Jr., of Rensselaer Polytechnic Institute, will lecture on The Development of the Pumping Engine.

Sespe River Project to be Financed

The Sespe Power Corporation, which plans the construction of five hydro-electric power units on the Sespe River, Ventura County, Cal., has been authorized by the railroad commission to issue $2,000,000 of bonds and $1,000,000 of its common stock to secure funds with which to carry out its development program. The company asked for a $3,000,000 bond issue. None of the money raised by the stock and bond issue is to be expended, however, until there are sufficient funds on hand to construct the plant expeditiously.

In the event that the company is unable to finance the project, the money is to be returned to the stockholders, less such an amount as may be allowed by the commission for expenses.

Among the restrictions governing the financing of the proposed new utility is one requiring that for every $1,000 bond sold the company must sell concurrently at least $1,000 of stock at par.

The Sespe company's estimate of construction costs totaled $3,722,748. The commission's engineers say this figure is entirely too low. Their estimate is $5,500,000. The corporation's estimate of output, 197,926,017 kw.-hr., is not concurred in by the commission's engineers, who hold that only an average annual output of 75,000,000 kw.-hr. can be depended upon.

The company is authorized to enter into an agreement with the Southern California Edison Co. to sell to the Southern company the output of the hydro-electric plants.

To Supply Oil to Shipping-Board Vessels on Pacific

As a result of bids received, award has been made to the Standard Oil Company of California, under date of Sept. 23, for supplying lubricating oil requirements of all Shipping Board vessels at Pacific Coast ports and Honolulu. Deliveries are to begin under this award Oct. 24 and to continue for a period of one year from that date. All bids received for supplying lubricating oils at Atlantic and Gulf domestic ports were rejected, and tenders will shortly be reinvited.

The prices per gallon in wooden barrels ranged from 52 to 56 cents for steam-cylinder and for superheat-cylinder oil; from 31 to 35c. for ice-machine cylinder oil; from 61 to 65c. for marine-engine oil for all wick- and sight-feed systems; from 33 to 37c. for light oil for forced feed; from 33 to 37c. for medium oil for forced feed and turbine-reduction gears, and from 46 to 50c. for heavy oil for turbine-reduction gears. The prices on marine-engine oil for wick- and sight-feed systems, as given, were approved with the option of substituting Polar marine-engine oil at six cents per gallon less. If wooden barrels are returned, allowance of one dollar each is given. If delivered in five-gallon cans in wooden cases, prices are five cents higher on all items. If delivered in iron barrels to be immediately returned, prices are five cents lower on all items. The total requirements are estimated to be 371,716 gal., to cost $195,808.30.

Coal Association Predicts Early Relief

The Executive Committee of the American Wholesale Coal Association, at a recent meeting in Washington, made a thorough canvass of the present coal situation. As a result it feels justified in advising members of the Association and the public generally on the following points:

1. The American people some months ago were of the opinion that there was danger of an impending shortage of bituminous coal. The satisfactory production since July 1 has proved this momentary alarm to have been unfounded.

2. Abnormally high prices were paid by the consumers while they were animated by the fear of possibly impending famine. These prices are now placed wholly out of line by the quite satisfactory production.

3. For a while many restraints were put upon distribution of bituminous coal, with the result that retail dealers were unable to fill urgent orders. Since the supply promises to be abundant, there is no reason for continuing any such restrictions. Due allowance should be made by the public for the fact that this statement relates only to soft coal and for the further fact that retailers cannot do all of their normal winter business in a month or two. They have not and cannot get the equipment necessary to such a feat even if they could get the coal.

It is the opinion of the committee that a great change in the whole market situation is imminent. Therefore, it suggests to buyers of bituminous coal who have a month's supply in storage that they confine purchases to immediate needs.

Petroleum Data for August

The Geological Survey figures show that for August, 1920, the total consumption, including exports, of domestic and imported petroleum was 47,814,000 bbl., while the production of domestic oil fields was 39,144,000 bbl. Imports in the same month reached a new high record, 10,790,686 bbl., making a total of domestic production and imports of 49,934.686 bbl.

It will be seen from these figures that the domestic production of crude oil in August was more than 8,000,000 bbl. below the actual consumption. The imports, however, were so great that stocks of imported oil held in the United States increased in this month by about 1,250,000 bbl. It should be borne in mind that all this imported oil is of very low gasoline content and does not, to any great extent, increase the available marketable supply of gasoline.

Plans Are Completed For New Cedar Falls Power House

The completion by the city architect on Aug. 25 of plans and specifications for the new Cedar Falls power house designed to accommodate the necessary machinery to develop 20,000 hp. additional marks the last step preparatory to beginning actual construction work on this much needed unit, which is to cost $1,000,000.

The new concrete and steel structure will adjoin the present power house below the falls and is to house a Pelton overhung turbine connected to a Westinghouse generator and to Allis-Chalmers transformers, which will bring the current up to 60,000 volts. This is the first generating unit of large size to be installed under the new system designed by Superintendent of Lighting J. D. Ross, by which the generating unit and transformers are considered as an inseparable unit without intermediate switches and busbars as is found in all other plants. The same system will be used at the Lake Union steam plant and is to be used by the Detroit-Edison Co., of Detroit, one of the largest electrical engineering firms in the world, in its future installations.

Personals

Harry B. Joyce, formerly power engineer of the United Electric Light and Power Co., New York, has joined forces with Johnson & Benham, Inc., Engineers, 150 Nassau St., New York.

A. F. Elliott, formerly chief electrician in the Coal Mining Department of the Tennessee Coal, Iron and Foundry Co., has been appointed general master mechanic for the Sloss-Sheffield Steel and Iron Co., of Birmingham, Ala.

J. C. Stevens and R. E. Koon, consulting engineers, have consolidated under the firm name of Stevens & Koon, with offices in the Spalding Building, Portland, Oregon.

D. Tarshes, formerly with the Walworth Manufacturing Co., Boston, and the Best Manufacturing Co., Pittsburgh, is now the New York, New England and Eastern Canadian representative of the M. J. Dougherty Co., piping fabricators and erectors, of Philadelphia. Mr. Tarshes is located at 23 West 43rd St., New York City.

Society Affairs

The Cleveland Engineering Society will hold open house for all members and their friends, election night, Nov. 2, and will have the latest Election Returns.

The Detroit Engineering Society is to hear a talk Nov. 5 on "Conditions in Europe from a Political, Social and Engineering Standpoint," by E. J. Mehren, editor of *Engineering News-Record*, who recently returned from an extensive trip through Europe.

The Buffalo Section of the A. S. M. E. will meet on Oct. 26, at the University Club. S. T. Dodd, of the General Electric Co., will speak on "Steam Railroad Electrification." Preceding the meeting, which will be at 8 p.m., an informal dinner will be served at 6.30.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will meet Nov. 6 to hear addresses on "Electric Heat Treatment, Present Practices and Future Possibilities." The speakers will be: George P. Mills, of the Electric Furnace Construction Co., Philadelphia, Pa., J. R. Bower, of the American Car and Foundry Co., Berwick, Pa., and James E. Wilson, of the Treadwell Engineering Co., Easton, Pa.

The American Society of Mechanical Engineers has recently organized two new sections. One, the *Aeronautic Section*, was started with the purpose of promoting in a large way the broad engineering development of aërial navigation regarded as an essentially international science, art and business. Among those who have registered in this section are Howard E. Coffin, Jesse G. Vincent, Orville Wright, C. F. Kettering, Elmer A. Sperry, James Hartness, John R. Cautley, Lionel S. Marks, Miller R. Hutchison, Charles E. Lucke and Joseph A. Steinmetz. The other one, the *Materials Handling Section*, will devote itself to a solution of the various local and national problems of handling and distributing materials and products. The aim of its 400 members will be to build up a comprehensive fund of information by holding special meetings on particular subjects and by co-operation with other sections and organizations.

The American Institute of Electrical Engineers at a meeting of the Board of Directors held in Philadelphia, Oct. 8, decided to hold the 1921 annual convention jointly with the Pacific Coast convention, at Salt Lake City, Utah, during the week beginning Monday, June 20. At the same meeting the following twelve members were appointed as the official representatives of the Institute upon the American Engineering Council, which is the governing body of the Federated American Engineering Societies: Comfort A. Adams, Cambridge, Mass., A. W. Berresford, Milwaukee, Wis., H. W. Buck, New York, N. Y., F. L. Huchinson, New York, N. Y., W. A. Layman, St. Louis, Mo., William McClellan, Philadelphia, Pa., L. F. Morehouse, New York, N. Y., L. T. Robinson, Schenectady, N. Y., Charles S. Ruffner, New York, N. Y., Charles F. Scott, New Haven, Conn., L. B. Stillwell, New York, N. Y., Calvert Townley, New York, N. Y.

Business Items

The Frederick Engineering Co., of Frederick, Md., has opened a district office at Chicago, 1247 Marquette Bldg., to place the company's automatic underfeed stoker and steam jet ash conveyor in this territory. Ralph W. Gillette will be the district sales manager.

Trade Catalogs

The Fuel Engineering Co., of New York, has brought out a booklet entitled "How Successful Manufacturers are Making Mechanical Power Produce More and Cost Less." This booklet describes in considerable detail the company's thirteen years' experience in raising the efficiency of various power plants.

The Bastian-Blessing Co., Austin Ave. at La Salle St., Chicago, claims to have developed a new principle in oxyacetylene welding and cutting, which is described in their catalog of Rego apparatus. This new equipment is said to be absolutely free from the usual flashback difficulty and to be economical in the use of oxygen.

Nonpariel Insulating Brick is described in a new 72-page book put out by the Armstrong Cork Co., Pittsburgh, Pa. The book is well gotten up and goes into great detail regarding the character of "Nonpariel" brick, tests that have been made upon it, various methods of using it and examples of actual use. It is illustrated with photographs, diagrams and a great many tables of interesting data.

The Dravo Co. of Milwaukee has issued a short bulletin containing photographs and diagrams which show the general construction and application of the Dravo superheater.

"The Petroleum Outlook" is the title of a short but comprehensive book just put out by Arthur D. Little, Inc., chemical engineers, 30 Charles River Road, Cambridge, Mass. It deals with the degree of exhaustion of our oil fields and the future outlook for them. The book will be sent free of charge to bankers, brokers, manufacturers and investors upon application.

New Construction

PROPOSED WORK

Mass., Hyde Park (Boston P. O.)—The City, Public Bldgs. Dept., is having plans prepared for a 3 story, 75 x 165 ft. building including a steam heating system on Everett Sq. About $350,000. Desmond & Lord, 15 Beacon St., Boston, Archts.

Mass., Springfield—The Bd. Educ. will receive bids until November 3 for a 3 story junior high school including a steam heating system on State St. About $800,000. Henry L. Sprague, 310 Main St., Archt.

N. Y., Brooklyn—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for an underground electric light and power distribution system at the Naval Hospital here from the General Electric Co., 22 Leight St., $26,435; Harry Alexander, 20 West 34th St., $31,530; Lord Electric Co., 105 West 40th St., $31,760. All of New York City. Noted Oct. 5.

N. Y., Brooklyn—The New York State Hospital Comn. will receive bids until December 10 for several hospital buildings here, including a steam heating system. About $3,000,000. L. F. Pilcher, Hall of Records, New York City, Archt. and Engr.

N. Y., Buffalo—The Delaware Vacuum House Cleaning Co., 150 Chenango St., is in the market for one 5-hp. gas engine.

N. Y., Buffalo—The Hub Dry Cleaning Co., 110 Grant St., is in the market for one 2- or 3-hp. vertical boiler.

N. Y., Central Islip—The State Hospital Comn., Capitol, Albany, will receive bids about February 5 for 2 asylum buildings here, including a steam heating system. About $350,000. L. F. Pilcher, Hall of Records, New York City, Archt. and Engr.

N. Y., Cortland—The State Bd. Educ., Capitol, Albany, will receive bids about January 2 for several buildings for the normal school including a steam heating system. About $1,750,000. L. F. Pilcher, Hall of Records, New York City, Archt. and Engr.

N. Y., Kings Park—The New York State Hospital Comn., Capitol, Albany, will receive bids about February 5 for 2 asylum buildings including a steam heating system. About $350,000. L. F. Pilcher, Hall of Records, New York City, Archt. and Engr.

N. Y., New York—The Bd. Educ., 500 Park Ave., is having plans prepared for a 5 story school including a steam heating system on St. Pauls Ave. near Washington Ave. About $400,000. C. B. J. Snyder, Municipal Bldg., Archt. and Engr.

N. Y., New York—The Chelsea Methodist Episcopal Church, c/o Polhemus McKenzie & Coffin, Archts. and Engrs., 15 East 40th St., plans to build a church including a steam heating system on 178th St. About $400,000.

N. Y., New York—The Lincoln School for Teachers, c/o Starrett & Van Vleck, Archts. and Engrs., 8 West 40th St., is having plans prepared for a 5 story, 100 x 150 ft. school including a steam heating system on 5th Ave. and 102nd St. About $1,000,000.

N. Y., New York — The Peoples Home Methodist Episcopal Church, c/o Polhemus, McKenzie & Coffin, Archts. and Engrs., 15 East 40th St., plans to build a church including a steam heating system at 542 East 11th St.

N. Y., New York — The State Hospital Comn., received bids for soot blowers and repairs to the heating system in the Manhattan State Hospital, from the Bayer Steam Soot Blower Co., 11 John St., $5,700; Diamond Power Specialty Co., 30 Church St., $7,955.

N. Y., Penn Yan—J. T. Andrews & Co. plans to install 3 hydraulic turbines to replace present ones. C. R. Andrews, Operating Engr.

N. Y., Rochester—The Chocolate Shoppe, 11½ Clinton Ave., North, is in the market for a 12-in., 110-volt, alternating-current electrically driven blower.

N. Y., Rochester—Tatlock Bros is in the market for one 50-hp marine type boiler.

Pa., Bethlehem—The Traveler Rubber Co., 111 North Montgomery St., plans to build a 1 story [illegible] x [illegible] ft. pumping house and a 50 x [illegible] ft. cement house. About $10,000. J. O. Hunt, Trenton, N. J., Archt.

Pa., Chester—The Stalium Metals Corp. of America, 226 Lafayette Bldg., Philadelphia, plans to build a plant including several buildings for the manufacture of stalium. A steam heating system will be installed in same. About $[illegible]. R. Beard, 2519 North Woodstock, Philadelphia, Archt.

Pa., Lancaster—The Edison Electric Co. of Lancaster and the Harrisburg Light & Power Co. of Harrisburg are planning to build a hydro-electric plant here, on the Susquehanna River, to generate an ultimate capacity of 100,000 kw.

Pa., Lansdale—The Borough Council has arranged to sell $50,000 bonds for the installation of additional equipment at the municipal electric light plant.

Pa., Philadelphia—The Engineering Gear Co., 130 Walnut St., is in the market for one Gleason generator.

Pa., Warren—The Struthers Wells Co., 1003 Penn. Ave., W., will soon award the contract for a 1½ story, 68 x 140 ft. forge shop and a 40 x 86 ft. boiler house. About $100,000.

D. C., Washington—The Methodist Episcopal Bd. of Temperance Prohibition and Public Morals, 204 Pennsylvania Ave., has had plans prepared for a 6 story office and apartment building. About $500,000. Ballinger & Perrot, 328 South Broad St., Phila., Pa., Archts. and Engrs.

N. C., Southern Pines—S. B. Richardson and A. S. Newcomb plan to build a resort hotel. About $275,000.

O., Canton—The Bd. Educ. received bids for a 3 story, 130 x 160 ft. school, including steam heating system on Grace Ave. from Geo. Whiker & Son, $296,500, and Melbourne Bros., Eagle Blk., Tuscarawas, West, $311,680.

O., Maple Heights (Bedford P. O.)—The Bd. Educ., c/o W. N. Blanchard, Pres., will vote on $300,000 bonds Nov. 2 for a 2 story school including a steam heating system, at Stop 11½. Architect not selected.

O., Zanesville—The Baltimore & Ohio R.R., Market and 2d Streets, is having preliminary plans prepared for an electrical plant and a new heating plant at the railroad shops on Lee St. About $300,000. H. A. Lane, Baltimore, Md., Engr.

Ind., Fort Wayne—The Fort Wayne Storage Co., Harrison and Grand Sts., plans to build a 6 story, 95 x 194 ft. storage warehouse at Francis and Hayden Sts. About $500,000. Moore & Dunford, First Natl. Bank Bldg., Chicago, Ill., Engr.

Mich., Detroit—Kassler & Sons, c/o S. E. Remey, Archt., Whitney Bldg., plans to build a 2 story, 30 x 150 ft. garage including steam heating system on Dix Ave. About $10,000.

Wis., DePere—St. Norberts College, Boyle Hall, is having plans prepared for a 3 story, 80 x 260 ft. science hall including a steam heating system. About $400,000. W. E. Reynolds, 113 South Roosevelt St., Green Bay, Archt.

Wis., Fond du Lac—The Sheboygan Dairy Products Co., c/o M. G. Douma, Mgr., 936 North Water St., Sheboygan, is having plans prepared for a 2 story, 120 x 300 ft. dairy products factory including a steam heating system and electric power on West Division St., here. About $100,000. B. E. Mehner, 6 East Division St., Archt.

Wis., New London—The Sheboygan Dairy Products Co., c/o M. G. Douma, 936 North Water St., Sheboygan, plans to install equipment including ice machine, motors, pumps, mixers, etc., in its ice cream and dairy products factory, here. About $25,000.

Ia., Sioux City—The Bd. Educ., City Bldg., plans to build a 3 story, 150 x 130 ft. school, including a steam heating system, on 7th and Jackson Sts. About $250,000. H. C. Roberts, Secy. Beuttler & Arnold, 235 Grain Exch., Archts.

Iowa, Tama—The J. G. Cherry Co., E. T. Cherry, Vice Pres., had plans prepared for canal work and dam for a lighting system. Power Eng. Co., Metropolitan Life Bldg., Minneapolis, Minn., Engrs.

Minn., Aitkin—The Bd. Educ. is having plans prepared for a 3 story high school, including a steam heating system. Cost to exceed $400,000. A. Casey, Clk. K. T. Snyder, 738 Plymouth Bldg., Minneapolis, and H. S. Swanson, Crosby, Archts.

Minn., Chisholm—The Bd. Educ., c/o Ernest Drew, clk., plans to build a vocational school including a steam heating system. About $250,000.

Kan., Portes—J. E. Kissel, City Clerk, will receive bids until Oct. 26 for waterworks improvements, including a motor distribution system, etc. About $32,000. Noted Oct. 5.

S. D., Huron—Beadle Co. will receive bids until Nov. 16 for a 3 story, 92 x 108 ft. courthouse, and a 2 story, 31 x 53 ft. jail, including a steam heating system. About $400,000. W. E. Hulse & Co., 320 Grain Exch., Sioux City, Ia., Archt.

Tex., Kennedy—The Kennedy Oil Mill Co. has been granted a franchise for electric lights and power here, and will install machinery in connection with its oil mill.

Tex., La Porte—The La Porte Light, Water & Ice Co. plans to rebuild its plant recently destroyed by fire, causing a loss of $20,000.

Col., Sterling—The Great Western Sugar Co., University Park Siding, is having plans prepared for a factory near here. About $2,000,000. Edwin Morrison, Sugar Bldg., Denver, Engr.

N. B., Grand Falls—The International Paper Co., Three Rivers, Que., plans to develop water power here.

Ont., Almonte—A. F. Macallum, Engr., City Hall, has prepared report, estimate and preliminary survey for a water-works system, including pumphouse, etc. About $263,695.

Ont., Toronto—Cudland & Sons, 1450 Gerrard St., East, plan to build a 2 story meat packing factory, including refrigeration equipment. About $40,000. Archt. not yet appointed.

Ont., Windsor—Colthurst, Trace & Nichols, Archts., 16 Sandwich St., West, are preparing plans for a 2 story, 120 x 400 ft. cold storage plant. About $600,000. Owner's name withheld.

B. C., Vancouver—The Bridge River Power Co., c/o R. W. Bonnycastle, Engr., 606 Bank of Nova Scotia Bldg., plans to build a dam and a power house to develop a total of 400,000 kw., initial construction from 50,000 to 15,000 kw., and units of 25,000 kw. to be developed under a 600 to 700 ft. head.

CONTRACTS AWARDED

N. H., Lincoln—The Parker-Young Co., Lisbon, has awarded the contract for a 1 story power house here to the Osgood Constr. Co., 25 East Hollis St., Nashua, at $20,000.

Mass., Fitchburg—The Fitchburg Gas & Electric Light Co., [illegible] Main St., has awarded the contract for a [illegible] and 3 story, 58 x 152 ft. addition to plant, including a boiler house at Sawyer's Passageway, to Wiley & Foss, Central St., at $125,000.

Mass., Lynn—The General Electric Co. has awarded the contract for a 1 story, 35 x 40 ft. boiler house, to C. W. Wright, 23 Central Ave. Cost between $25,000 and $30,000.

Mass., Peabody—The City School Comn. has awarded the contract for the installation of a steam heating system in the proposed 2 story high school on Central St. to Stone-Underhill Heating & Ventilating Co., 139 Pearl St., Boston. Noted Sept. 28.

N. Y., Buffalo—The Central Park Methodist Episcopal Church has awarded the contract for a 3 story, 150 x 180 ft. church on Morris and Wesley Sts., to Robert E. Williams, Iroquois Bldg., at $350,000.

N. Y., New York—The Tivoli Amusement Co., c/o Arena Theatre, 40th St. and 8th Ave., will build a theatre and office building, including a steam heating system on 50th St. and 8th Ave. About $500,000. Work will be done by day labor.

Md., Baltimore—The American Ice Co., Calvert Bldg., has awarded the contract for a 32 x 99 x 82 ft. ice storage building, on Montford Ave. near Chase St., to the G. A. Fuller Co., American Bldg., at $200,000.

O., Cleveland—The Fisher Body Co., Oakland and Piquette Sts., has awarded the contract for a 1 story, 95 x 114 ft. power house, on East 140th St. and Coit Rd., to the Thompson Starrett Co., Perry Payne Bldg., at $200,000.

Ind., Indianapolis—The Westinghouse Lamp Co., 165 Bway, New York City, has awarded the contract for a manufacturing plant, including a steam heating system, here, to D. P. Robinson, 125 East 46th St., New York City, at $500,000. Noted Aug. 31.

Ill., Clearing—The Hamler Boiler & Tank Co., 3906 South Halsted St., Chicago, has awarded the contract for a 1 and 2 story, 100 x 300 ft. factory, including a steam heating system, on 65th St. and 60th Ave., to W. J. Nelson, 1537 West 63d St., Chicago, at $500,000.

Ia., Wapello—F. G. Wright, Co. Aud., has awarded the contract for a drainage pumping plant, including 2 centrifugal pumps of equal capacity driven by oil engines, to Layton Constr. Co., Muscatine, at $76,085. Noted Sept. 14.

Minn., Minneapolis—The Bd. Educ., c/o G. F. Womrath, Supt., City Hall, has awarded the contract for a heating and ventilating system in the Clinton School addition to Bjorkman Bros., 712 South 10th St., at $41,399. Noted Oct. 5.

Minn., St. Paul—The city has awarded the contract for the installation of a vertical triplex motor driven pump to have a 350 gal. capacity per minute against a total 150 ft. head, single acting, belt for 150 lb. pressure, to the Robinson, Cary & Sands Co., 4th and Wacouta Sts., at $3,510.

S. D., Sioux Falls—The city has awarded the contract for a motor house and well to Fauenust Bros. at $16,600.

Mo., Kansas City—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., has awarded the contract for the complete installation of outside steam service here to the MacMahon Plumbing & Heating Co., 1329 Oak St., at $10,476.

Ont., Ottawa—Dey Bros., Laurier Ave., W., have awarded the contract to the Dominion Bridge Co., Imperial Life Bldg., Toronto, for steel work in connection with their new artificial ice rink. A plant for manufacturing and maintaining artificial ice surface and a steam heating system will be installed.

"SEARCHLIGHT" is the "OPPORTUNITY"
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See Pages 81 to 96

Think "SEARCHLIGHT" *First*
For Every Business Want

See Pages 81 to 96

POWER

Volume 52 New York, November 2, 1920 Number 18

Horse Power per Man Power a Measure of Modernism

SINCE the maximum number of producers in the world is always less than the maximum number of consumers, we have the economic law, as inevitable as any other law of nature, that only by increased productivity per worker may we increase the average standard of living.

Mechanical devices, so-called "labor-saving" machinery, and above all the substitution of mechanical power for human effort, all increase human productivity. It is evident, therefore, that the greater application of power is almost invariably an indication of advance in industry. As a unit by which we may measure this advance, we can well take the relationship between the horse power of generating equipment used to the man power employed. In other words we may well say that every increase in horse power per man power represents a modernizing tendency of industry. Unfortunately, data are not available by which we can measure each industry accurately with respect to this unit. But each establishment within any industry may well take this unit into account. It affords the best measure of progress which industrial management can have of this important relationship.

Simple Methods of Determining Dissolved Gas Content in Boiler-Feed Water

By J. R. McDermet[*] and Daniel Wertheimer[†]

By the methods described no special laboratory glassware is necessary; the operator need not be a chemist or have had laboratory experience.

THE laboratory of the Elliott Co. has developed to a high stage of technique, methods for the determination of dissolved gas content of boiler-feed water. Dissolved gases, and in particular oxygen, have become of significance with the advent of high steam pressures and superheats as dangerous accelerators of corrosion in boilers and economizers. Control of this corrosion depends primarily on knowledge of dissolved gas content. The following methods seem to the writers the simplest and easiest to apply. Photographs of the actual apparatus are shown, so that the reader may cheaply assemble the necessary parts with the aid of a chemical glassware catalog. Fig. 1 illustrates the set-up for Reichardt's method of boiling out and measuring the dissolved gases directly. At the beginning bottles *A* and *B* and adapter *C* are filled with water and the water boiled free from air by gentle heating with flames under the bottles. Bottle *A* contains a definite volume to the lower line of the stopper, below which the glass delivery tube does not extend. The dissolved gases are expelled from *C* by steam from *A* and withdrawn through the pinch cock. Bottle *B* is included to compensate with air-free water for changes in the volume of the contents of *A* and *C* in the boiling process. The delivery tube in *B* extends completely to the bottom. Another tube extending through the stopper of *B* is provided to vent steam from *B*. Where several determinations are to be run consecutively, it is useful also in refilling *B*, by siphon action on cooling, with water that has been made partly air-free by boiling over a flame. At the conclusion of the boiling-out process the flame is removed from *A*, and bottle and delivery tube are allowed to fill with water from *B*. The pinch cock in the delivery tube is then closed so that the tube will remain full of water when bottle *A* is subsequently removed. Bottle *A* is then removed refilled with water to be tested, and the stopper replaced to the definite volume mark, care being taken that no air bubbles are retained in the top of the bottle. The pinch cock in the delivery tube is then opened and the boiling continued until all the dissolved gases in the sample collect in *C*. This usually requires about thirty minutes.

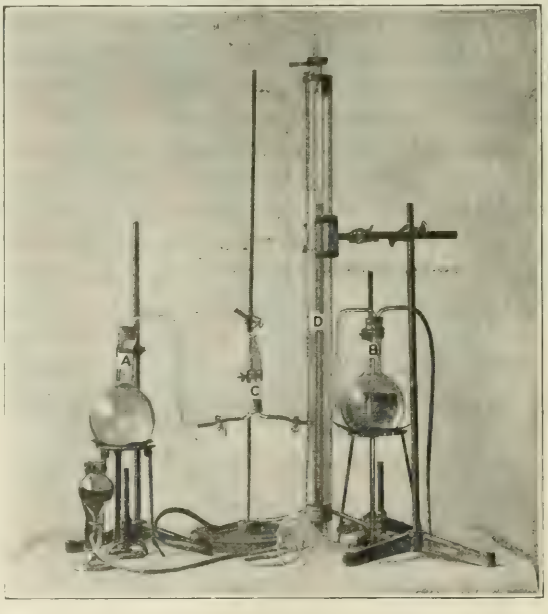


FIG. 1. APPARATUS USED IN REICHARDT'S METHOD OF BOILING OUT DISSOLVED GASES IN WATER DIRECTLY

When all the gases are collected in *C*, it is connected to the water-jacketed gas burette *D* and the gases are withdrawn. Burette *D* and its leveling bulb may be filled either with mercury covered over its meniscus surface with non-volatile oil or with a saturated salt solution. It is impossible to prevent some water being drawn over from *C*, and unless such precautions are taken in selecting the confining liquid in *D*, considerable reabsorption will take place when this water cools to the temperature of the jacket water. At the end of about fifteen minutes the gas will have attained the temperature of the jacket water, and its volume may then be read directly from the burette scale by bringing the level of the liquid in the leveling bulb to the precise height of the liquid in the burette. This burette volume may be calculated into standard volume from the temperature of the burette jacket water and the barometric pressure.

Some steam is always drawn into the burette along with the dissolved gases. This condenses in a film on the surface of the burette inclosing the gases, and for precise work it is necessary to correct the barometric reading for the aqueous tension at the temperature of the jacket water. The vapor pressure of the concentrated salt solution, when it is used, may ordinarily be neglected. With such waters it is necessary to employ Lenossier's method, which also is a chemical means of determining dissolved oxygen. The phenosafranine indicator employed in this method is not so decisive in its color change (red to straw color) and has an appreciable lag in its indications, but from the standpoint of apparatus and manipulation the method is indeed attractive. Separatory funnel *A*, Fig. 2, of about 500 c.c. capacity is filled with about 400 c.c. of mercury and the balance with water to which has been added 20 c.c. of sodium-hydroxide solution (36 deg. Bé.), 20 c.c. of rochelle salt (20 per cent), and a few drops of an alcoholic solution of phenosafranine (1 in 2,000). The two-hole stopper is then replaced, the burette *B* filled with a standard solution of ferrous sulphate (O2N) and sufficient sample poured into the 125-c.c. graduated separatory funnel *C*. After the apparatus is found airtight, ferrous sulphate is added to the water in *A* to absorb all the oxygen. This is accomplished by opening the stop cock of burette *B*, permitting the mercury in funnel *A* to run out drop by drop. After additions of every few drops of ferrous sulphate all stop cocks are closed and the solution well shaken to cause diffusion of the ferrous sulphate. The whole apparatus is arranged on a stand to facilitate this shaking, and the mercury is put in solely for this purpose. When neutralization is established, the stop cock of *B* is closed, stop cock of *C* opened, and a measured volume of the water sample run in, the volume being read from the graduations on funnel *C*. With the addition of the oxygen the mixture in *A* turns red again, and neutralization with ferrous sulphate is accomplished as before. In this case the volume of ferrous sulphate, as given by the burette readings before and after the addition, is a measure of the amount of oxygen in the volume of the sample added. The process of alternate additions and titrations may be repeated indefinitely as long as there is sufficient mercury in *A* to accomplish the mixings. It is possible to calculate oxygen directly from the volume and normality of the ferrous sulphate, but it is desirable to calibrate it from determinations made by the Winkler method on a sample free from nitrates and nitrites. Experimentally, the results from Lenossier's method are strictly consistent and fairly accurate, but the results calculated from normality, etc., of the ferrous sulphate are likely to be high. The method is to be regarded as useful only where the Winkler method is inapplicable.

[†] Chemist, Elliott Company.

[*] Research engineer, Elliott Company.

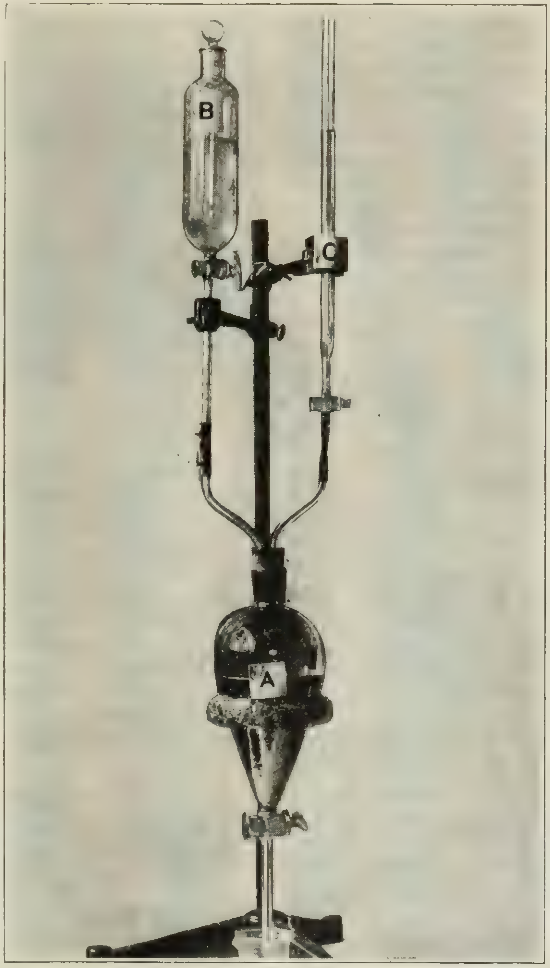


FIG. 2. SEPARATORY FUNNEL FOR DETERMINING OXYGEN CONTENT IN WATER

In the application of any of these methods to samples from which air has been partly removed, it is necessary to emphasize that preliminary to testing, the greatest precautions must be taken to avoid contact with air and particularly agitation. This method is desirable only because of its simplicity. It is the least accurate of the three and calls for constant and painstaking attention in its performance, but it requires no special knowledge of chemistry or high degree of laboratory technique.

The Winkler chemical titration method for the determination of dissolved oxygen is considered by the writers as the best of the three methods discussed. Its advantages lie in the following:

1. Minute traces of oxygen may be determined with the highest degree of accuracy and rapidity, by an operator having had only a few hours' experience.

2. The method gives the determination directly in terms of dissolved oxygen, which is the significant factor in corrosion due to dissolved gases.

3. No special pieces of glass apparatus are required, and the apparatus may be readily assembled in kit form for field use. The field kit is shown in Fig. 3.

The solutions required are: (a) Manganous chloride (400 parts in 1,000 parts water); (b) alkaline iodide solution (700 parts sodium hydroxide and 150 parts potassium iodide in 1,000 parts water); (c) sulphuric acid (equal volumes conc. acid and water); (d) starch indicator (1 part starch paste in 400 parts boiling water); (e) sodium thiosulphate solution, approximately 0.025 normal. This solution should be prepared and standardized by a competent chemist or bought already prepared from a chemical-supply house. It is unstable if kept for long periods, so purchases should be limited to about two months' supply.

The method is briefly as follows: To a 500-c.c. sample of water 4 c.c. each of manganese-chloride solution, alkaline iodide solution and sulphuric acid are added in the order mentioned. To permit diffusion of the reagents, the additions are made at two-minute intervals. This procedure results in the liberation of iodine in the sample in exact proportion to the original amount of dissolved oxygen present in the water. The solutions are most easily added by means of 4-c.c. suction pipettes which are filled to the calibration mark on the stem by suction applied with the lips. The last two solutions are, respectively, caustic and acid, and therefore care should be taken that none of these liquids comes into the mouth. Special precaution must be taken not to disturb the water until after the addition of sulphuric acid.

A 250-c.c. sample of this treated water is then taken and a few drops of starch indicator added. This colors the solution a beautiful blue. The liberated iodine is then titrated with sodium-thiosulphate solution by adding it drop by drop from a calibrated burette until the blue color disappears. The difference of burette volume readings before and after the addition of the thiosulphate is the measure of dissolved oxygen. In samples heavily saturated with oxygen the iodine color of the sample should be partly discharged by the addition of the thiosulphate before the starch indicator is added. The color change of the indicator is both sensitive and decisive.

The chemistry of the method is based upon the fact that iodine is liberated in the sample in exact proportion to the amount of oxygen dissolved. A standardized solution of sodium thiosulphate is merely a solution containing a definite calibrated amount of sodium thiosulphate per unit volume. Each volume then has a definite capacity for dissolving iodine, and it is possible to eliminate consideration of intermediate reactions and calculate oxygen directly from volume of thiosulphate solution.

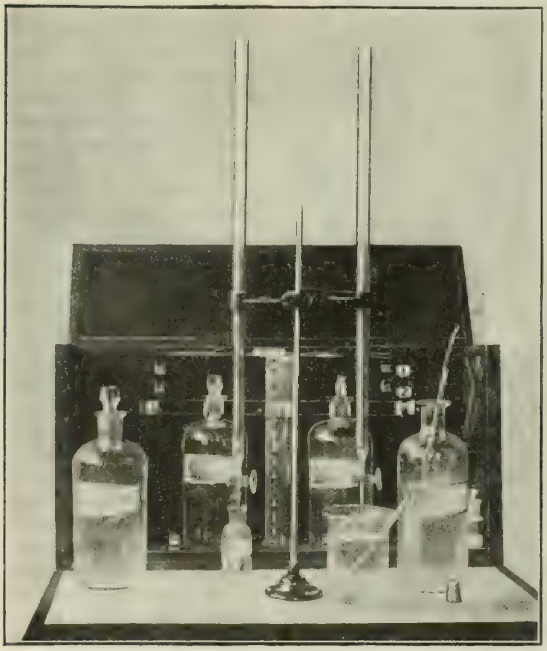


FIG. 3. FIELD KIT USED FOR WINKLER METHOD OF TITRATION FOR DISSOLVED OXYGEN IN WATER

$$\text{Oxygen (c.c. per liter)} = \frac{139.5N \times A}{V - 0.0025}$$

in which N = number of cubic centimeters of thiosulphate used in titration; V = volume of solution titrated; and A = normality of thiosulphate solution.

If it is desired to know the volume of air dissolved, it is possible to determine it from the oxygen content by comparisons with a solubility table.

Unfortunately, the Winkler method is inaccurate for waters containing either organic nitrates or organic and inorganic nitrites.

Water has the greatest avidity for redissolving air, and therefore methods of collecting samples represent in many cases more of a problem than the actual determination of dissolved gas content.

Midwest Pumping Set

Of late years water-works engineers, to insure a constant service, have installed many gasoline-engine-driven centrifugal pumps. The pumping set here represented consists of an electric motor direct-connected to a four-stage Midwest centrifugal pump manufactured by the Midwest Engine Co., Indianapolis, Ind. To the other side of the pump is fitted a 40-hp. Midwest four-cylinder gasoline engine. The pump is ordinarily driven by the electric motor. In event of failure of the electric power, the engine is started and clutched to the pump. In this manner constant service at the water station is assured. In many localities this combustion will allow a lower insurance rate. The engine is of the four-cylinder valve-in-the-head type, having a bore of 4½-in. and a 6-in. stroke.

MIDWEST PUMPING SET

Diesel-Engine Pointers

In aligning the bottom shells of oil-engine main bearings, the thickness of each shell should be measured at the ends and center. If one bearing has worn thinner than the others, it should be shimmed up or the others scraped down.

Most oil engines run best with 0.004 to 0.006 in. clearance between the shaft and the top bearing. To secure this, lead wires can be used to check the clearance.

If the crankshaft has an endwise movement, the ends of the bearing should have babbitt rings run on them; steel washers placed between the crank throws and bearings are equally good. If not corrected, the sidewise movement will bell the crankpin bearings.

If a main journal or crankpin gets roughened the scores can be removed by careful filing and lapping with emery compound.

If a babbitt lining shows evidences of being cracked, it should be removed and rebabbitted at once.

After rebabbitting a bearing, it should be bored true before scraping, in order to preserve the alignment of the shaft and bearing.

Protective Relays—Reverse-Power Type

By VICTOR H. TODD
Test Engineer, Westinghouse Electric and Manufacturing Company

Conditions produced in a system of parallel feeders when a short-circuit occurs are discussed and then types of reverse-power relays that will operate under these conditions are considered. Both single-phase and polyphase relays are treated of.

A REVERSE-POWER relay's function is to isolate trouble on a system of parallel alternating-current feeders. The most common use of the reverse-power relay is shown in Fig. 1, where alternator *A* is connected to a bus *B* which supplies a sub-bus *C* over the parallel feeders *D* and *E*. If a short-circuit occurs at *X* on feeder *D*, power will not only flow from *B* over *D* into the defect, but it will also flow from *B* over *E* to sub-bus *C* and back to the fault *X*. Therefore to isolate the fault it will not only be necessary to open switch *S* at bus *B*, but also switch *S′* at the sub-bus. Switch *S* can be tripped with a relay, having a definite-time setting; however, in order to open switch *S′* before switch *R* can open a reverse-power relay is required that is set for a shorter period than the time-limit relay at *R*. To develop a satisfactory reverse-power relay for the protection of parallel alternating-current feeders has always been one of the most difficult protection problems. It might appear, at first thought, a very easy matter to place contacts or a wattmeter which would hold open on normal direction but close on reversal of power. However, should the short be near the substation the voltage will be very low, although the current may be high, and the power actuating the wattmeter will be extremely low in this case. In fact, some tests made, in which the line was actually shorted intentionally, show that the voltage may drop as low as 1 per cent of normal. Furthermore, we are dealing with three-phase current, and phase distortions must be considered, particularly in the case of short-circuits from one line to the ground, or on one phase only. These short-circuits may so distort the relation of current to voltage as to cause the angle between them to be almost 90 deg., thus producing the worst condition for low torque in the wattmeter element; namely, very low power factor and voltage.

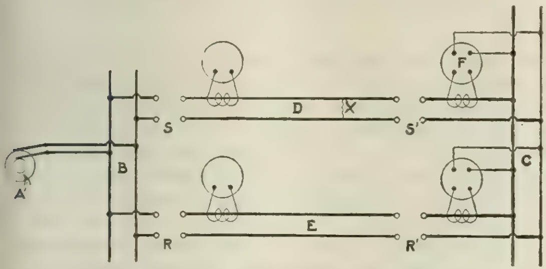


FIG. 1. PARALLEL FEEDERS CONNECTED BETWEEN A MAIN AND A SUB-BUS

One of the first relays used for reverse-power tripping had a wattmeter element which closed contacts. In this form the movement was the same as the induction wattmeter. There was a movable arm and contact and two stationary contacts, one on each side of the movable contact, with separate adjustments provided to allow different setting for tripping points in normal and reverse directions. The movement was controlled by a strong spring to allow setting to two or three times full load. No attempt was made to introduce time lag or damping, the relays acting instantly. These relays were found to be entirely inadequate on account of insufficient torque when short-circuits cause the voltage and power factor to drop to low values. They proved conclusively that a pure "wattmeter" relay was not satisfactory.

A practical reverse-power relay should fulfill the following conditions:

1. It should close its contacts positively when the direction of power flow is reversed, under all possible conditions of voltage, power factor and current.

2. It should never, under any circumstances, close its contacts when the direction of power flow is normal.

These are the fundamental requirements. In addition it is desirable to have a time element that can be accurately predetermined and quickly adjusted to any desired value. It is assumed as a matter of course that the relays are reliable and rigid in their mechanism and have the necessary current-carrying capacity both in windings and contacts. A most important step toward fulfilling these conditions was in adding a separate wattmeter element with contacts in series

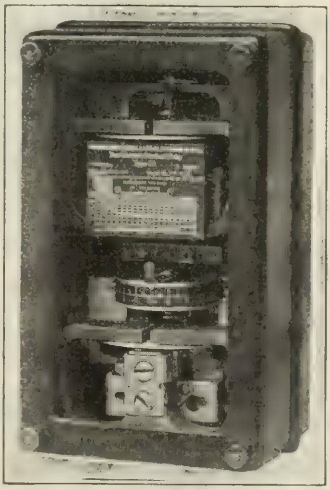


FIG. 2. SINGLE-ELEMENT TYPE REVERSE-POWER RELAY

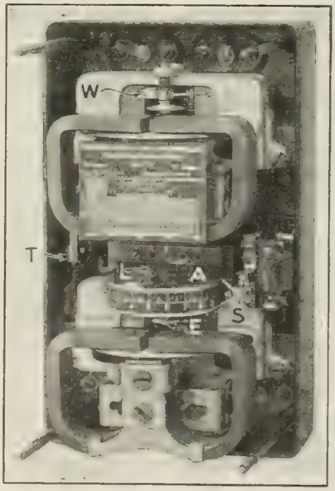


FIG. 3 THE SAME AS FIG. 2. WITH COVER REMOVED

with those of the excess-current relay. The wattmeter element was very carefully constructed, with a weak spring and quick-time element, so that the least flow of current in the normal direction would hold the contacts open and prevent the excess-current relay from tripping the breaker, even in the event of overload. Should the power reverse the wattmeter element quickly close its contacts, but since they were in series with the excess-current relay contacts the breaker could not trip until both closed; that is, an excess current in the reversed direction. This combination clearly selected between an overload in the normal and reverse direction even if the voltage dropped to 2 per cent of normal and the power factor to 10 per cent. This reverse-power relay as finally developed contained two separate elements; a plain excess-current relay, and a sensitive reverse-watts relay with their contacts in series. This allows the current to be set high enough so that it will not operate except on excess current in either direction, but still the reverse-watt element insures that the breaker can never trip except when the excess current is in the direction of reverse power.

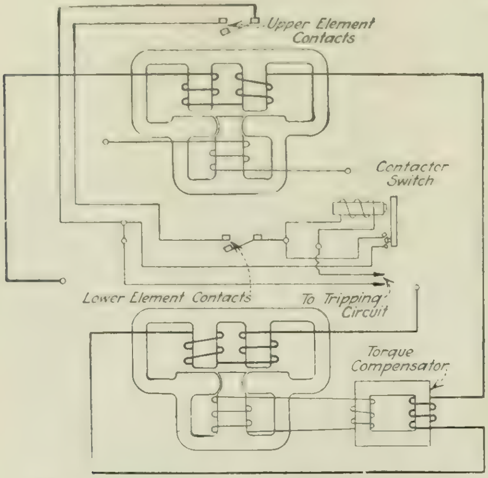


FIG. 4. DIAGRAM OF RELAY CIRCUITS, FIG. 2

In Figs. 2 and 3 is shown a reverse-power relay of the foregoing type. This relay combines all the points heretofore mentioned. It will be noticed that the single case contains two separate induction elements, each with its windings, disc, magnets, contacts, etc. There is no mechanical connection whatever between the two moving elements. The top element is the quick-acting, sensitive watt element with a contact switch *W* controlling the contactor *S*. The lower element is a standard "excess-current" (overload) relay, provided with an adjustable time lever *L*, current-adjusting plate *A*, excess-current contacts *E* in series with the watt-element contacts *W*, torque compensator *T*, etc. The wiring diagram, Fig. 4, gives the internal connections, the current winding being shown by the heavy lines.

Owing to the flow of heavy currents the vibration of the discs prevented the making of good contacts at the watt element and the excessive torque also caused the discs to slip on the shafts. The fluttering contact was changed into a positive one by means of the contactor switch shown at *S*, Fig. 3. This consists of an electromagnet *A*, Fig. 5, capable of attracting an iron armature *B*, which is pivoted at *C* and carries a silver contact *D*. The contacts *E* are those on the lower-element relay contacts shown in Fig. 4. When contacts *E* close and are vibrating or chattering owing to the heavy induced currents in the disc to which they are attached, their partial touching allows a small current to flow in the solenoid *A*, Fig. 5. This weak current causes the solenoid to attract the armature *B*, and causes *D* to short-circuit the two contacts *F* and *G*, thus positively energizing the trip coil and tripping the breaker. It is evident that should contacts *E* still flutter there will be no spark. In fact, the first touch is enough to close *D* and trip the breaker. The trip circuit will stay energized and contact *D* closed until the circuit is opened by the auxiliary pilot switch on the breaker, which is arranged for this purpose. The contactor switch not only assures positive contact, but increases the tripping-circuit capacity from two to ten amperes, thus avoiding the use of an auxiliary relay switch except in the case of very heavy trip currents.

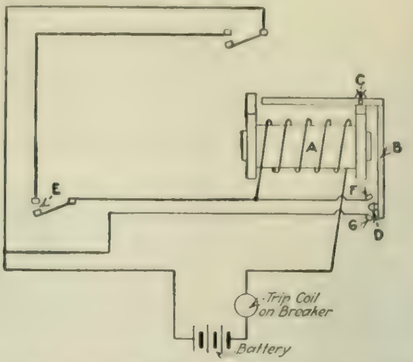


FIG. 5. DIAGRAM OF RELAY TRIP CIRCUITS

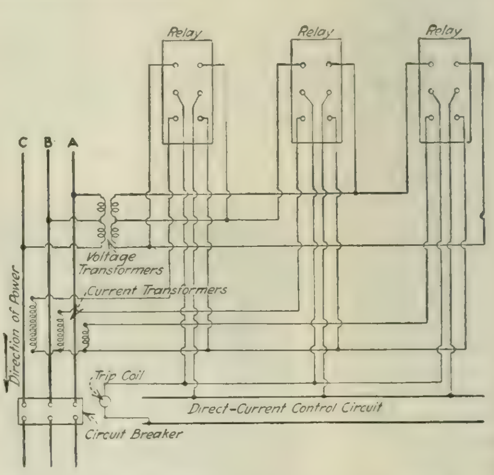


FIG. 6. CONNECTIONS OF RELAYS TO CAUSE THE CURRENT TO LEAD THE VOLTAGE ON NON-INDUCTION LOADS

Excessive torque is overcome by means of the "torque compensator," which is a small transformer, Fig. 4, with the primary winding carrying the main current, the secondary supplying the relay windings. The compensator is so proportioned that the iron becomes saturated at heavy overloads, thus preventing excessive flow of current in the relay.

In view of the fact that the heavy overload currents produce such strong fields it might be suspected that this alternating field would weaken the permanent magnets and change the time setting. This, however, is not the case, as the magnets are placed on the diametrically opposite side of the disc from the driving coils, and thoroughly shielded by the framework, exactly as in an integrating wattmeter. Moreover, in testing, the relays are subjected to many times more current than they would ever get in actual practice, so any demagnetizing effect would make a permanent change the first time the relay was tested and following excess current could not change its action.

The most important requirements of a reverse-power relay is that it should operate when the potential at its terminals is between 1 and 2 per cent of normal. If we assume the case of a No. 0000 cable normally carrying 300 amperes at 12,000 volts connected to a generating station having a short-circuit current of 3,000 amperes, the loss which would occur between the busbars and a metallic short-circuit 100 ft. from them would be 45 kw. per phase, or less than three-quarters of one per cent of the relay setting.

The statement has frequently been made that a reverse-power relay cannot operate when there is no voltage, but neither can there be a flow of current unless there is a difference of potential. The problem is, therefore, nothing more than a question of securing a contact-making wattmeter which is sensitive to operate on the small potential that is always present when a short-circuit occurs. Numerous tests have been made that show that when a cable breaks down the arc through the insulating space between conductors will maintain a voltage of between 1 and 2 per cent, and it has been found that a higher voltage is maintained when the current is small than when it is excessive—a fact that materially assists reverse-power relays. It should be pointed out that on large systems it is practically impossible to obtain a metallic short-circuit, because any small object that could be brought into contact with the busbars would be immediately destroyed.

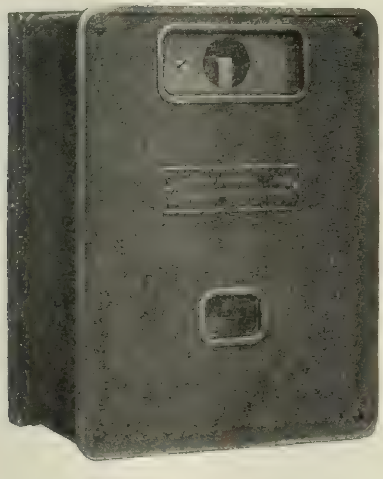


FIG. 7. RELAY HAVING THREE REVERSE-POWER ELEMENTS

In the past the operation of reverse-power relays has been somewhat unsatisfactory because means were not taken to insure correct operation at times when the power factor of the system was bad owing to unbalanced short-circuits. As a result of several years' investigation it has been found that the method of connecting reverse-power relays with their potential coils in star, as has been the usual custom, is theoretically incorrect, and the relays will fail to operate upon the occurrence of the most common form of short-circuit. When unbalanced short-circuits occur a large number of combinations of circumstances are possible, but it has been found that the most severe condition is when only two conductors of a three-phase line are short-circuited, and if relays will operate properly under this condition they will satisfy practically all other.

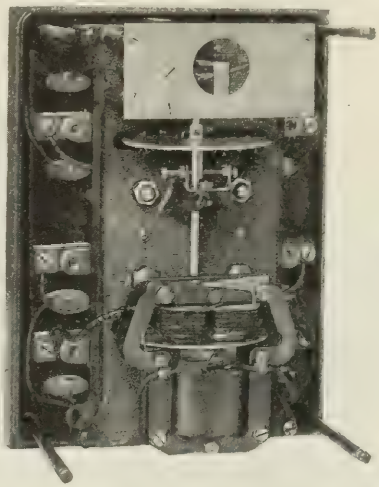


FIG. 8. SAME AS FIG. 7 WITH COVER REMOVED

One method of taking care of the distorted condition in the system due to a single-phase being short-circuited is to connect the relay's voltage coils across the same conductors that are causing the short-circuit. In other words, the voltage coils are connected in delta in accordance with Fig. 6. Because the current will lag behind the voltage when a short-cirucit occurs by practically 90 deg., the connection should be so made that at unity power factor the current in the current coils of the relays will lead the voltage by 30 deg. This connection not only overcomes the trouble from distortion, but it allows the relays at all time to operate under a higher power factor. In order to make this connection satisfactory it is necessary to take into account the direction of the rotation of phases.

There are two very simple methods of determining the correct connection. One is to connect the current coils of a single-phase power-factor meter in series with the relay-current circuit and then, with 100 per cent power factor load on the line, select the pair of voltage leads that give about 86 per cent power-factor lead on the meter. The second method is to use a single-phase indicating wattmeter and, with a lagging power factor load on the line, select the pair of voltage leads that give the highest reading. Just after making this test is the proper time to see that the contacts are held open. If they close the voltage leads must be reversed. The foregoing discussion is not based solely upon the mathematical study of the problem, but is the result of actual tests made on a number of systems where the reverse-energy relays connected according to the old method have not given satisfactory service. Experiments have shown that this method of connection should also be used on systems having a grounded neutral. This connection (with the current 30 deg. ahead of the voltage) must be used with care on an ungrounded - neutral system having a heavy charging current to ground. Difficulty may also be encountered on some systems where the load current is leading. But in both these cases the lagging short-circuit currents will be much greater than any possible leading current and no difficulty due to incorrect operation of the reverse-power relays will be experienced if the excess-current elements operate on short-circuits only.

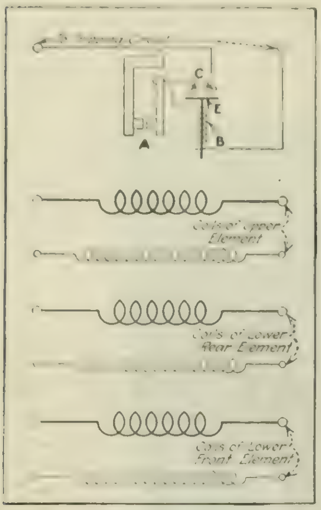


FIG. 9. INTERNAL CIRCUITS OF RELAY, FIG. 7

To insure satisfactory protection on a grounded-neutral system current transformers should be placed in each wire, and it is advisable to do the same on an ungrounded-neutral system. This is because two conductors in different phase of different sections of line are likely to be grounded simultaneously, thus resulting in a short-circuit which involves two lines. For instance, suppose that phase *A* in one section of line becomes grounded and the resulting surge in voltage causes a breakdown in phase *B* in another line. If both of these wires should happen to be without current transformers the short-circuit could not be cleared.

Two voltage transformers connected in open delta are sufficient to operate three reverse-power relays. On high-voltage systems it is sometimes inconvenient to connect voltage transformers on the line side of the power transformers, in which case they may be connected to the low-tension bus, but if the high-tension transformers are connected star-delta then the voltage transformers must be connected the same way to preserve the correct phase relations.

Instead of combining a watt-element and an overload relay in one case and using three combination instruments on each three-phase line some engineers prefer to house the three watt-elements in one case and use this relay in conjunction with two or three overload relays, of either the plunger or the induction type. Such a relay is shown in Figs. 7 and 8, and the internal wiring diagram in Fig. 9.

From Fig. 9 it will be seen that there are three separate current coils and three potential coils, and since the relay operates on the induction principle there is no mutual inductance between coils; consequently, no induced voltage in the potential coil from the heavy current flowing in the series coil. Two discs are used, the upper one of which is driven by one element. The lower disc is driven by two elements, one in the front, shown in Fig. 8, and one in the rear. Under normal direction of power the discs tend to rotate to the right and keep the contacts open. Reversal of power flow causes the discs to rotate to the left, thus closing the contacts; no attempt is made to dampen the movement and the arc of disc travel is very small.

Fluttering trip currents such as might be due to vibration of the disc, bouncing of contacts, etc., are overcome by means of the auxiliary switch at the top of the figure. When the main relay contacts *A* first make contact the solenoid *B* is energized, which quickly forces *E* against contacts *C*, thus relieving the current from switch *A*. Once closed, however, they stay closed until the trip circuit is broken by an auxiliary switch which operates when the circuit breaker opens.

This reverse-power relay must be used in conjunction with a three-phase on three single-phase overload relays, such as the induction type of solenoid-bellows type, to secure proper protection. Each overload relay's coil is connected in series with a current coil of the reverse-power relay. Complete connections for a three-phase circuit are given in Fig. 10. The main three-phase line is protected by a circuit breaker and supplied with three current and three voltage transformers. Each current transformer supplies one current coil in the reverse-power relay and one overload relay. The trip of the reverse-power relay is connected in series with the overload relays and operates the breaker.

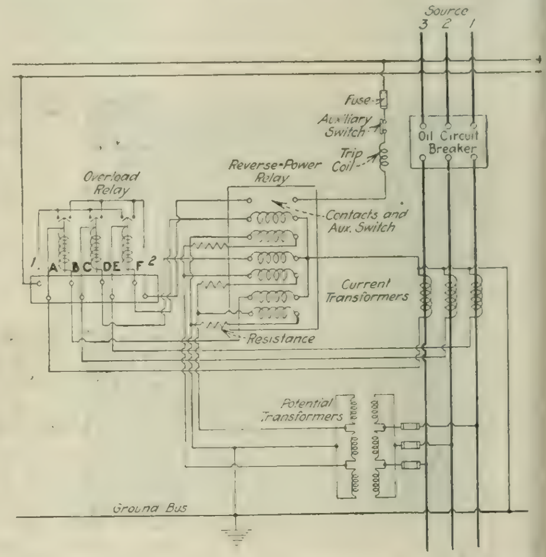


FIG. 10. CONNECTION FOR PROTECTING A THREE-PHASE CIRCUIT WHEN THE RELAY, FIG. 7, IS USED

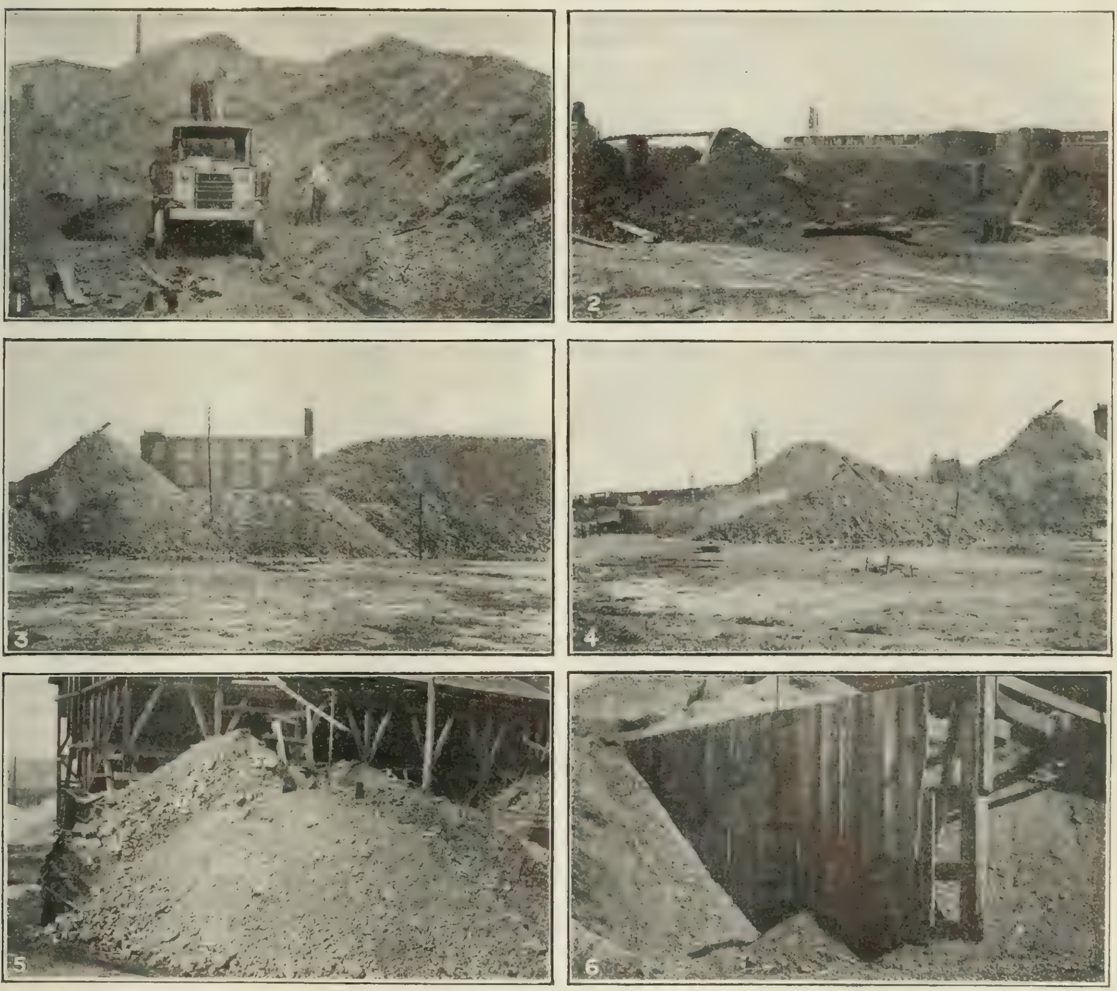
There have been a number of other types of relays developed to operate on reverse power, but in most cases they can be regarded only as a modification of "overload" (excess-current) relays, which, with given conditions of superimposed voltages as regards value and direction, will trip at different values of current. They become practically "current" relays when the voltage drops very low.

The Storage of Coal

The Relation the Method of Piling Coal Bears to the Number of Fires—Data Collected and Here Presented, Shows That Hand Shoveling Reduced the Fire Hazard

By W. D. LANGTRY
President, Commercial Testing and Engineering Company, Chicago

WHEN placing his storage, it would seem that the average consumer of coal thinks only of how to unload it in the cheapest manner possible. He seldom takes into consideration the expense attached to removing a pile of coal should it catch on fire, or using some other means of quenching it. The one thought is to get it on the ground and then trust to luck that spontaneous combustion will not occur.



METHODS OF PILING COAL

Fig. 1—Screenings unloaded by clamshell. Fig. 2—Coal unloaded by wheelbarrows. Fig. 3—Coal unloaded by clamshell. Fig. 4—Coal being removed after firing. Fig. 5—Coal unloaded by conveyor and chute. Fig. 6—Coal unloaded from side-dump cars on a trestle.

Proper piling of coal is probably the greatest factor in reducing spontaneous combustion to a minimum. It may seem to be a little more expensive to pile the coal properly at the start, but the old saying of "an ounce of prevention is worth a pound of cure" applies in this case. The cure at one yard in Chicago was to pick up several thousand tons of coal, haul it a mile to a vacant lot and spread it out to allow it to cool off.

Some interesting data were gathered, and are now being printed by the Illinois Engineering Experiment Station in Bulletin No. 116, on different methods of unloading coal and the number of fires that started. The accompanying table was taken from this source. It indicates that coal shoveled by hand shows the least percentage of fires. The reason for this may be that when the hand method is used, the piles will be small and low. No doubt one of the greatest contributing factors to spontaneous combustion is the segregation of the sizes. No matter what the device is for unloading, it should not have the tendency to separate the fine coal from the large. The finer the coal the more rapid will be the oxidation.

In every one of the accompanying pictures fire started and it could be attributed in each case either to pyramiding of the coal or to the inflammable material around which it was piled. When coal is placed in a conical pile, the finer pieces naturally will be found in the center of the pile, while the larger lumps will be at the outside and toward the bottom. This arrangement gives a free passage of air between the lumps to the finer coal, where spontaneous combustion is most likely to be found. The finer coal obstructs the free passage of the air so that it is not cooled by ventilation, and when the fire once starts, plenty of air comes through the coarser coal to accelerate combustion.

Figs. 3 and 4 give an idea of the height of some of the piles. In the background of the latter view a portable crane and clamshell is at work. In subsequent articles more will be said on proper methods of piling coal.

EFFECT ON SPONTANEOUS COMBUSTION OF METHOD OF PILING COAL

Method	Questionnaire A Total	Questionnaire A Fired	Questionnaire B Total	Questionnaire B Fired
Shoveled by hand	11	5	201	35
Dumped from wagon	1	1		
Wheelbarrow	1		4	2
Dumped from truck			4	
Wheeled scraper	2	2		
Dropped from car			9	3
Crane (locomotive)			13	7
Conveyor			5	4
Dropped from car on trestle	1	1		
Elevator			7	3
Bridge			2	
Hydraulic				
In hopper	1	1		
Not stated			58	21
Clamshell	9	7	..	
Crane	35	17		
Dodge storage system	1	1		
Belt conveyor	3	1		
Elevator	1			
Bridge	2	2		
Raising track on coal	7	3		
Under water	1			
Not stated	2	2		
Totals	78	45	303	75

Two previous articles on coal storage by the same author appeared in the Oct. 5 and Oct. 19 issues of *Power*.

The Oil Situation—The Effect on the Oil-Engine Industry

By E. T. ADAMS

THE production of oil within the United States is now believed to be practically at its maximum. New development may hold our output for a few years at the present figure or even make a small increase, but very soon we must face a constantly diminishing supply of crude oil. At the same time, the production of motor cars, trucks, tractors and oil engines is increasing at a rate never before equaled in our history.

There are those who discount heavily all tales of oil shortage. They point to our reserve of oil-bearing shales; they expect the chemist to make good when the oil prospector fails. But no one denies that demand is now increasing much faster than supply, nor longer ignores the fact that soon there will not be enough oil to go around. This is not a matter of opinion; it is a matter of statistics, available to anyone who has the interest to look them up.

Economy Necessary

Before we abandon ourselves to utter despair it may be well to consider the grounds upon which these predictions are based, and when we do so we at once find a 100 per cent ray of hope. All predictions as to the future of our oil supply are based on three things: The present rate of supply, which we admit to be near its maximum; the present demand, which we admit will increase at a rapid rate; and present methods of use, which are wasteful, extravagant and foolishly short-sighted. By economy we can, in effect, double our present oil supply, and we will speedily practice that economy because rapidly advancing prices of the higher grades of oil and preferential selection in its use will speedily drive us to it.

A statement that half of our oil supply is wasted by the user is a sweeping assertion, difficult to prove, but no one who knows the facts doubts its substantial accuracy. I shall not attempt a proof, but here submit some of the bases for this belief. First, the motor car. In so far as power is concerned, cars are sold on the basis of speed and acceleration. The motor and the carburetor are designed solely on that basis. There is probably no motor salesman who knows the fuel consumption of his motor in terms of fuel per horsepower-hour at any load. It is his business to sell cars, and in order to do so he talks economy and demonstrates speed and acceleration. He boasts openly of speeds double that which are allowed by any law, and he shows you all the acceleration that he can attain. Since it is the demand of the buyer, every car has a motor designed to give speed and acceleration, normally operating with very poor economy because the motor is underloaded and the carburetor is set with a mixture far too rich for economy. Carburetor manufacturers build carburetors to sell to car manufacturers, who, in turn, insist on the speed and the acceleration that you and I demand. When you and I demand economy we will have cars with smaller motors, and carburetors designed for economy. This, even in our present large and therefore wasteful motor, would give an increase of 50 per cent in economy. Such a carburetor would be very different from present types. It would actually put into the cylinder a true vapor or, at worst, a very near approximation to it. Our present-day speed and acceleration carburetors do not by any means put into the cylinder either of these things, as inspection through a glass manifold will speedily show.

The truck and the tractor should use kerosene either in a carburetor which actually vaporizes the oil, or under a boiler, or in a high-compression engine which burns the oil practically with Diesel economy.

We have a merchant marine, designed seemingly by that fond generation who believed that all our natural resources were "boundless" and "inexhaustible," a new but antiquated oil-burning mechant marine which demands three times as much oil per ton-mile as would be required if the oil were burned in modern marine oil engines. When oil was "cheap" and the supply was plentiful, the railroads were cultivated as potential users of large quantities of oil, and today oil-burning locomotives haul freight and passengers parallel to streams that might furnish hydro-electric power, or past mines the waste from which would generate at the mine electric current which would save the oil burned in many locomotives.

ILLUMINATING GAS DEMANDS

Then there is gas oil, a rich oil of about 34 gravity, high in illuminants, supplied to our public utilities; this is a preferential use, ahead of your demand and mine, because the good of the community is of higher importance than the good of the individual. But why do we use gas oil? We use gas oil to enrich gas, to supply illuminants to a gas already high enough in heat value; we furnish gas oil to comply with laws regulating the candlepower of gas sold to communities, and candlepower relates to the illuminating power of gas when burned in an open burner. Very little gas is now burned in an open burner since a mantle-type burner gives far better light and uses much less gas than that consumed by the open burner. Furthermore, electric light has largely supplanted gas light and gas is now chiefly used in stoves. It is a means of heat rather than light, and illuminants have no special value in a heating gas or in a gas burned in a mantle. Our lawmakers are not supposed to know this, but if we could make them know it, it would cost less money to make gas, to the potential benefit of the user. This would at once eliminte another serious waste of oil.

If the reader is not prepared to admit that we use a half and waste a half of our oil supply he must at least admit an astounding waste and therefore be prepared for the changes which wasteful use is bringing about; for it is no longer entirely a matter of price, although the price naturally will be higher. It is a question of preferential use, a question as to who shall have oil and who shall do without. Preferential use of oil has been with us for a long time; it began years ago, when the familiar red 28-gravity "fuel oil" disappeared from the Eastern market. One recalls the consternation and despair with which one received the announcement that "fuel oil" would no longer be supplied, yet today the gas producer has entirely supplanted the fuel-oil tank, and this fuel oil is now converted into a large percentage of gas and a small percentage of heavy residuum.

FUTURE GRADES OF FUEL

This is the new condition that now confronts us. The majority of the old familiar grades are no longer on the market, but by modern processes are being converted into four products—gasoline, kerosene, a heavy Diesel oil and an extremely heavy residuum which can be burned under a boiler only by the use of special appliances. Of these products two may be further broken down to furnish gasoline and a heavy residuum—kerosene which furnishes a large percentage of gasoline and a small percentage of residuum, and Diesel oil, which is already largely residuum and, when "cracked," furnishes but a small amount of gas. Because of the lamp trade and the stove trade, and because of a system of tankage of unappreciated magnitude, wonderful even in this day of wonders—because of these things, kerosene will be a permanent product, as will be the heavy residual oils. We may therefore safely adjust our lives and our industries to the four oils—gasoline, kerosene, Diesel oil and residuum; these are the oils from which presently we shall be compelled to choose. Of the others—gas oils, distillates, engine oils of 26, 28 and 24 gravity, and the surplus stocks of kerosene—all are passing, and higher prices will come, especially for the lighter oils.

We may expect that the motor car and the truck will react to this condition but slowly; each has its special problems, aside from mere economy in the use of oil. But the tractor manufacturer has no excuse to offer; a tractor must operate long hours at full power, its operating cost is a tax on a nation's bread. The tractor engine should get entirely away from the carburetor; it should use higher compression and give an approach to Diesel economy. Such an engine is as simple to manufacture as a gasoline engine of the carburetor type. Here at least is an economy that is near at hand.

NEW ENGINE DESIGN

The most sweeping result of these new oil conditions is the effect to be expected on the engines designed to use the intermediate grades of oil, such as distillate, gas oil and 28-gravity fuel oil. "Semi-Diesel engines" one might call them from the frequency with which the term appears in their literature. All these will change, the smaller engines to kerosene burners and the larger engines to the high-compression type, not necessarily to the full Diesel with air injection, but changed to an engine that will burn any oil that a full Diesel will burn, to an engine which will produce a brake horsepower from one-half pound of Diesel oil and which is simple, solid and easily operated and cared for. This is the small-power type of the immediate future, and nowhere is oil economy more closely associated with the cost of our daily bread, nowhere an economy more important. There are thousands of acres of lands not accessible to gravity water and beyond the reach of electric power, which are dependent on the use of an economical oil-engine operated pump to keep them in intensive cultivation. To these farmers, to the manufacturer, and the multitudinous user of small power this newer type of oil-burning motor is a momentous advance. I do not know by what name motors of this type will be called, but I believe that they will be called Diesel engines. They will lack the panoply which we have come to associate with the name Diesel—there will be no air injection. The type will be simple, dustproof and foolproof; they will burn Diesel oils, on approximately the Diesel cycle, and will give approximately Diesel economy. They will be in truth highly simplified Diesel engines of moderate power.

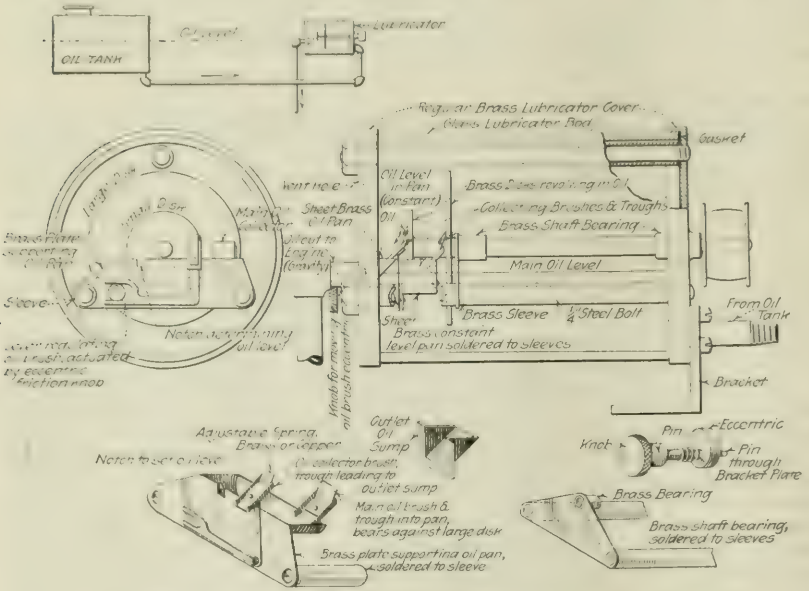
We have reached the peak of our oil production through a period of reckless waste by user and by manufacturer. From now on we will conserve our diminishing stock of natural oils by the use of motors of the most economical type and by refusal to supply oils for unnecessary use. The next generation will approach our untouched shales with appreciation of their value and economy in their use, and they will recall with proper horror the criminal waste and foolish extravagance that characterized the attitute of us, their fathers, toward the oil supply which was our heritage.

Mechanically Driven Gravity-Feed Lubricator

By H. H. Parker

If an engine or machine bearing is to be supplied with oil by gravity feed, it is in some cases an advantage to have the oil fed into the lubricator pipe by positive mechanical means, so that when the machine stops the oil will also stop feeding (the lubricator being driven from the machine itself) without the operator having to shut down and open it up; furthermore, as the machine slows down or speeds up, the oil supply will be correspondingly affected.

The illustration shows a lubricator of this type that can be built from an old glass-body gravity-feed oiler with but little machine work, the construction being chiefly drilling, cutting, bending and soldering sheet brass. It has the advantage that, owing to the glass body, everything is always in plain sight. The lubricator body is turned on its side and a shaft fitted into one end. Usually, the regular brass heads may be used by cutting away the central column and plugging and soldering up openings and cutting new ones where required. Instead of the usual center support for the heads, three small steel through bolts are used with brass spacing sleeves slipped over them to which the various parts are soldered.


OIL TANK
Oil Level
Lubricator
Regular Brass Lubricator Cover
Glass Lubricator Body
Gasket
Oil Level in Pan (Constant)
Oil
Brass Disc revolving in Oil
Collecting Brushes & Troughs
Brass Shaft Bearing
Main Oil Level
Brass Sleeve
¼" Steel Bolt
Sheet Brass constant level pan soldered to sleeves
From Oil Tank
Bracket
Large Disc
Small Disc
Main Collector
Sheet Brass Oil Pan
Outlet to Engine (Gravity)
Brass Plate supporting Oil Pan
Sleeve
Notch determining oil level
Lever regulating oil brush, actuated by eccentric friction knob
Knob for moving oil brush eccentric
Adjustable Spring, Brass or Copper
Notch to set oil level
Outlet Oil Sump
Oil collector brush, trough leading to outlet sump
Main oil brush & trough into pan, bears against large disk
Brass plate supporting oil pan, soldered to sleeve
Pin
Eccentric
Knob
Pin through Bracket Plate
Brass Bearing
Brass shaft bearing, soldered to sleeves

GRAVITY-FEED LUBRICATOR MECHANICALLY DRIVEN

As the shaft is under no working strain, it can be of small diameter, and two brass discs are soldered to it, one as large as will swing inside of the sleeves and the other smaller. These discs must run as true as possible on the shaft. The outer shaft bearing is soldered or screwed into one of the lubricator heads, while the other is soldered to a sheet-brass support plate, which in turn is held to two of the sleeves.

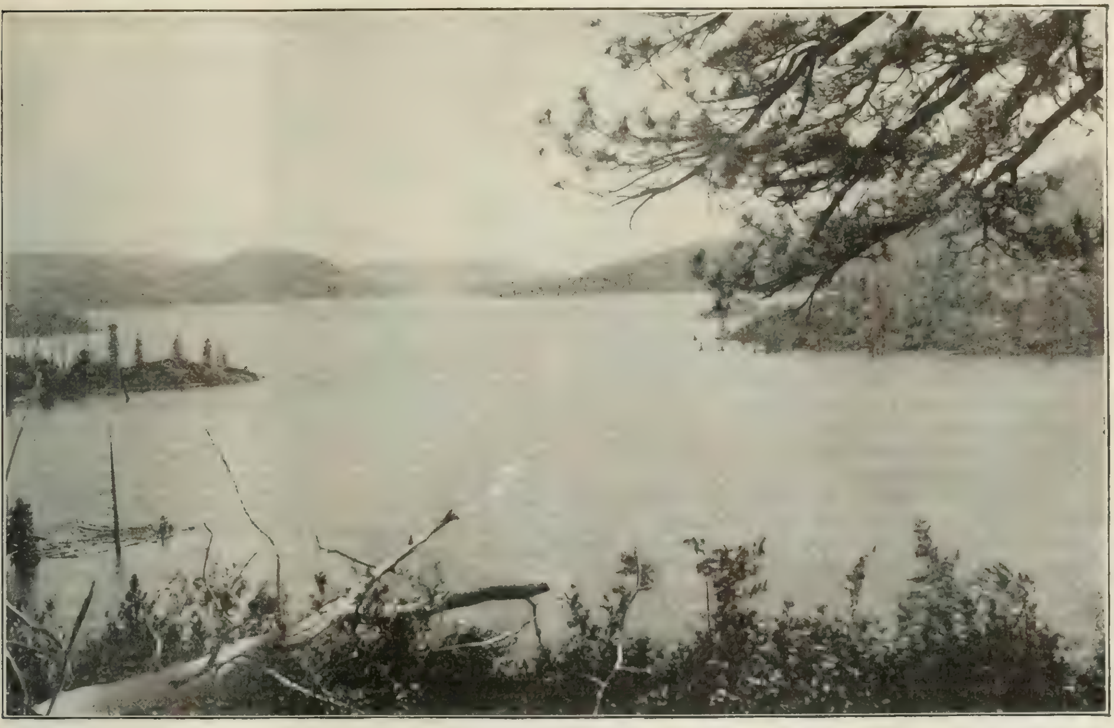
Near one end of the lubricator body, opposite the drive-pulley end, is attached a sheet-brass oil pan into which the small disc will dip; the top of this pan reaches nearly to the shaft, though the depth of oil in it is regulated by a notch cut in the side, should this prove necessary. A sheet-brass triangular-shaped oil sump is riveted and soldered to the inside of the head next to the oil pan; a brass pipe screwed into the head leads into the sump pan and furnishes an outlet for the oil running to the bearings to be lubricated. Another pipe from the oil tank, if one is used, forms the oil inlet. Two spring brass or copper brushes bear against the revolving discs and scrape off the oil; small troughs bent around the collector brushes guide the oil into the pans. The brush bearing against the smaller disc should be the narrower.

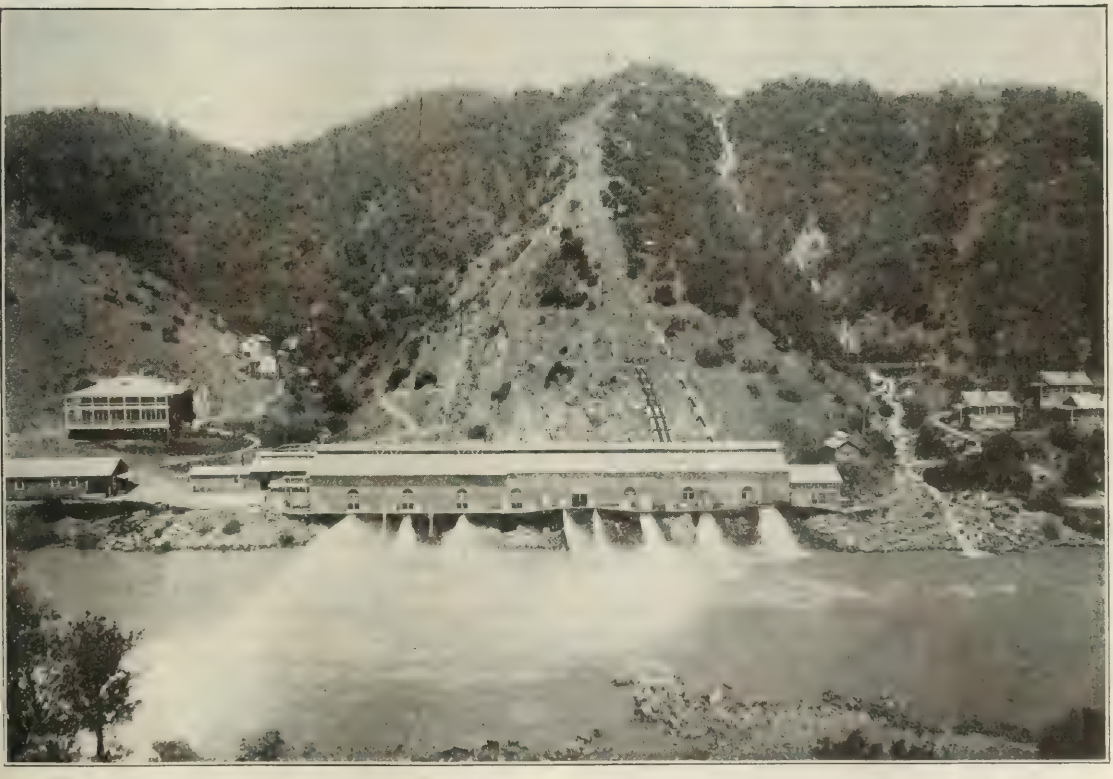
In operation the lower part of the lubricator body is filled with oil, preferably from a large separate tank whose oil level will be the same as the level of that in the lubricator. The large revolving disc carries the oil around until it is scraped off by the collector brush and runs into the constant-level oil pan (the oil level in the lubricator will not stay constant), from which a smaller quantity is taken off the other disc and led into the sump and thence by gravity to the bearings. The amount of oil finally delivered is determined by the level in the pan, the size and speed of the disc, the width of the collector brush and the position of this brush on the face of the disc. This latter may be changed during operation by a sheet-brass bell-crank lever and an eccentric actuated by a milled knob on the lubricator head, which will shift the brush back and forth over the face of the small disc, and thus regulate the amount of oil delivered. The excess which runs into the constant-level pan overflows and joins the main oil supply in the bottom. The speed of the shaft must be slow enough so that the oil will not be thrown from the edges of the discs; this, as well as the proper dimensions of the discs, height of oil level, etc., is best found by trial.

A bracket screwed to one or both heads secures the lubricator to the engine or machine frame, from the shaft of which it is driven by flat or round belt, chain, gears or even a ratchet wheel. No dimensions have been given, as these would depend entirely upon the size of lubricator used and the amount of oil feed desired. The separate oil tank may be placed at a point distant from the lubricator, but at the same level, and piped to it; without the tank the lubricator would require frequent refilling unless but a small amount of oil was required.

Upon taking charge of a new plant, do not begin making promiscuous adjustments. It is better to wait until the equipment is thoroughly understood. Neither does it pay to criticize the departing engineer until you fully understand the plant's condition.

Two Views of the Pacific Gas and Electric Company's Properties, San Francisco, Cal.





TOP: LAKE SPALDING: A 275-FT. DAM CLOSES A NARROW GAP AT FAR END OF THE LAKE USED FOR WATER STORAGE. BOTTOM: COLGATE POWER HOUSE ON YUBA RIVER, 20,000 HP. CAPACITY

Operation and Adjustment of Turbine Machinery X—Lubrication Troubles

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Md.

OIL troubles may be classified under two headings: First, those caused by the mechanical condition of the machine which results in overheating or vibration; second, those due to composition of the oil itself and its behavior in the machine. Fortunately, mechanical troubles, while few in number, arise from a variety of causes and are diagnosed by different characteristics.

MECHANICAL OIL TROUBLES

1. Vibration in starting; no heating. Cause: Low oil pressure, generally caused by the strainer being stopped up; sometimes caused by trouble with the oil relief valve or pipe stoppage. This is seldom experienced in small machines.

2. Vibration in starting up, heating at one bearing. Causes: Bearing too small for the shaft; high spots in the liner; lack of proper clearance in the thrust bearing; misplaced shim or other element of the thrust bearing; rubbing between moving and stationary elements at point of heating.

3. Vibration appearing suddenly with hot bearing while machine is in normal operation. This is caused by failure of the oil supply, such as a break in the pump, stoppage in the oil system, and improper assembling of the liner so that oil holes or grooves do not properly function.

4. Vibration occurring with heavy loads. Sometimes slight heating of one or more bearings. Vibration disappears when load is removed. This is caused by bad alignment of the bearing pillow blocks or bearings bored out of true.

5. Vibration occurring when machine has reached a good hot running temperature and especially in changing over from condensing to non-condensing. Sometimes slight heating in one bearing. Cause: Self-aligning bearing having too tight a fit, so that it does not change its position when expansion changes the position of the shaft.

6. Continual vibration noticed in one bearing, principally with a slight pounding noise. This may be due to a self-aligning bearing fitted too closely in its ball seat.

7. Heating of bearing without vibration in starting or running. Causes: Liner too tight for the shaft; high spots in the bearing; thrust-bearing troubles as mentioned in No. 2; failure of the oil supply.

8. Slight heating of one bearing. No vibration. This is caused sometimes by extra weight due to being lined too high.

9. Failure of the oil supply. Causes: Strainer becoming stopped; water finding its way into the oil system; stoppage in piping; excessive clearance in the pump; bad oil leak in the system; lack of oil.

10. Oil leaks. Causes: Pipe joints; vibration of piping; strains in piping due to improper support or alignment; porous metal.

11. Oil throwing. Caused in general by air currents carrying minute particles of oil from the bearings or from leakage oil.

The following information was prepared for the author by Robert J. Stringer, chief of sales and engineering, Pittsburgh Oil Refining Corporation, Baltimore, Md.

SYSTEM OF LUBRICATION

Steam turbines employ two systems—Circulation oil, and ring-oiled bearings.

Large steam turbines have a pressure or gravity oil feed, where the oil is circulated through bearings, drains into the sump and is returned by a pump which again delivers oil to the bearings directly or through a gravity head tank. Only the largest installations are equipped with an elevated oil gravity tank. Inasmuch as the oil usually passes from an oil cooler direct to the distributing pipes, it is necessary to provide a spring-loaded relief valve in the delivery pipe near the bottom pipe to maintain a correct oil supply at a proper and steady pressure.

It is good practice to install sight feeds in the return oil pipes by means of which the flow of oil from each bearing may be observed. Test cocks are often fitted to the top of the bearing housing, which, if opened, show the flow of oil reaching the bearings. Both the elevated oil gravity tank and the bottom tank (sump) are equipped with drain cocks to permit draining off sludge and water should these collect.

The oil pressure for bearings varies from 3 lb. to 35 lb. per sq.in. In cases, however, where oil is used to operate the governor gear it may be introduced under a pressure from 25 lb. to 80 lb. per square inch.

TWO OIL PUMPS ARE SOMETIMES USED

Two pumps are occasionally used in the oil-circulation system—one for bearing lubrication and one for supplying oil under high pressure to the governor. In a direct-pressure feed system one pump only is used, and this pump must deliver all the oil at a pressure sufficiently high to work the governor.

When starting up turbines not equipped with overhead tanks, the oil supplied to the bearings is not sufficient until the turbine is running at about 25 per cent normal speed. Therefore it is necessary when starting up a small turbine, to feed the bearings by hand pump. Large turbines are supplied by means of auxiliary steam-driven or electrically driven pumps for this purpose. As soon as the turbine reaches normal speed the auxiliary oil supply should be discontinued, as the pump operated by the turbine will now supply the right amount.

Small steam turbines are lubricated by means of ring-oiled bearings—a metallic ring suspended on a shaft and partly submerged in an oil reservoir within the bearing housing. As the shaft revolves, the ring automatically carries oil to the top of the shaft, where it is distributed over the bearing surface. Many turbine bearings have two or sometimes three metallic rings.

Water, unfortunately, does find its way occasionally into the oil system through steam leakage of the gland packings and from water leakage of the oil-cooling apparatus. If a large quantity of water works into the oiling system, it is usually due to leakage of water from the cooling apparatus. A large accumulation of water is harmful, and steps should be taken immediately to drain off the water. If the conditions of leakage cannot be corrected, a water trap should be installed in the bottom tank or sump. Excessive water circulating with the oil will, by this means, enter the trap, from which it can be easily drained off.

Water in a circulating system is objectionable. It is therefore considered good practice to remove a certain quantity of oil from the bottom tank each day. Three to six gallons should be withdrawn daily in large turbine installations and put through a steam separator and filtered. An amount of oil should be added equal to the quantity withdrawn, plus any necessary "makeup" oil required.

Large oil-circulation systems are an important factor in correct lubrication as they afford time for the impurities to settle from the oil. If only a small quantity of oil is in the oil system, circulation is too fast and the impurities have not time to separate readily from the oil.

A dual, or double, oiling system is ideal. By such a system the life of the oil is maintained almost indefinitely.

BROKEN-DOWN OIL

Broken-down oil is the result of the steady circulation plus the action of heat, air and moisture. An analysis of broken-down oil will generally reveal an increase in viscosity and gravity, sludgy deposits and strong acidity.

The life of an oil is dependent upon its quality and suitability. Incorrect oils will not stand up for any considerable time, and their breakdown is sure, quick and complete. A drawn-off sample of broken-down oil shows that it contains three distinct substances. The top section represents clear oil, the next layer is a slimy mixture composed of sludge, and the bottom is discolored water. Broken-down oil in the middle of the three sections may be due to inferior oil or to an electrical or mechanical action upon the oil.

Broken-down oil always accumulates in the most dangerous places—the oil pipes which lead the oil from the distributing pipes to the bearings. This sludge accumulation frequently results in a partial blocking of the pipes, sometimes retarding the flow of the oil. Broken-down oil also clings to the coils in the oil-cooling apparatus, thereby lowering the cooler efficiency, resulting in a rise in the temperature of the oil, which in time will unduly shorten the life of the oil.

The amount of makeup oil to be added to a system on account of leakage and evaporation varies with the type, size and speed of the turbine, and the capacity of the oil system.

STARTING A NEW TURBINE

When starting a new turbine the oil should be strained before it is put into the system and care should be taken to allow no dirt or other impurities to enter. The original charge of oil should be removed after a run of two or three weeks, to allow any dirt, sand, waste, packing, etc., which do at times get into a new circulating system, to settle. If the original charge of oil, when removed for settling, is badly contaminated it should be heated and then put through a good filter.

The oil temperatures in circulation systems rise gradually until they become constant. In large turbines the constant is reached in approximately twenty-four hours' continuous work and in small turbines in four hours' continuous running.

If the oil cooler is correctly designed it will absorb most of the heat in the oil. The governing factors on the temperatures of the oil are the temperature of the cooling water and the size and capacity of the coils in the oil cooler. Generally, the larger the coil surface the lower the temperature of the oil.

To avoid danger of leakage of water into oil, the oil should pass through the cooling apparatus at a pressure greater than that of cooling water.

The temperature of the oil as it leaves the bearings should not be over 130 to 175 deg. F. Thermometers should be installed in all return oil pipes, and if the temperature on any main bearing exceeds 175 deg. F. immediate steps should be taken to ascertain the cause. Most efficient operating temperatures should be about 130 to 140 deg. F.

The following temperature readings should be taken and recorded hourly in the engineer's log book: (1) Temperature of oil as it leaves each main bearing; (2) temperature of oil before it enters the cooler; (3) temperature of the oil after it leaves the cooler; (4) temperature of cooling water before it enters the oil cooler; (5) temperature of the cooling water after it leaves the oil cooler.

OIL VAPORS AND DEPOSITS

Oil vapors occasionally are drawn from the bearings and oil tanks into the electric generators, even under normal temperatures. These vapors are caused by the rapid circulation of the oil, in conjunction with air-producing small "oil-air" bubbles. These bubbles, when bursting, produce the oil vapors. If the return pipes are not large enough to carry off the oil, it foams and produces more vapors. A vent pipe may, in some instances, be fitted into the oil reservoir to carry off this excessive vapor and foam. It is of vital importance that the oil pipes be kept free from air as far as it is practically possible.

Deposits are the results of the following effects or causes: (1) Water; (2) air and heat; (3) solid impurities; (4) electric action; (5) adding excessive amount of new oil to old oil.

Water: Large quantities of water, when in violent agitation with oil in circulation, will form an emulsion. If a great quantity of water leaks into the oil system the mixture becomes brownish yellow in color. If a sample is heated and allowed to settle, it will evaporate into three distinct substances (see paragraph on broken-down oil). The layer of oil in such cases will be darker than when originally placed in the oil system and will tend toward manifesting a strong odor. Its viscosity will be higher and it will contain a small percentage of mineral acid, due to the breaking down of the oil from oxidization. The mineral acids do not affect materially the metals used in turbines, but they will in time slightly dissolve zinc or alloys composed largely of zinc. The sludge produced by the water will clog the oil strainers, oil pipes to the bearings and the oil inlet to the governor.

Air and Heat: Air in small quantities is always present in a circulating system, and if the oil temperature is above normal the air tends to oxidize the oil. If oxidation takes place the oil becomes much darker and a black carbon deposit will choke up the oil pipes to the bearings and may stop the governor gear.

Solid Impurities: Solid impurities such as iron oxides, dirt and dust, when oxidized by the high temperature of the oil in circulation, will darken the color of the oil, increase the viscosity, produce mineral acids and broken-down oil. The oil will smell burnt and will deposit a slime on the cooler coils. Oil tanks should be kept clean, free from dirt and rust and never painted with non-oilproof paints, as the oil will in time decompose the paint and oxidation will result.

Electric Action: Electric currents sometimes leak along the bearings from both alternating- and direct-current generators and act injuriously on the oil. The effects of electrical action are an increase in the intensity of dark color of the oil, high percentage of acidity, and a deposit which sticks to all parts of the lubricating system, particularly the oil cooler. The deposit is dark, hard, brittle and difficult to remove. It is good practice to insulate one of the generator main bearings from the turbine bedplate, thereby preventing the passage of electric currents and the resultant deposits.

Adding New Oil: If little or no water is finding its way into the circulating system, and if the leakage of oil is so small that little or no oil is added every week, the oil will in time turn very dark and become quite acid. In such cases, particularly if ordinary non-homogeneous oils are in use, the action of new oil on the old produces a dark deposit.

Correct lubrication means the *right* oil, the *right* flow, applied in the *right* way at the *right* time. By this means turbine oil will operate at least 12,000 working hours, and in an oil-circulation system and under abnormally hard operating conditions for 3,000 working hours. Turbine oil, when used in ring-oiled bearings, should be drained from the housing and recharged with new oil every six months.

Hints for the Engineer

High-grade turbine oils, refined from selected crudes, are the correct lubricants for turbine lubrication because they are more immune from heat, water, air and impurities than asphaltum-base oils; furthermore, they will separate quickly from all impurities, absorb the heat in the bearings and thereby keep operating temperature of bearings normal.

When starting a new turbine, oil should always be strained before placing it into a lubrication system. Remove and strain the oil after not more than three weeks' operation and replace it where it is not practicable to install a new charge.

The amount of makeup oil to be added depends on the size and capacity of the system as well as the quality and suitability of the oil in use. If the system is free from leaks, the amount of makeup needed will be small. It is good practice to add a little oil every day rather than a large quantity once a week.

The writer has not here attempted descriptions of the oil filtration systems so largely used with steam turbines.

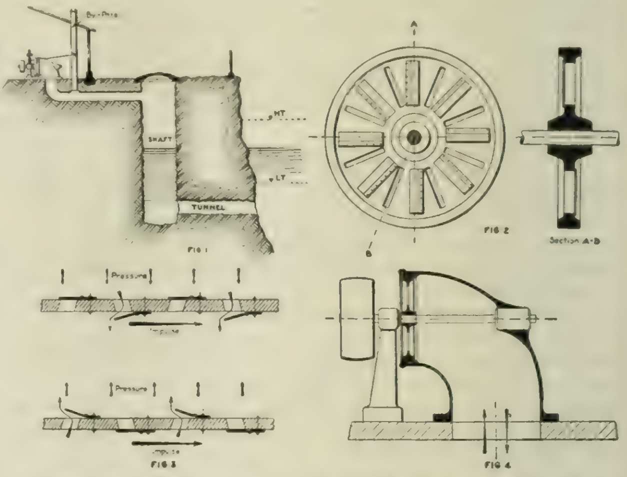
Babbitt metal should not be reused since every time the babbitt is melted some of the tin and antimony are burned out.

Wave-Motion Turbine

By Arthur Palme

The practically never-ceasing wave motions of oceans are responsible for the legion of mechanical devices intended for their utilization. As far as known to the writer, most of these contrivances are based on the same principle, namely, a body of wood or hollow-metal floats upon the surface of the water, is made, therefore, to go up and down with the waves, and by some device the reciprocating motion is either used directly to pump water or to compress air, or is transformed into rotatory motion by ratchets, etc. All these constructions have inherently four main faults, which either make their function not satisfactory at all or permit of only a short usage.

The first disadvantage is caused by the fact that next to wave motion every ocean has a more or less pronounced tide. It is therefore necessary to so arrange and regulate the floats that their proper action is not interfered with by the tides. If this has to be done by hand, constant supervision is required.



FIGS. 1 TO 4. ASSEMBLY AND PARTS OF WAVE-MOTION TURBINE

The destructive chemical action of sea water to all metal that comes in direct touch with it and all machinery that is exposed to sea atmosphere constitutes the second disadavantage.

Seaweed floating on or near the surface of the water interferes frequently with any mechanical apparatus that may be floating in the water and represents the third disadvantage.

The fourth, and probably the greatest enemy of all known "wave-machines," are storms, with their almost unlimited energy.

Ten years ago I was delegated to investigate the possibilities of a new wave-motion turbine, the principle of which is so radically different from all previous designs that a short account of the device will be of interest. The inventor, is Bouchaux-Praceique, of Royan, France, near Bordeaux. All the light and power used in his house was generated with this wave-motion machine. It is not the purpose of this article to reflect upon the possibilities of this scheme on a larger scale. The fact is that a turbine of this kind, coupled to a one-kilowatt direct-current generator ran during practically all the time I was investigating the plant (one week). Short periods of rest were easily taken care of by a small storage battery.

A rocky part of the sea shore is essential for the location of this scheme (see Fig. 1). The lowest level of the tide *LT*, is determined, and some 10 ft. below this level a horizontal tunnel is driven. At a suitable distance inshore a vertical shaft is sunk to meet this tunnel. It is obvious that the water within the shaft, communicating with the sea, will duplicate all motions of the sea-water level, so that the waves will cause an alternate rising and falling of the water level within the shaft.

The top of the shaft is closed up by masonry work or a dome of cement, and a pressure pipe is carried from the top of the shaft to the turbine location. This pipe should be located high enough above the high-tide, *HT*, level to prevent water ever entering it. The turbine is a low-pressure unit of special design, the runner of which may be horizontal or vertical. The runner consists of a disc flywheel, Fig. 2, with a number of obliquely arranged radial openings. All the even openings are closed upon one side and all the odd openings on the other side of the wheel. Closing these openings are long, narrow strips somewhat wider than the former, made so that they will open along a radius of the wheel as axis-like vents. Metal-lined leather, held down with springs, has been used by the inventor.

By referring to Fig. 3 it will be seen that if there is a positive pressure applied against the wheel, the inner vents will all be closed and all the outer vents will open to permit the escape of the pressure. A reaction will take place, giving the wheel an impulse in the direction indicated. If negative pressure is applied, the outer vents will close, the inner vents will open with a resulting reaction impulse in the same direction as before.

In case of a wheel on a horizontal shaft this runner is mounted at the mouth of a 90-deg. tube, as shown in Fig. 4. Sufficient rim weight is used on the wheel to obtain the necessary flywheel effect to overcome the periods of diminishing pressure, reversal and starting suction.

MEANS OF REGULATING VOLTAGE

Regulation of generator voltage may be obtained, either by employing a type as used on Pullman cars, where the voltage is practically constant within a considerable range of speed, or else mechanically. The machine in question had a small centrifugal governor operating an air bypass in the connection between the surge well and the turbine. While this special turbine will no doubt have a very low mechanical efficiency, it might be possible to develop along similar lines a type of better characteristics. The inventor had a storage battery floating on the mains all the time, to tide the set over occasional idleness.

This idea represents a decidedly novel way to utilize the energy of sea-wave motion. It is independent and unaffected by tides. No wooden or metallic parts are exposed to sea water and liable to corrode. Seaweeds floating on the surface of the water cannot affect any mechanical part or clog the tunnel. Storm and surf of the most violent nature find nothing but nature's rocks to beat against. As a matter of fact, the more violent the waves the more power may be obtained from the turbine.

Thor Moisture Separator for Air Lines

The Independent Pneumatic Tool Co., 600 West Jackson Blvd., Chicago, builds the Thor moisture separator shown in the illustration for separating and cleaning the moisture and dirt out of compressed air. It fills a want that is appreciated by every user of pneumatic tools who has experienced difficulty due to water and dirt causing the pistons and valves to stick.

The air enters the separator through two separate pipes and strikes the inside wall or casing of the separator tangentially, causing the air to revolve rapidly, and the centrifugal force throws the moisture and dirt to the walls, from which they drain off and fall to the bottom, while the cleaned air passes on to the pipe line. A drain at the base of the separator is provided for removing the accumulations of water and dirt. The separator is built in two sizes of 150 and 400 cu.ft. capacity per minute. It is equipped with a pressure gage having a face 3 in. in diameter. The height of the separator is, including the gage, 31 and 47 in. respectively. The diameter of the base is $8\frac{1}{2}$ and $12\frac{1}{2}$ in. according to the size of the machine.

THOR AIR-MOISTURE SEPARATOR

Suspension of the service order giving priority to coal for Lake shipment seems imminent. The saturation point appears to have been reached in the Northwest. There is great congestion of coal in lower Lake ports, with little market in evidence in the Northwest. A potent factor in the situation was the transfer by the Northwestern railroads of 3,000,000 tons of coal from the Lake territory to Illinois. Apparently, considerable numbers of industrial orders have been placed in Illinois at better prices than could be obtained at the lower Lake pools. The National Committee on Gas and Electric Service is being flooded with requests from public utilities for relief. Most of the requests, however, are for assigned cars. George W. Elliott, the secretary of the National Committee on Gas and Electric Service, is advising all public utilities that an emergency must be clearly established before any type of relief is extended and assigned cars are to be granted only when all other means of securing coal for the utility have failed. Mr. Elliott points out that the Interstate Commerce Commission feel that it is incumbent on the public utilities to secure their coal supply by regular commercial methods.

Throwing water on burning oil merely spreads the flames. Sawdust or sand, if liberally sprinkled over the oil, will subdue the flames.

Refrigeration Study Course—XVI Ammonia Pipe Calculations

By H. J. MACINTIRE
Professor of Refrigeration, University of Illinois, Urbana, Ill.

ALL steam engineers understand the importance of proper pipe sizes and connections. With steam it is necessary to prevent excessive pressure drop as well as to keep the headers and pipes drained and free from the possibility of water hammer. The pressure drop from the boiler to the engine or turbine results in some loss of efficiency and power. On the condenser side it means the same thing to a much greater degree.

In refrigeration the same general conditions are true, especially as applied to the suction line. The ideal condition is to have the same cylinder suction pressure (the actual pressure during the suction stroke) as the pressure of evaporation in the refrigerating (expansion) coils. This condition is an impossibility because there must be a pressure drop to make the gas flow along the pipe, just as water will flow only when there is a head to cause the flow. This drop of pressure is increased when the connection between the compressor and the expansion coils is increased, when the pipe is decreased in diameter or when fittings, valves, ports and passages offer resistances and cause whirlpool and eddy currents in the gas as it passes along the pipe or passage.

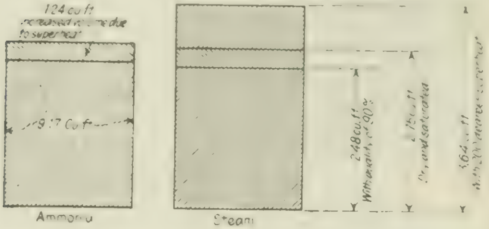


FIG. 1. SHOWING EFFECT OF QUALITY ON VOLUME OF A GAS

The bad effect of excess head pressure, due to resistances to flow of the compressed gas into the condensers, and of wiredrawing of the suction gas have already been given considerable attention in this study course. The first is reacted directly in the power required to drive the compressor, but the second causes a loss of capacity of the compressor and an increase in the power required. Pressure drop in the suction line is a serious matter and cannot be tolerated. Where the pipe connections in the suction line are short, this loss is not serious as a rule, but frequently, in packing-house, cold-storage and other plants, the return gas has a long way to travel and the velocity must be kept low to prevent excessive losses. But before going into the design of ammonia lines, a few other considerations will be in order.

Fig. 1 shows the effect of the quality on the specific volume; that is, the volume of one pound of the substance. For example, the volume of one pound of ammonia at zero degrees F. boiling temperature is 9.17 cu.ft. for dry and saturated ammonia and 10.41 cu.ft. for superheated ammonia with 50 deg. F. superheat. Therefore there will be an increase of 13½ per cent in volume by being careless in the use of the expansion valve and thereby permitting the gas to return to the compressor headers in a very hot condition. Usually, we try to bring the frost back to the headers, because this gives an outward sign of the condition on the inside of the pipe. But if the volume of the gas may be reduced by eliminating superheat in the suction headers, why not go a step farther and decrease the volume a little more?

Wet compression, the result of bringing wet ammonia into the compressor, has few advocates at present. The same liquid ammonia is believed to give much better results by being allowed to perform its proper function of providing refrigeration in the cooling coils. It seems a roundabout method of cooling the gas on the compression stroke by spraying liquid into the cylinder. Of course the temperature of the gas discharging from the cylinder is reduced, but at the expense of liquid suitable for cooling effect in the expansion coils. The important thing for us all is, What do we get in useful refrigeration per horsepower or per kilowatt input? Most American engineers believe that we get the most economical operation with gas returned to the suction headers in a dry and saturated condition. The use of liquid injection to the cylinders also does not lend itself to easy control without constant care. This brings to mind certain troubles encountered in the expansion coils.

Expansion Coils May Feed at Top or Bottom

The expansion coils may be designed for feeding at the top or at the bottom. With the expansion valve at the top it is believed that there is less danger from slugs of liquid returning to the compressor. The reason for this is that, as the liquid cannot collect appreciably in the coils, the feed cannot well be of the wrong amount without this being noticeable by lack of frost or by too much frost.[1] About the only chance for slugs of liquid is where the pipe allows pockets from which the liquid might be picked up by the return gas. And yet, judging from steam-engine practice, such slugs of liquid are usual only when a great sudden demand for gas or steam due to a change of load causes an appreciable increase in the vapor velocity.

On the other hand, the liquid feed at the bottom of the coils allows them to be operated flooded with better heat transference. Being flooded, the coils may fill completely with liquid (as is frequent if the suction pressure is not low enough for the temperature carried in the surrounding medium) and "lost" or "dead" ammonia results. In addition the liquid is likely to slop over and cause liquid hammer or worse in the compressor. In consequence it is wise to use a large liquid separator in the suction line when feeding at the bottom.

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[1] The presence of frost on the suction bends means that a cold gas is being returned to the machine, with a temperature of 2 deg. F., or lower. Lack of frost means that the ammonia has too great a temperature to hold frost on the pipe or to freeze moisture on the pipe.

In the refrigerating system we have the following pipe calculations:

First, the connections from the compressor to the condenser to convey the superheated gas at a pressure corresponding to the condenser. This may vary from 100 to 215 lb. gage, depending on the temperature and the amount of water used on the condenser.

Second, the liquid line connecting the liquid receiver with the expansion valves.

Third, the suction return from the expansion coils to the compressor lines.

Fourth, the amount of linear feet of piping to be used in the ammonia expansion system.

THE SUCTION AND THE DISCHARGE LINE

The discharge line should be given careful attention. It is true that the amount of pressure indicated by the pressure gage on the condenser is determined by the condenser itself and the amount and temperature of the water showered over the condenser. In other words, the condenser pressure is dependent on the so-called vapor tension of the condensed (liquid) ammonia, but this is not the pressure against which the compressor is pumping. The reason for this is because the compressed gas is made to pass through the ports and valves of the compressor head, then through the discharge bends, past many valves and fittings and perhaps through a long pipe connection (frequently from the basement to the roof) before reaching the condenser and the cooling water. The compressor has the same practical condition as exists in the case of a water pump which discharges into a tank situated at some elevated position. The pump has to work against the static head plus the resistances, which vary directly as the length and inversely as the inner diameter and increased by the kind and number of fittings used. Likewise, the steam engineer who desires a pressure of 175 lb. at the throttle notes that whereas the boiler pressure may be only slightly more than 175 lb. at light loads, yet frequently at full loads or overloads the boiler pressure has to be considerable in excess of 175 pounds.

In like manner the suction pressure is maintained at a certain amount in the refrigerating coils. This pressure has to be a certain amount if refrigeration is to be obtained at a particular temperature. These temperatures are prescribed for each case by the kind of refrigerating work being performed and may vary from 40 deg. F. to minus 10 deg. F. or lower, whereas the boiling temperature of the ammonia has to be 10 or 15 deg. lower still. This suction pressure is maintained by means of the compressor, which "pumps" from the expansion line per minute as great a weight of ammonia as is evaporated every minute. The effective piston displacement is equal to the weight of ammonia evaporated times the volume of one pound of ammonia at the suction pressure.

But naturally, the pressure in the inside of the compressor must be less than that in the suction bends, and these have to be less than the pressure in the expansion coils, for otherwise the gas would not flow in the proper direction. The case is somewhat similar to the condition of a flowing brook. If the water flows, then there is a difference of level. It requires some difference in level (or pressure) to maintain a flow of any fluid against the skin or other resistances of the pipe, duct or channel. Therefore, in the case of the suction line there will be a drop of pressure to get the gas into the compressor.

The whole matter of pressure drop may be clarified on referring to the diagram, Fig. 2. This diagram is worked out for a straight length of pipe of 100 ft. Pressure drop increases with the density of the substance and as the square of the velocity. To get this diagram on the paper to best advantage, the author has made the lower diagram for a uniform density corresponding to 20 lb. gage and with different gas velocities up to 6,000 ft. per min. For any other density it is necessary only to project upward until the proper gas pressure is obtained. For example, a 4-in. pipe with gas at 60 ft. per sec. would have a pressure drop of 0.33 lb. per sq.in. per 100 ft. of straight length for 20 lb. density, but this will be 1.9 for 200 lb., 1.47 for 150 lb., 1.03 for 100 lb. and only 0.15 for zero lb. gage pressure. Valves and fittings increase the resistance greatly, which vary from 100 times the diameter of the pipe for a 90-deg. ell to 200 times the diameter for a globe valve. Irregularities of the interior, which will cause whirlpool or eddy currents, increase the pressure drop. The result is that the engineer has to calculate the total effective length of pipe, allowing for each ell, tee, coupling, valve or other fitting, and find the approximate pressure drop from the diagram. Then, by using a liberal factor of safety, the practical working value may be closely approximated.

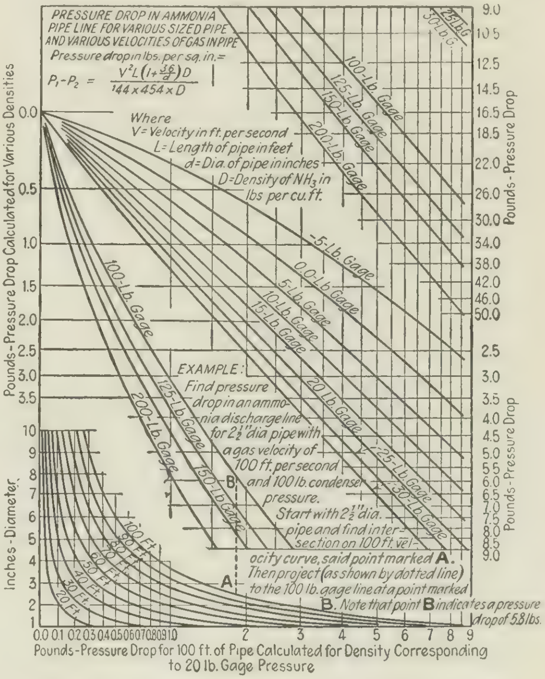


FIG. 2. SHOWING PRESSURE DROP IN AMMONIA GAS LINES

The question may arise as to how the velocity of the gas may be found. This is determined by dividing th total volume of the gas passing through the pipe pe minute by the cross-sectional area of the pipe. The volume is found from the ammonia tables. For example a 50-ton machine pumps against 175 lb. gage and with a temperature of discharge of 200 deg. F. and a suction pressure of 15 lb. gage. The specific volume at 175 lb. and 200 deg. F. is 2.03 cu.ft., and at 15 lb. gage is 9.17 for dry saturated vapor. At 15 lb. gage boiling pressure of ammonia, there will be required

$$\frac{200}{L_{15} + q_{15} - q} \text{ pounds of liquid ammonia per ton, or}$$

$$\frac{200}{572.1 - 33.5 - 6.86} = 0.426 \text{ pounds.}$$

In other words, there would be required 0.426 lb. of ammonia per ton of refrigeration per minute. For 50 tons there would be 50 times 0.426 times 9.17 equals 195 cu.ft. of suction, and 50 times 0.426 times 2.03 equals 43.3 cu.ft. discharge gas per minute. In a practical problem it is unwise to figure too closely, and therefore the warmest condensing water should be used in calculating the condenser pressure, as well as the lowest suction pressure which experience has shown is likely to be used in getting the work out. Dividing the volume in cubic feet by the area in square feet will give the required answer in feet, velocity of the gas.

In the foregoing an attempt has been made to show the factors influencing the design of discharge and suction lines. Whereas, the first cost of the installation must be kept down to the practical minimum, yet the daily operation must not be handicapped by faulty designs. A refrigerating plant, like any system with continuity, must be balanced in all its parts.

Air for Burning a Pound of Coal

By C. C. Phelps

Pounds of water evaporated per pound of fuel, or per pound of combustible, is the telltale of a boiler plant's efficiency. This ratio, in turn, depends primarily upon another ratio—that of pounds of air supplied to burn each pound of fuel. If the air-fuel ratio is large, the evaporation will be low, and conversely, if the air-fuel ratio is small the evaporation will be high unless some other factors interfere to prevent the latter result. It should always be the aim to burn fuel with the minimum quantity of air that will give practically complete combustion. The indication of such result is, of course, high CO_2, as shown by the table.

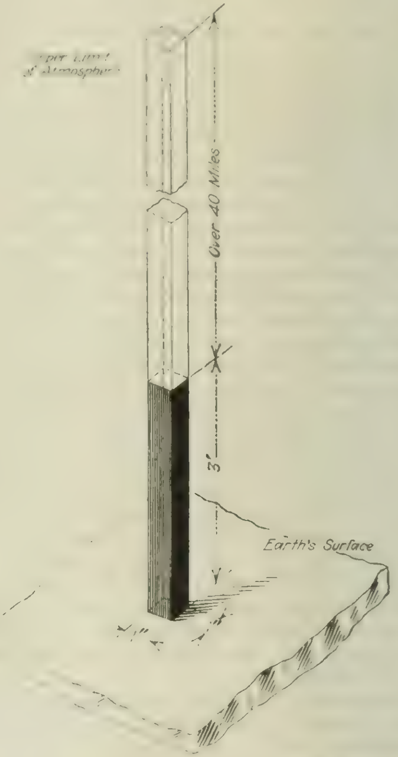
WEIGHT OF AIR PER POUND OF CARBON IN THE COMBUSTIBLE AS INDICATED BY CO_2 IN THE FLUE GAS

Per Cent CO_2	Pounds of Air	Per Cent CO_2	Pounds of Air	Per Cent CO_2	Pounds of Air
21	11.6	14	17.4	7	34.8
20	12.2	13	18.7	6	40.7
19	12.8	12	20.3	5	48.7
18	13.5	11	22.1	4	61.0
17	14.3	10	24.4	3	81.3
16	15.2	9	26.1	2	121.8
15	16.2	8	30.5	1	244.0

It is a general mistake to give more thought to the fuel than to the air supply, in spite of the fact that from fifteen to fifty or more times as much air as fuel enters the boiler furnace. Air being invisible, many engineers and firemen do not appreciate how much of it they deal with daily.

A pound of carbon, the preponderant element of fuel, requires 11.6 lb. of air in theory for its complete combustion. Actually, it requires more because there must be a surplus of air to provide for the difficulty of mixing the air and fuel completely while burning. Forty per cent excess air should be sufficient for coal fuel. Therefore coal containing 10 per cent ash and burned with 40 per cent excess air would require about 14.6 lb. of air per pound of fuel.

We know that the pressure of the atmosphere on each square inch of the earth's surface at sea level is 14.7 lb. That means that all the air directly above a square inch of the earth's surface weighs 14.7 lb. The earth's atmosphere is estimated to extend up into the sky for a distance of over forty miles from the earth's surface. Such a column of air, then, one inch square and over 40 miles in height would be just about sufficient to completely burn a pound of coal if it could be brought in contact with the fuel. The pound of coal would occupy a volume of about 36 cu.in. or a column 3 ft. high with a one square inch base. Although the forty-mile (or more) column of air certainly makes the little column of coal look insignificant in comparison, it must be borne in mind that this proportion represents best conditions and in practice two or three times as much air is frequently employed, to the detriment of high efficiency.



A COLUMN OF AIR 1 IN. SQUARE AND EXTENDING UP TO THE END OF THE ATMOSPHERE IS JUST ABOUT ENOUGH TO BURN A POUND OF COAL

A similar mass of air on the ground would, of course, occupy a smaller volume because of the greater and uniform density of the air at the earth's surface. Nevertheless that figure is correspondingly impressive. One pound of air at 62 deg. F. and atmospheric pressure occupies 13.14 cu.ft. Therefore, 14.6 lb. of air, the amount required to burn a pound of coal, would occupy 192 cu.ft. of space. Multiplying this figure by 144 gives 27,648 ft. (or 5¼ miles) which is the length of a column of air 1 in. square, of normal atmospheric density, required to burn one pound of coal (about 36 cu.in.). This air represents 9,216 times the volume of greatest quantity of coal which it can burn, namely 36 cu.in.

The Anderson Semi-Diesel Oil Engine

During the war the Anderson Foundry and Machine Co., of Anderson, Ind., was engaged in munition work and was unable to give any great amount of its manufacturing facilities toward the production of the Anderson Semi-Diesel oil engine. Considerable development, however, was done in the engine design. With the release from war work, the company has turned all its energy toward the manufacture of the K-type engine.

This engine is of the vertical two-cycle medium-compression surface-ignition type. Units of one, two, three and four cylinders are manufactured. The sizes range from 30 to 300 hp. The fuel consumption of 0.50 to 0.59 lb. per brake-horsepower, while higher than that of a Diesel engine, is sufficiently attractive to allow the engine in many plants to show a total over-all economy quite equal to the Diesel. This is especially true in those plants where the output is seasonal, as in cotton ginning or irrigation.

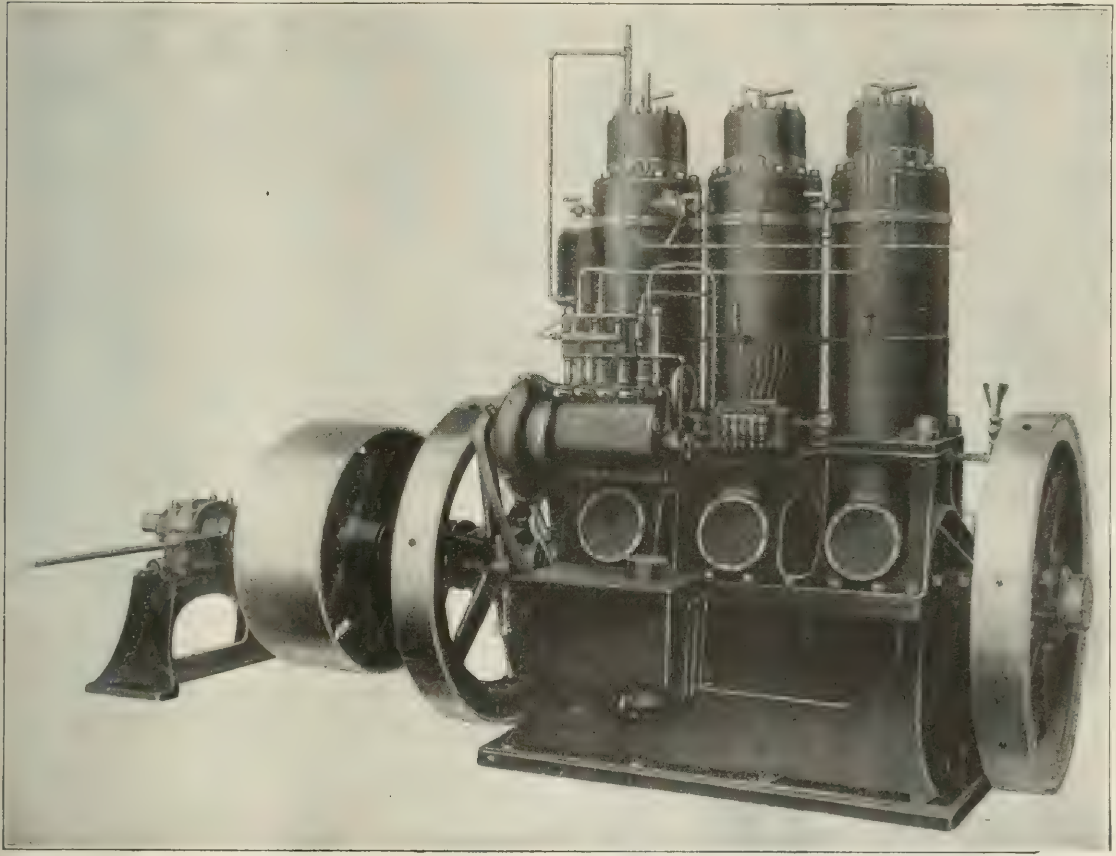


FIG. 1 ANDERSON VERTICAL, TWO-CYCLE, SURFACE-IGNITION SEMI-DIESEL OIL ENGINE

The bed of the engine, regardless of the number of cylinders, is of one-piece construction. The upper half of the crankcase or cylinder sub-base is a separate casting, being bolted to the base. The cylinders are bolted and doweled to the upper casting.

After the engine base and cylinder sub-bases are assembled, they are placed on a special horizontal boring mill. The crankshaft bearing housings are bored in correct alignment. The bearings are of the shell design with babbitt liners. Replacement of worn bearings is easily secured. Since the housings are true, there is no difficulty in maintaining the alignment of the journals.

The crankshaft is forged from a billet. The crank throws are provided with counterweights. To prevent the escape of the scavenging air along the crankshaft, air-seal rings are placed between the crank throws and the inner ends of the main bearings. The main bearings are provided with oil rings and oil cellars. Oil is led to the top of the main bearings from a mechanical pump. The excess from the main bearing drips into an oil ring leading to the crankpin bearings. After fulfilling its purpose the oil falls into the bottom of the crankcase; whence it passes into a filter and is used again. This circulation of the oil lowers the lubricating costs. The pistons and piston pins are lubricated from a separate mechanical lubricator.

The Anderson oil engine is of the so-called "dry type." No water injector is supplied to the working cylinder to keep the cylinder temperature below the preignition point during compression. As a consequence, the combustion space is confined to a spherical-shaped cavity contained in the cylinder head. Fig. 2 shows the shape of this combustion chamber. The cylinder head is in two parts; this construction facilitates the manufacture and lowers the cost of replacement. The entire combustion chamber is water-cooled. In starting, a plug at the side of the combustion chamber is heated by a torch. The fuel is injected through a nozzle at the top of the head, and the oil spray is directed downward, toward the opening into the cylinder. A deflector consisting of a small stem with a blade at the bottom serves to direct the spray onto the starting plug. As soon as the engine has turned over a few times, the deflector is shifted, allowing the oil to spray downward.

The engine is capable of delivering its full rating without water injection. On overloads, if water injection is used, the engine can develop 30 per cent overrating. To give this reserve capacity, a water drip valve is furnished; since the drip enters the air passage and not the cylinder itself, there is no danger of water washing away the piston lubrication.

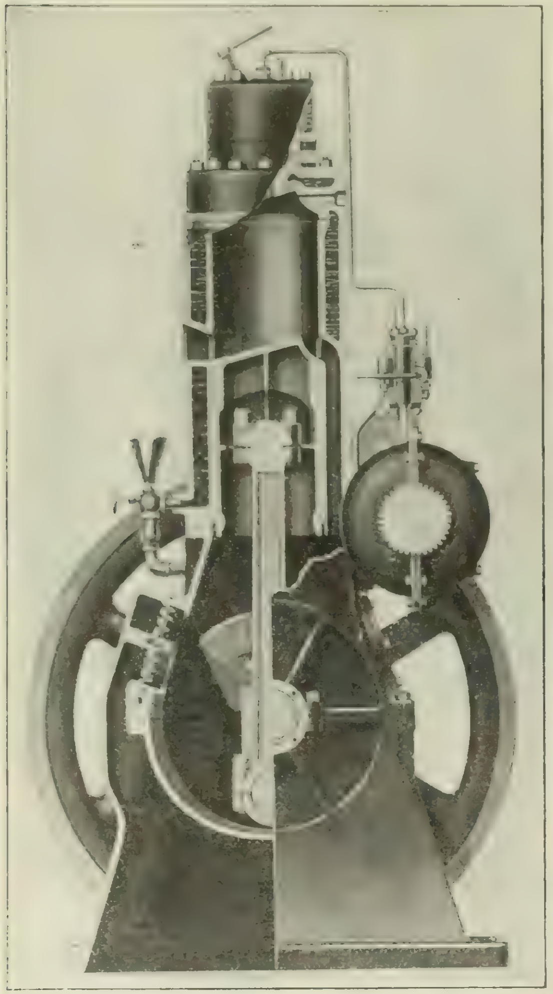


FIG. 2 ENGINE CROSS-SECTION

The governor, with the fuel pump, is placed in a cast-iron housing at the front of the engine. The assembly is driven from the engine shaft through a silent chain drive. The governor consists of a disc with two weights and arms. At a change of speed the arms shift the cam sleeve, which is mounted on the governor shaft and carries a cam for each engine cylinder. About the cam is placed a stirrup, as appears in Fig. 3. The upper end of this stirrup contacts with the fuel-pump plunger. The cam has a sloping face, so that a shifting of the cam sleeve alters the pump stroke. The pump is a bronze casting fitted with a steel plunger. Needle valves enable the amount of fuel entering each combustion chamber to be varied by the operator.

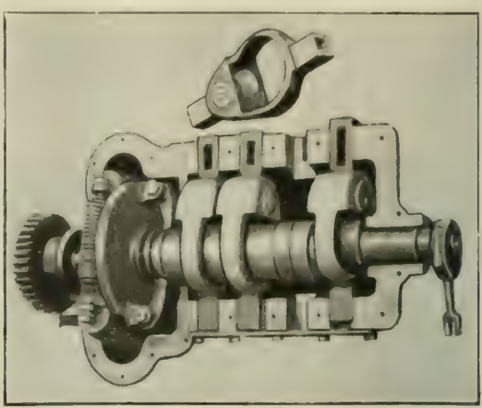


FIG. 3 GOVERNOR AND PUMP CAMS

When direct-connecting to a generator, the generator shaft is coupled to one end of the engine shaft. For belt drive the engine is supplied with an extended shaft and friction clutch pulley. Many of these engines are in use in the oil fields, where a reversing clutch pulley is standard equipment.

Electric Drive Applied to Cargo Vessels

The United States Shipping Board has adopted electric drive for twelve new cargo vessels for the purpose of determining the relative advantages of this and other types of propulsion. The first of these ships, the "Eclipse," has been put through her dock and sea trials and will shortly be ready for service with the International Mercantile Marine. Electric drive has already been tried in United State battleships, but this is the first such installation to be made in this country in a general cargo merchant vessel. The matter is of more than passing interest because it is safe to say that future practice in the design of propulsion apparatus will depend to a considerable extent on the performance of these vessels.

FIG. 1. THE UNITED STATES SHIPPING BOARD VESSEL "ECLIPSE"

The "Eclipse" is a vessel of 11,868 dead-weight tonnage, is 440 ft. long, and has a beam of 56 ft. It was built by the Union Iron Works, of San Francisco. The present electric-propulsion machinery was designed and manufactured by the General Electric Co. and was installed by the Vulcan Iron Works, of Jersey City.

The driving machinery consists of a 3,000-hp. marine turbine-generator set which operates normally at 3,000 r.p.m., and a three-phase induction motor which drives the single propeller shaft at a normal speed of 100 r.p.m. This makes a total reduction between turbine and propeller speeds of 30 to 1. There are also two steam-engine-driven 125-volt exciters and a control equipment for maneuvering the ship.

The turbine is of the horizontal Curtis type and was designed expressly for marine service. It is controlled by a hydraulic variable-speed governor at speeds from 20 to 110 per cent of normal. The turbine is further provided with protective devices in the way of a centrifugal type pre-emergency governor controlling the speed up to 115 per cent of normal, and a ring-type emergency governor which prevents it from running at speeds exceeding 125 per cent of normal. It is direct-connected to the three-phase generator, which generates at 2,300 volts. This generator incorporates several features necessary to meet the particular requirements of the class of work that it is called upon to do. The stator consists of a cast-iron one-piece frame with openings in the top for ventilation. The core is built up of annealed segments of thin sheet iron of special material, to insure low core loss and is held in place by heavy cast-iron frame flanges at each end. The windings are formed coils pressed from enameled cable, each turn consisting of rectangular copper strips in multiple. Eddy currents are eliminated by thorough insulation between the strips. Ventilation is provided by a centrifugal fan mounted at each end of the rotor.

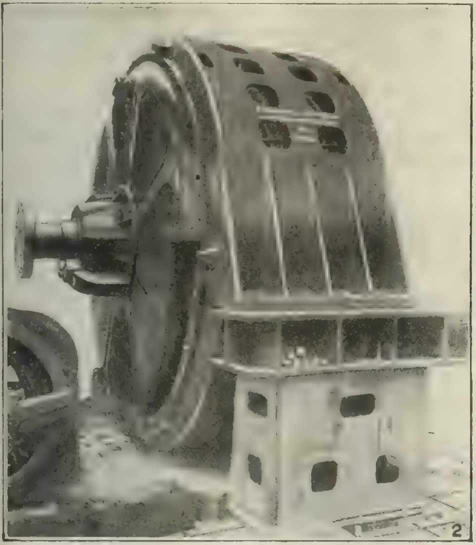


FIG. 2. THE 2,300-VOLT 3,000-HP. INDUCTION MOTOR

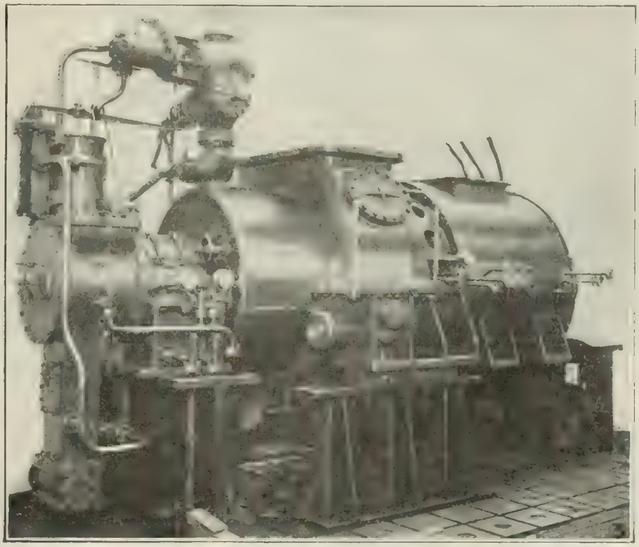


FIG. 3. MARINE TURBINE-GENERATOR SET

The propelling motor is of the induction type and revolves at a normal speed of 100 r.p.m. It is ventilated by a motor-driven blower. The construction of the motor stator is similar to that of the generator stator. The rotor consists of a cast-iron spider keyed to the shaft on which the rotor core is assembled.

The control equipment comprises a control group, a water-cooled resistor and a control panel. The water-cooled resistor is inserted in the motor circuit when operating the motor at low speeds and is mounted on top of the control panel. The panel is a structural-iron cell, faced on one side by a sheet-steel plate upon which are mounted all the electrical instruments and the electric and speed levers for normal operation of the machinery. The electric and speed levers are mechanically interlocked, to prevent improper starting and running conditions. The electric lever moves the master controller, which in turn energizes the contactors of the control group, normally operated by solenoids. In addition to the speed and electric levers there is a field resistor for regulating the generator field resistance, and an auxiliary handle for operating a fuse disconnecting switch in the control circuit leading from the 125-volt power supply to the master controller. There are also levers for connecting either exciter into circuits, two exciter resistors (one for each exciter) and levers for connecting the blower and generator field to the exciter bus. If for any reason it should become necessary or desirable to operate the control group manually, it may be accomplished by means of three levers mounted

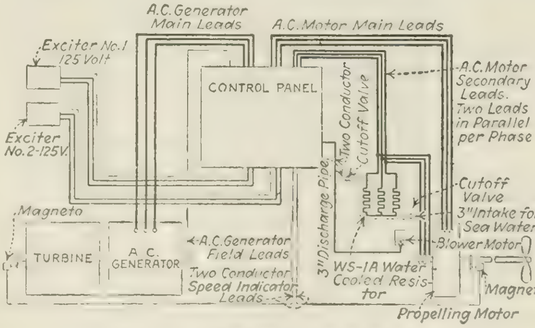


FIG. 4. DIAGRAM OF THE WIRING

to the left side of the control panel. These levers, the resistor lever, the field lever and the reverse lever actuate the contactors directly by means of cams.

No conclusions may as yet be drawn from this installation relative to application of electric drive to cargo vessels, but when the "Eclipse" has been in service for a while, the results of its performance should prove decidedly interesting.

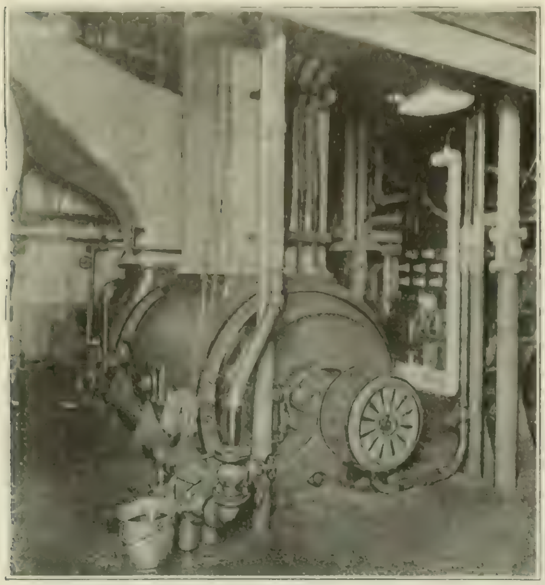


FIG. 5. TURBINE AS INSTALLED IN THE SHIP

Twin Strainer and Water Separator for Gasoline-Engine Fuel Line

By H. H. Parker

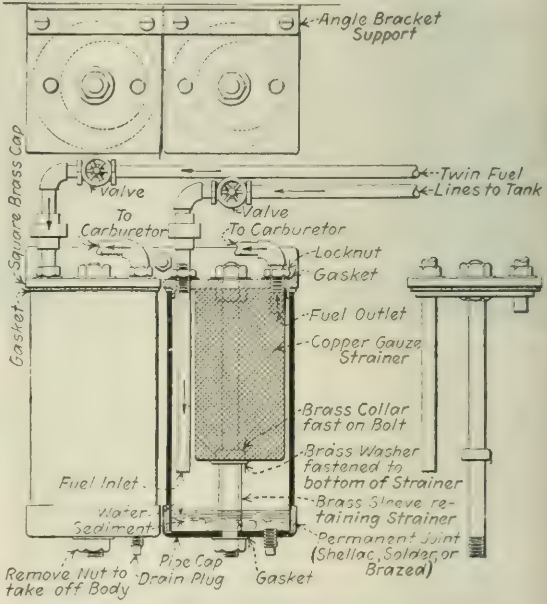
The sketch shows a twin strainer originally designed for a heavy-duty marine-engine installation, but which would also be applicable to stationary work where gasoline, distillate or kerosene is used as fuel. The combination of shutoff valves and unions is such that either separator may be removed for cleaning or repair without disturbing the other or without interfering with the operation of the engine.

Two square brass plates with circular countersunk bottom bosses are faced off to take the strainer bodies, preferably made of brass pipe of as large diameter and length as practicable; the larger the strainer the longer it will run without cleaning. The two top plates are held together and bolted to a bulkhead or other support by means of a steel angle plate; if a large lathe is handy for the machining, but one top plate with two bottom bosses and cast supporting brackets would be best.

The lower end of each strainer body is closed by a pipe cap set in shellac, soldered or brazed permanently in place. The upper end is accurately faced and presses against a leather, cork or lead (not rubber) gasket, this gasket being pressed on the top plate and set in shellac. A through bolt, preferably brass, with lead gaskets under the nuts, holds the body in place, but the whole may be quickly removed by loosening the lower nut. A copper-gauze strainer is made up as shown; a stiffening ring soldered around the top edge and a brass washer to the bottom, through which the bolt fits. A brass collar above, fast to the bolt, and a loose brass sleeve, slipped over the bolt from below, hold the strainer in place, but allow of easy removal after the body is taken off.

As shown, the strainer is smaller in diameter than the inside of the pipe body, as the fuel intake pipe does not enter it, but comes down one side within about two inches of the bottom. The outlet pipe, though, is within the strainer and is short. Both pipes are fitted with running threads, screw up through the top plates and are secured by locknuts and gaskets on top. A pipe plug screwed into the lower cap of each separator allows the removal of water and sediment without dismantling the whole.

Twin fuel lines to the tank are shown, but one line and the proper arrangement of tee and unions and shutoff valves can be used just as well. The fuel enters the separator near the bottom, and any sediment and water will quickly settle where it can be occasionally drawn off. Floating sediment will not be able to enter the intake pipe, owing to the strainer, and as this is of large area it will not be easily clogged. Furthermore, the outlet pipe is near the top and therefore out of reach of all impurities.



SHOWING DETAILS OF TWIN STRAINER AND WATER SEPARATOR

In making up such a separator, the chief point to be looked to is to keep all joints gasoline-tight by the use of gaskets and shellac. Before replacing the separator body, it would be well to scrape a bar of yellow soap over its upper edge and set this layer of soap up against the gasket.

EDITORIALS

The Oil Situation

THE public, while showing alarm over the diminishing petroleum supply, are inclined here, as in all other phases of economy, to "let George do it." If each owner of a "high-powered" fifty to eighty horsepower automobile could be made to feel his personal responsibility when his car turns but five miles per gallon of fuel, instead of twenty to thirty miles as it should, he would show less interest in acceleration and more in economy.

The same inertia possesses the artificial-gas manufacturer. No logical excuse exists for the use of oil in "fixing" gas. Candlepower is no longer the characteristic to be used in determining the value of a gas; the heat content decides the actual value, and this in no way is increased by "fixing." One of the first steps in oil conservation is the abandonment of its use in gas plants. The change in the plant equipment is by no means great.

E. T. Adams, in his article on "The Oil Situation," which appears on another page, discusses these points as well as the influence the oil supply will have on oil-engine design. As he brings out, the tractor requirements will be enormous in a short time and the manufacturers should anticipate the future shortage of gasoline and design engines to use heavy oil. While heavy oils such as kerosene and distillates are not unqualified successes in automobile engines, satisfactory performance should obtain in tractor use. This is for the reason that in tractor work the engine is always loaded, so does not experience the temperature changes occurring in an automobile engine.

The world has been warned of the oil shortage that will exist if steps are not speedily taken to cope with the situation. It is no longer a problem to put up to George to do, but concerns each individual, both manufacturer and consumer. Economy should have been practiced in the past; it must be enforced in the future.

Conservation By Interconnection

FOR several years past the country has been subjected to periodic fluctuations of its coal supply in the face of a steadily increasing demand for power. Obviously, this demand will continue to increase, and unless economy and conservation are speedily effected the fuel situation will become more acute year after year.

Under the stimulus of war, and with constant pressure exerted by the Fuel Administration, phenomenal savings were secured while the conflict lasted, but with these factors removed and business flourishing, a tendency arose to relax vigilance at the coal pile. Educational propaganda will accomplish much, but without supervision or some such incentive it is unreasonable to expect an approach to war-time economy. There are, however, large wastes that are beyond the control of the operator; they are inherent in the layout of the plant or system or the conditions of load.

The investigation now being conducted by the Superpower Survey shows that there is approximately seventeen million horsepower installed capacity in the Washington-Boston zone, operating at a power factor of approximately fifteen per cent; the central stations alone, owing to the low power factor, averaging a coal consumption of four and one-fifth pounds per kilowatt-hour. By interconnection the power factor could be raised to fifty per cent and the fuel consumption cut to nearly one-third. W. S. Murray, chairman of the Superpower Survey, has estimated that a system of interconnection and electrification would effect a saving of thirty million tons of coal annually in this zone alone.

Recent investigations of the St. Lawrence project indicate an available supply of one million horsepower on the American side, which, according to estimates of the engineers, could be transmitted to the New York district, a distance of three hundred miles at a loss of not more than ten per cent and at an initial investment, including transmission lines, power house and substations of two hundred million dollars.

California has led the way in interconnection of power systems and has tied together practically every system within the state. Only by such means was it possible to cope with the power situation on the Coast.

Interconnection, however, must not stop with central stations; it should take into account the industrial plants, aiming wherever possible to run the industrial plant at its most economical heat balance supplemented by central-station service. In this way only can there be the greatest conservation of coal as relates to its use for power generation.

Testing Welds

HOW to know when a weld is made properly is one of the problems, which up to this time the autogenous welding engineer has not solved. Although many suggestions for testing welds have been made, none of these has offered a complete solution. The manufacture of iron and steel is generally done in such quantities that where necessary the process can be carried on under the supervision of an expert, therefore conditions are favorable for the product having a uniform quality. And if tests are made on a few samples of a given lot, it is a good barometer as to the quality of the whole product. But with autogenous welding the quality of the metal in the weld depends very largely upon the man who did the job The metal is deposited drop by drop, and every drop affords the welder an opportunity to cause a defect in the weld by allowing a variation of any one of the many factors under his control. Therefore even if one weld or a section of a weld is tested, the result is not an insurance that another made by the same man is of equal quality. All who have had experience with the failure of welded pressure vessels have seen the weld fail at some weak point only a few inches from where the work was properly done. When tests are made on such a weld, if they happen to be in the good section the whole is passed as having high quality. Therefore the ideal way would be to test the whole weld, which obviously is practically impossible without destroying it, and this is just what is not wanted.

In a paper on "Testing Welds," recently presented by S. W. Miller before the Chicago section of the American Welding Society, an abstract of which is published on page 719 of this issue there are outlined a number of methods for testing welds. Among these are tests made on samples of welded bars which are subjected to tensile, bending, alternating-stress tests, etc. Such tests will give a good indication of whether a welder can make a good weld or not and the percentage of such welds that he can make which will come up to a certain standard, and in training welders these tests serve a useful purpose. However, if the welder has passed one hundred per cent on making these sample welds, whether in bars or plates from which samples are cut, it is no guarantee as to the quality of his workmanship when doing routine work day after day, and these are the welds we are chiefly interested in. The acid test referred to by Mr. Miller apparently could be so developed that it can be applied to almost any part on the surface of a weld. Although this would not show all that is desired, it would give a fairly good check on the quality of the welder's work and, combined with microphotography, would give a reasonably good record of the weld.

Why Exempt Oil-Country Boilers?

ABOUT a year ago the State of Oklahoma adopted the A. S. M. E. Boiler Code, placing the administration of the law in the hands of the State Labor Commissioner. It now develops that the manufacturers and jobbers handling the type of boilers used in the oil fields have advised the operators and purchasers that the A. S. M. E. Boiler Code is going to work a great hardship upon them, and the Commissioner of Labor has been requested to meet in conference with the Mid-Continent Oil and Gas Association to see if it will not be possible to make an exception in the case of the oil-country type boiler.

Meanwhile the secretary of the Boiler Code Committee has been approached as to whether there is an appreciable difference in cost between the existing type and that built in accordance with the A. S. M. E. specifications; whether the former is reasonably safe for oil-field use; and whether compliance with the Code would be likely to hold up delivery. In order to gain a representative opinion upon these questions the secretary addressed letters to a number of well-known manufacturers of such boilers, soliciting their opinions. The replies are most interesting. Out of eleven that have been received to date, the estimated increase in cost ranges from none at all to forty per cent. Only three of the manufacturers believed that compliance with the Code would hold up delivery. The majority believed that the existing type was reasonably safe for oil-country service, especially when used out in the open field, although a couple expressed the opinion that an A. S. M. E. Code boiler would be much safer. Two of the manufacturers did not hesitate to say that the existing type was not reasonably safe.

That certain of the local builders and jobbers are exerting every effort to create opposition to the Code is evidenced by the following quotation from a current issue of the "Daily Oil Bulletin" from *Petroleum Age*:

> Tulsa, Okla. Oklahoma oil men are preparing to give battle to protect from condemnation some ten thousand boilers in use in the oil fields of the state. They are valued at $8,000,000 Under the A. S. M. E Code, governing boiler inspection, they would be valuable chiefly as junk. The Mid-Continent Oil and Gas Association seeks to have them exempted, as the boilers have been in other oil states.

Right here there appears to be an attempt to befog the issue. It will be recalled that when the A. S. M. E. Boiler Code was promulgated, it was recognized that the rules for new boilers would necessarily work a hardship on those already installed, and therefore special provision was made for existing boilers with the idea that in time these boilers as they wore out would be discarded or the allowable pressure so reduced as to eliminate the risk. Therefore, existing boilers in Oklahoma would be affected only to the extent of being inspected as to proper fittings, etcetera, and would be condemned only when in a dangerous condition.

Certain states that have adopted the A. S. M. E. Boiler Code have exempted oil-country and agriculture boilers with the exception of periodic inspections. Undoubtedly in some cases this has been an expediency resulting from political influence and is most unfortunate, especially when it is consdered that many of these boilers are of lap-seam construction and are operated by very unskilled labor. It is true that their usual location minimizes the hazard to life and property as compared with boilers installed in industrial centers. Nevertheless, many of these boilers do explode and the loss of life is appreciable.

It is the fixed policy of the A. S. M. E. Boiler Code Committee not to recommend or approve specific designs or types, but merely to pass upon safe construction as set forth in the Code, which represents the combined opinions of the best authorities in the country. Those having to settle the question in Oklahoma should bear this point in mind.

Supply and Demand

MANY IDLE SHIPS PUT INTO SERVICE

More Coal Cargoes Offered Than Can Be Taken Care Of, It Is Declared

(Special to *The World.*)

WASHINGTON, Oct. 24.—The coal miners' strike in England is having a wide effect on American shipping. The walkout already has stimulated shipping in American bottoms to the extent that scores of vessels that had been tied up because of no cargoes are again at work.

The effect is especially apparent in the coal trade. It is stated here that shippers have been offered more coal for export than can be accommodated on the vessels now available, despite the fact that much of the idle tonnage has been put into service.—New York *World*, Oct. 25.

UNSOLD COAL IN THE CITY NOW DOWN TO 70,000 TONS.

Health Commissioner Copeland Says Orders Placed for 1,500,000 Tons Cannot Be Delivered

Health Commissioner Copeland said yesterday the Health Department's coal survey now shows that there are only 70,000 tons of unsold coal in the city and that all of this is needed at once. Orders aggregating 1,500,000 tons which have been placed, cannot be filled, he said.—New York *World*, Oct. 25.

CORRESPONDENCE

Where Should the Beginner Start?

It is somewhat difficult to define the qualifications of a first-class fireman and suit everybody. There are some who will study the best way to burn coal and get the most out of it, but such men are scarce and they do not remain firemen long as they generally get something better.

My idea of a combustion engineer is one who makes a special study of combustion factors in various plants and who designs furnaces to meet the existing conditions. A boiler-room manager must be a good fireman, a good boiler repair man and a generally good mechanic in all work pertaining to boilers, accessories and auxiliaries.

If a man wants to become a first-class fireman, he should go into the marine service and fire until he can get a marine engineer's license from Uncle Sam. Then he can say he is a fireman. About the poorest place for a man to learn to become a first-class fireman is in a stoker-fired plant. S. H. WINTERS.

Albany, N. Y.

Suction Lift of Pumps

On page 553 of the Oct. 5 issue of *Power*, C. W. Peters writes that he has seen a piston pump deliver water taken from a level of thirty feet below it. As he has seen it done, that settles this particular case. Every engineer knows what the theoretical lift is, and most engineering books dealing with pumps explain this matter. In practice theory will often fail to come even near the given result. I have installed hundreds of pumps, but the best of them would not give a satisfactory supply of water if the supply level was more than twenty-seven feet below the pump piston or plunger.

In many cases where the lift was under thirty feet, the pump had to be lowered several feet to get a proper delivery. With all pipe joints tight and the pump in first-class condition I at one time succeeded in delivering water with a lift of nearly twenty-nine feet, but the pump plunger would jerk violently at the end of every stroke and the delivery was under 40 per cent of what it should have been to be satisfactory; lowering the pump three feet made it easy working and satisfactory in the quantity of water delivered.

Various writers have brought up the idea shown in Mr. Peters' fifty-foot lift. After reading such a description some years ago, I tried it out with a new iron hand pump and a forty-five-foot lift, starting with a 1/32-in. hole and gradually increasing the diameter. I failed to get results up to the point when the hole was ⅜ in. Then I gave it up and did not succeed in getting water to the pump.

The holes were made at the water lever so that both water and air would be taken into the suction pipe at each stroke. Probably the idea was first suggested from knowledge gained by air-lift experience, but the conditions are not the same in both cases. It may be possible to raise water fifty or eighty feet with a reciprocating or rotating, so-called, suction pump, by removing the air pressure from the top of the water and allowing air to mix with the entering water, but I have some doubts as to its success and I should like to hear from someone who has seen the experiment successfully demonstrated. It is noticeable that none of the writers describing this method have made any claim to have seen such a fifty- or eighty-foot lift in operation. JAMES E. NOBLE.

Portsmouth, Ont., Canada.

Commutators Made from Copper Block

Noting an article in the Sept. 21 issue of *Power*, page 458, by Vernon Pearson, on the building of small direct-current commutators, also a warning of patent infringement, on page 591 in the Oct. 12 issue, by H. E. Weightman, I am moved to call your attention to the following facts:

In April, 1900, I was, on account of business relations, permitted to have access to all parts of the factory of the Eck Motor Works, which at that time was located in the Atlas Power Building, Newark, N. J. This firm made direct-current fan motors, also motors for automatic pressure apparatus; in fact, their business was solely in direct-current motors of sizes up to five horsepower.

The stock from which the commutators were made was hard-drawn copper, and, in some instances in the larger sizes, rolled bronze. This material was received in the proper diameter, and put through special machinery for slotting and boring. As I remember, both operations were made on the same machine, the stock feeding through a hollow spindle. After the boring and slotting it was received in a container and taken to the filling room, where the mica and insulating bushing were applied. The commutator bars were not finally separated until the commutator was permanently insulated, bound and baked. What made such an impression on me was the speed of the process compared to the very slow way where the commutator was built up bar by bar on a form, then pressed into shape and finally baked and machined.

I am not familiar with the patent laws and have no desire to enter a controversy, but am writing this that it may perhaps shed some light on a long-forgotten process. WILLIAM J. CUMMINGS.

Haskell, N. J.

How an Engine Bearing Shell Was Lengthened

Recently, we had to make some repairs on a 10 x 12-in. high-speed automatic engine running at 300 r.p.m. Among other things the main bearings needed attention, and as one of them was in bad shape a spare set of shells was made ready. One of them required a little scraping, but the other was found to be ¼ in. short. It was decided to make a wooden mold and pour babbitt onto the end of this short shell, which was plain except for a lip at one end, as shown in Fig. 1.

Two pieces of 1¾-in. stock were sawed out and fitted to the inside and outside of the shell, Fig. 2. Then a rabbet was cut around the arc of the wood block forming the outer part of the mold. Several bores were drilled in the end of the shell, and the surface was carefully trimmed. The blocks were fastened in place with a wooden hand clamp, after which the babbitt was poured.

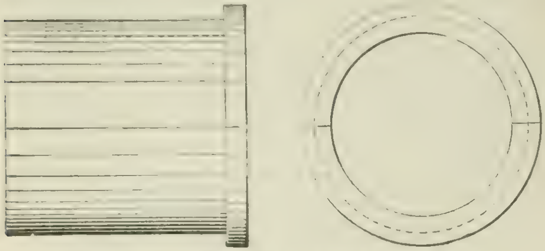


FIG. 1 BEARING SHELL, LIP AT ONE END

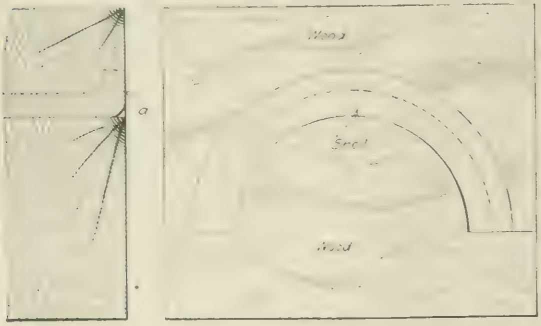


FIG. 2 SHELL FITTED TO WOODEN MOLD

The same blocks that were used as a mold for the babbitting job came in very nicely for holding the shell while the end was being filed and fitted. Fig. 3 shows the shell being held in the vise with its axis horizontal. When it was desired to hold it with the axis in a vertical position, the blocks were clamped around the babbitted shell with a wooden hand clamp and the jaw of the screw was gripped in the vise. The shell was so long that it would not be held firmly enough were the blocks gripped in the vise—the lower end of the shell projected below the screw of the vise as shown in Fig. 4.

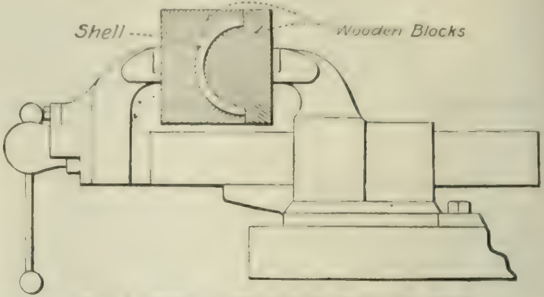


FIG. 3. SHELL AND MOLD HELD IN VISE

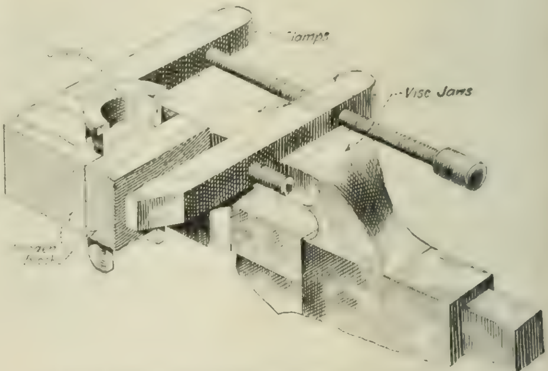


FIG. 4. SHELL AND MOLD HELD VERTICALLY

While placing the shells in the engine and fitting them, top shells persisted in dropping out of the top castings of the boxes while they were being raised and lowered during the process of fitting. The "chief" solved the problem in short order by slapping some cup grease into the box and pressing the shell into it. The suction prevented the shell from dropping out. After the fitting had been done, each upper shell was pinned to the top section of the box to prevent the shell from turning, which has caused difficulty with the bearings on this engine, as when the shells turned they did not get enough oil. JOHN D. EBERHARDT.

Arlington, Mass.

Engine Thumps and Pounds

Reading the letter of A. C. Waters, on page 515 of the Sept. 28 issue of *Power*, regarding engine thumps recalled a couple of experiences I ran up against. The first was with a Corliss engine in a lumber mill. One day a regular steam-hammer thump let loose. Upon shutting down, no loose parts were found, but after starting up again and while feeling the crosshead, I discovered that the locknut on the piston rod was three complete turns loose. After setting it up and checking for piston clearance on each end, everything was all right.

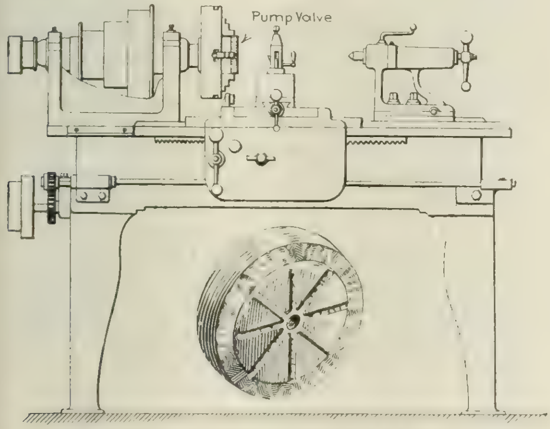
The second instance was with a straight-line engine, built with a Y-shaped frame and on the three-point suspension idea. The cylinder is on one leg and the frame ends on the other two. The two flywheels are between the frames and just far enough apart for the crank. One wheel carries the governor. The crosshead is designed just opposite to most crossheads, as the pin is held rigid in the end of the rod and oscillates in the crosshead, which is of the slipper type. On each side of the rod are fiber rings around the pin. The rod must have a certain amount of side play at the crosshead and wheel end. I had one of these engines, and when it ran with light load it would rattle away for dear life. This was because the weight on the governor hit the rim of the wheel. But the thump was caused by the slipper guide being loose.

I have seen men look all over a straight-line engine for a knock when it was in the bushing that takes the place of packing. These engines have no packing on either rod, but have a long metal bushing. If screwed up too hard, these bushings break with a resulting pound. R. G. SUMMERS.

Geneva, N. Y.

Refacing Pump Valves

A wrinkle for refacing pump valves is as follows: Put them in a small lathe, turn them up with a facing tool and finish with a block of wood covered with No. 00 or No. 1½ sandpaper. This is quicker than handwork and makes just as good a job. R. G. BROWN.



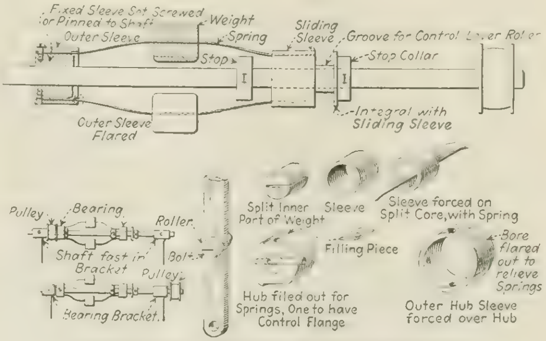
REFACING PUMP VALVE IN LATHE

Geneva, N. Y.

How to Make a Simple Gas-Engine Governor

Frequently, an internal-combustion pumping, vehicle or marine engine is adapted to stationary purposes, where the load is constantly changing. In this case a governor is required, which, even if it does not regulate as accurately as a specially designed one, can be relied upon to keep the engine from racing or stalling. Small marine engines, even of the heavy-duty type, are not always supplied with governors, and the throttle must be closed before throwing out the clutch; a governor would be of considerable value here also.

The sketches show the construction of a small governor of the Pickering type on which but little lathework is required. The size will depend on the speed at which it is to be driven and the amount of pull required to move the throttle valve, which will be of the plain butterfly type. The higher the speed the smaller the weights required or the stiffer the springs. Two brass or steel hubs are turned up and reamed to fit the driveshaft and filed off to take the governor springs: Two, three or four springs and weights can be used, according to requirements; heavy clock spring will answer the purpose for a small governor. The ends only of the springs are drawn; then they are held in place and sleeves driven on over them and the hubs; holes are drilled through the sleeve, spring and hub and tapped for machine screws. The inner ends of the outer sleeves should be flared out to relieve the springs when the weights are all the way out. One hub is pinned or keyed to the shaft, while the other is a sliding fit and is provided with a grooved flange to take the control-lever roller; or else the shaft is fixed in place and the two hubs revolve on it, one having the drive pulley or gear integral with it and held between two collars which are fast on the shaft.


Fixed Sleeve Set Screwed or Pinned to Shaft
Outer Sleeve
Weight
Spring
Stop
Sliding Sleeve
Groove for Control Lever Roller
Stop Collar
I
I
Integral with Sliding Sleeve
Outer Sleeve Flared
Pulley
Bearing
Roller
Shaft fast in Bracket
Bolt
Pulley
Bearing Bracket
Split Inner Part of Weight
Sleeve
Sleeve forced on Split Core, with Spring
Filling Piece
Bore flared out to relieve Springs
Hub filed out for Springs, One to have Control Flange
Outer Hub Sleeve forced over Hub

DETAILS OF GOVERNOR CONSTRUCTION

The springs are not drilled for the weights, as this would weaken them; instead, each weight is built up of an inner piece, slit almost through with a hacksaw to take the spring, and an outer sleeve forced over the inner part and spring, thus holding both tightly together. The weights may be brass or steel. A stop collar on the shaft is necessary to limit the amount of governor opening, otherwise the springs might buckle; in any event, there should be no great strain on the springs when the weights are all the way out.

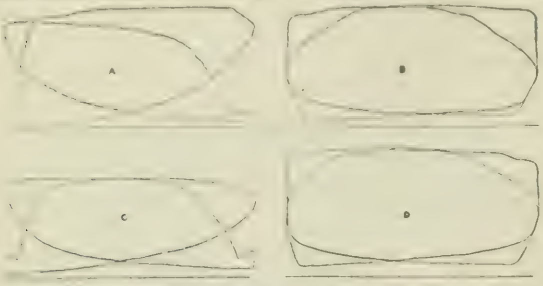
The easiest way to arrange the control lever is to attach a small brass roller to it, running on a steel stud; the roller fits into the grooved flange, and it and the lever are pushed back and forth as the governor weights move in or out. I used such a roller and lever for several years upon a marine engine with perfect success, though a split yoke would be more nearly mechanically correct. For a governor of this type a simple butterfly valve and lever, in the intake pipe, is probably best, though in many cases connection can be made directly to the throttle lever on the carburetor.

A positive drive is best, by gear, sprocket or direct coupling to cam or pump shaft; a round or flat leather belt will operate the governor well enough, but care must be taken to close the throttle independently when leaving the engine unattended, for if the belt broke there would be disastrous racing should the throttle happen to be wide open. H. H. PARKER.

Oakland, Cal.

Steam Loss Caused by Faulty Valve Adjustments

The accompanying diagrams were taken from a pair of 26 x 18-in. direct-connected coal-shaft hoisting engines, fitted with balanced slide valve. Diagram *A* shows the conditions of valve adjustments of the left engine as I found it upon first indicating. Diagram *B* shows the results after advancing the eccentric 32 deg. and equalizing the valve rod. Diagram *C* shows the conditions of valve adjustment of the right engine as found upon first indicating. Diagram *D* shows the results after advancing the eccentric 22 degrees.



EFFECT OF CHANGING ECCENTRIC ON TWIN HOISTING ENGINE

The average steam consumption per horsepower calculated from diagrams *A* and *C* was 49.69 lb., and that calculated from diagrams *B* and *D* was 32.99 lb., which shows a saving in steam of 16.7 lb. per horsepower-hour. C. J. HALLORAN.

Avoca, Pa.

Coal Prices Here and Abroad

I recently read an article in an English engineering paper in which it was stated that the price at which imported coal is being sold in England was causing a most unpleasant awakening among the English coal operators and dealers.

In the years preceding the war England exported 70,000,000 tons of coal per year, exclusive of bunker coal supplied to outgoing steamers, and the British merchant service was largely used in transporting this coal to all parts of the world. Since the war, however, England has been importing coal; but what jars them is the fact that, according to the item, English-mined coal stands the purchaser $9.92 per ton, while American imported coal is being offered at $4.57 per ton, f.o.b.

The item does not state whether this coal is f.o.b. at an American port or at an English port, but assuming it to mean that the quoted price is f.o.b. at an American port, the question arises, How can coal be sold at such a price? According to newspaper reports bituminous coal is bringing around $8 per ton at the mine in America. How, then, can it be loaded into a vessel for export at a rate of $4.56 per ton?

Of course this price represents a satisfactory profit to the shipper, and if so, there is a difference of $3.44 per ton added to coal for domestic use. With an additional charge of about $8 or $10 per ton the American consumer seems to be "getting it in the neck."

If the Department of Justice is looking into the coal situation as regards profiteering, why not ascertain why coal can be shipped to England at a price that is $3.44 less than operators are getting at the mine for coal used by American steam plants? A. W. JACOBS.

New York City.

Steam-Heated Fuel-Oil Pipe Line in Underground Conduit

No sooner does one do something that he believes to be original (and therefore considers himself entitled to a little glory) than someone else bobs up to state that he did it long ago. It is doubtful whether the second someone acquires any glory; but rather he may be relegated to the ranks of the I-told-you-sos and the I-did-it-firsts.

In the Oct. 12, 1920, issue of *Power*, page 580, is a description of a steam-heated fuel-oil pipe line in an underground conduit, supposedly the first installation of the kind. Thoughtfulness would require me to keep silent as to any historical notes bearing on this article, but for the good of the art let me say that there has been in use for a year or more an underground oil-pipe line 900 ft. long, about two-thirds of which is run in ordinary tile pipe split in two and then put together again.

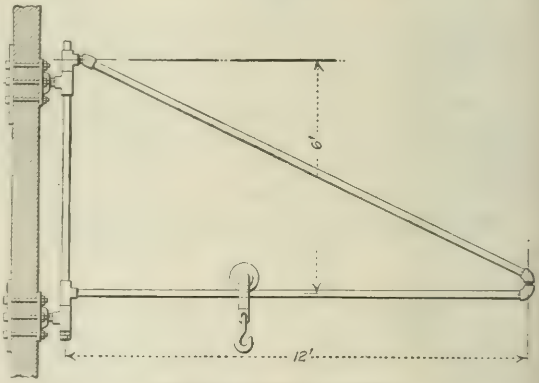
The line is of standard 6-in. pipe, laid on roller chairs, similar to those described in the article, and the steam pipe for keeping the oil warm is run inside of the 6-in. oil pipe, so that all the heat is taken up by the oil, making the problem of insulating the oil pipe itself a comparatively simple one. As a matter of fact, it has been found that for a very considerable portion of the year it is not necessary to use any steam, and that the oil can be pumped from the storage tank to the service tank without further heat than that taken up in the exhaust-steam heaters attached to the pump.

This line has been in use twenty-four hours a day and, so far as I know, has never given any trouble.

Providence, R. I. WARREN P. LEWIS.

Home-Made Wall Crane

The wall crane shown is not difficult to build and will prove useful in the repair department of a power plant or machine shop. It should be made from extra-heavy iron pipe and malleable or steel pipe fittings. A piece of 2¼-in. iron bar makes a neat fit inside an extra-heavy pipe fitting. A piece of iron plate can be used back of the wall at the bolt heads.



DESIGN OF WALL CRANE

Such a crane will handle weights up to ¾ ton. A chain or rope tackle can be used to raise the material handled. The carrying arm should be level. A plug is screwed into the bottom tee to prevent the bar from falling through. JAMES E. NOBLE.

Portsmouth, Ont.

INQUIRIES OF GENERAL INTEREST

Smoky Exhaust of Diesel Engine—Will low injection air cause my Diesel engine to smoke? G. M.

It will, especially if the engine is fully loaded. Air pressure below 50 atmospheres will often cause a smoky exhaust.

Gumming of Compressor Valves—What causes Diesel air-compressor valves to gum? P. R. C.

Gumming results from using too much lubricating oil. Two drops per minute per cylinder is ample for the average-sized compressor.

Time for Blowing Down Boilers—When is the proper time to blow down a boiler, when banked or when steaming at a high rate? T. B.

If the water is very muddy, the boiler should be blown down several times a day and preferably during intervals like morning, noon and night, when the boiler is doing the least steaming. If blowing down is done only once a day, the best time is in the morning or after the longest interval of rest and before the settled sediment becomes too much stirred up by the circulation during active steaming.

Imperfect Diesel Indicator Diagrams—With new fuel cam noses put on a Diesel, it is found that the indicator diagrams are very sharp, showing no admission lines. Is this caused by the new cam noses? H. C. C.

The new noses may give too great a lift to the fuel needle valve, allowing the oil charge to blow into the cylinder at once. Try giving the fuel rocker arm less clearance, which would cause the needle to open earlier and slower. Lowering the injection-air pressure often flattens the card. Your timing may be too early; if so, the maximum pressure will be above normal.

The "Locomobile" Power Plant—Why is the locomobile type of power plant so called, and what are the reasons for its superior economy? R. L.

The name "locomobile" came from the fact that as originally made these power plants were mounted on wheels and intended for portable use. The high economies are due to the precautions taken in their design to guard against initial condensation and to minimize loss of heat in the flue gases and the exhaust steam. The more economical plants are operated compound condensing. Steam generated in the boiler is passed through a superheater suspended in the smoke box with the direction of steam flow so arranged that the hottest steam is heated by the hottest gases. The steam then passes through a pipe within the flue to the high-pressure cylinder, which is jacketed by the hot flue gases. From the high-pressure cylinder the steam passes to a reheater receiver contained in the smoke box and is thence admitted to the low-pressure cylinder, exhausting through a feed-water heater to the atmosphere or to a condenser. The boiler-feed pump, and condenser pump if used, are driven directly from the main engine.

Effect of Negative Advance with Single Eccentric—If the eccentric of a Corliss engine is placed less than 90 deg. ahead of the crank, what effect will it have in the operation of the engine? M. D.

By setting the eccentric less than 90 deg. ahead of the crank, the events of admission, release and compression will occur later in the stroke. The lead may be corrected by shortening the steam-valve rods to obtain admission when the engine is on a center. But the steam valves would be partly open—that is, would have negative lap—when the wristplate comes up to its central position. Cutoff then could occur through greater range than one-half stroke, because the stroke of the piston would begin before the wristplate reaches its central position for cutoff may occur any time before the wristplate swings farthest to one side or the other of the central position during one-quarter of a revolution of the eccentric, or approximately while the piston travel is equal to one-half the length of the stroke. If earlier release is obtained by giving negative lap to the exhaust valves, they will not be closed when the piston reaches the end of the stroke and the exhaust will be open simultaneous with admission to the same end of the cylinder. To avoid this difficulty a long-range cutoff Corliss engine is provided with a separate eccentric for operation of the exhaust valves.

Reconnection of Armature Winding—What will be the correct pitch of the coil leads on the commutator of a single-series wound armature having 180 coils in the winding and 180 segments in the commutator? The machine has 6 poles and operates at 550 r.p.m. on a 250-vole circuit. At present the armature is wound single-series and is giving considerable trouble by heating excessively and also sparking at the commutator. Is there any way that I can tell if the armature should be wound single, double- or triple-series? C. R. S.

If the armature has 180 coils it cannot be connected single-series since the number of coils must agree with the formula,

$$C = \frac{P}{2} \pm 1$$

Where C equals number of coils in the winding, P the number of poles and X an integer which equals the pitch of the leads on the commutator and is obtained by dividing the commutator segments by the pairs of poles, in this case, $180 \div 3 = 60$; that is segments 1 and 61. Then the number of coils $C = \frac{6}{2} \times 60 \pm 1 = 181$ or 179. There are 180 coils in the winding, and since only 179 or 181 can be connected single-series, there is only one thing to do; namely, leave one coil dead and use 179. This will also require the bridging together of two segments in the commutator, thus obtaining 179 segments.

On account of the speed and voltage of the machine, it is very probable that a single-series connection is correct for the armature. If a single-series connection is correct, and the machine was connected double-series, the speed would be double that of normal, and with a triple-series connection the speed would be three times normal. However, a triple-series winding would not be used on a 6-pole machine, since the same results can be obtained with a single-parallel winding and the latter would be free from all the complications of the former.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses This is necessary to guarantee the good faith of the communications.—Editor.]

Thrift in Coal*

By GEORGE OTIS SMITH†

COAL is the shortest word we have to express industrial power and domestic comfort. Even the rumor of a coal shortage simply demonstrates that this fuel is in reality the staff of life to the industrial world, and the temporary stoppage of any of the larger sources of supply threatens a nation-wide crisis. Shut down our coal mines, and the country becomes not only cold but idle and hungry.

The figures of our total coal resources, millions of millions of tons, or even the few hundred million tons of our annual output, are too large to be grasped, and it becomes necessary to express the facts in smaller quantities. Roughly speaking, 1,000 tons of coal is what a mine worker mines in a year—the measure of what he contributes to the world's work and well-being. This human measure of 1,000 tons also has the advantage of being easily visualized as a short train load (20 cars) of coal on its way to serve the varied needs of the consumer, and in our brief review of the subject we may well first note what are these needs—the principal uses of coal, among which this unit of 1,000 tons is divided. (See Fig. 1.) Broadly stated, the largest use of coal is in furnishing motive power and heat for our industries and public utilities, 350 tons out of every 1,000 tons mined going to the boiler house of factory, mill, shop, or power plant. But next to these seven carloads of coal distributed throughout the country are five cars, or 250 tons of coal, which the railroads need for their own use. The domestic demand for coal comes next, 165 tons out of each 1,000 tons of anthracite and bituminous coal being used in the homes of the land for heating and cooking. The coke ovens require nearly as much as the homes, or 130 tons; and the balance of our miner's contribution includes the coal for export and bunker use, 60 tons; the 35 tons of coal used in operating the coal mines themselves, which of course does not make up a part of our train load; and the 10 tons that goes to the gas works.

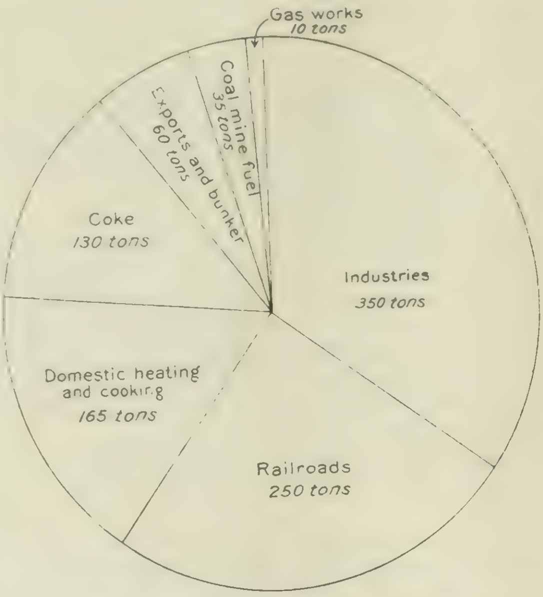


FIG. 1. WHAT BECOMES OF OUR COAL

Disposition of the miner's yearly output of 1,000 tons, including both anthracite and bituminous coal.

Even in this simple analysis of the uses of coal it would be difficult to establish any rigid scheme of priorities; we absolutely need coal for each of these uses, and this nation-wide dependence upon coal is so evident as to demand general attention to the subject of thrift in coal. Every citizen should do his part in making the best use of coal, but the responsibility of leadership in economy may with justice be placed upon the larger users.

The steel industry required in 1918 about 100,000,000 tons of coal, slightly more than two-thirds of it in the form of coke. So in dependence upon coal, this industry stands next to the railroads. At the bottom of the list of uses of coal, stated quantitatively, is blacksmithing, and the annual requirement of blacksmithing coal is less than a million tons. Contrast with the great steel plant, which consumes its 4 million tons of coal each year, the village smithy, which uses 50 pounds a day—and the question arises. Where is it of greater national concern that we begin to practice thrift in coal, at the little shop or at the big steel works? During the war the patriotic effort was made to save wheat and sugar in every home, however humble, and the aggregate results of such nation-wide thrift were most gratifying; yet with coal a different policy of initiating thrift seems warranted—the great industrial establishment or the superpower plant rather than the home is the place where saving will accomplish most.

We are on the threshold of fuel economy. Unprecedented high prices for coal have summoned American genius to the task of getting the full value out of the half billion tons of bituminous coal we burn each year; indeed, we have been too long content simply to burn coal rather than to use it. With coal at a dollar a ton the consumer was the profiteer, and profiteer-like he thought it paid him to disregard any claims except those of his own immediate gain. Now, the higher prices have opened our eyes to higher values in coal, and we begin to see the possibilities of profit in avoiding waste both in the mine and in the boiler room. We do not have to recognize the claims of posterity for coal conservation, for we can see money in it for our own generation — to mine the coal that we have been leaving underground, to utilize every possible heat unit in what we burn, and especially to recover everything of value that the coal contains. When we indorse Mr. Hoover's characterization of the bituminous coal industry as "the worst functioning industry in the country," it is with no spirit of unfriendly criticism. The simple fact must be faced that the story of coal is a story of waste, all the way from the face of the mine working to the smokestacks of the boiler plant—waste of a natural resource, waste of human endeavor, waste of capital, waste of transportation capacity, and waste of energy—and of none of these have we enough, much less any to spare.

It is customary to express our coal resources in terms of tons in the ground, but how inflated such an inventory becomes when we realize that of the ton of coal "in place," where Nature stored it for the use of man, the amount converted into mechanical energy, under the average practice of today, is only 76 pounds. The accompanying diagram, Fig. 2, exhibits the distribution of the losses thus indicated, in the responsibility for which mining engineer, mechanical engineer and consumer must all share. This general indictment of "average practice" makes the question of thrift in coal a national rather than an individual problem.

The proportion of coal we leave underground is a sad commentary on our appreciation of the value of coal, and the margin between high recovery, which may be stated at 95 per cent, and the average recovery of 70 per cent or less shows to what extent we are still wasting our coal at one place alone and where the world does not see the waste. By increasing the average output of the mine worker, we have made a gain of 50 per cent in the last three decades, so that we are saving man power if not coal.

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*From an address before the American Iron and Steel Institute, [illegible]

†Director, United States Geological Survey, Washington, D. C.

Not only is coal wasted in the mining, for no sooner does a ton reach the surface than 44 pounds of it is taken as toll for running the mine—indeed, in the anthracite mines, where often more water is raised than coal, the combined pumping, hoisting, and breaker operating cost expressed in coal has been stated as high as 200 pounds to the ton.

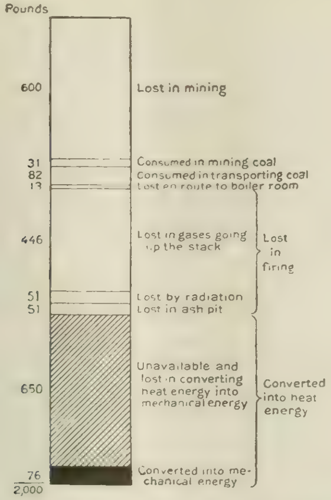


FIG. 2. EIGHT LOSSES IN COAL UTILIZATION

From data furnished largely by the Bureau of Mines, showing what becomes of a ton of coal under ordinary conditions.

But electrification of coal mines is gradually coming, with gratifying results in efficiency of operation and economy of fuel.

The consumer cannot evade his share of responsibility, because out of the 1,274 pounds of coal delivered at his boiler plant 548 pounds was lost in firing; he had been buying B.t.u.'s simply to throw away 40 per cent. Edwin Ludlow relates his observations at a large plant, where pride was taken in the fact that only the highest-grade coal was used, a standard of 15,000 B.t.u.'s being insisted on, but Mr. Ludlow called the attention of the company's executive officer to his boiler-room leaks, his steam results showing that he was obtaining only 11,000 B.t.u's from this high-grade coal. That coal user needed expert firemen more than chemists—better practice rather than more theory.

Another measure of coal waste in the generation of power, even where the conditions promoting efficiency are much more favorable, is afforded by the records of the public-utility plants of Massachusetts. During the month of June last the average coal consumption in all these plants was 2.29 pounds per kilowatt-hour, but at the largest plant of the largest company the average was 1.8 pounds—a saving in coal of more than 20 per cent, representing the difference between best practice and average practice.

How to save coal on a country-wide scale is the question. O. P. Hood, of the Bureau of Mines, has made the point that in a boiler plant construction, operation, and fuel are to a certain extent interchangeable. Skillful planning and careful operation can take the place of part of the coal; and on the other hand cheap coal has made possible careless firing of poorly constructed boilers without the wastefulness of the whole procedure being apparent on the books. Waste that can be seen only as a theoretical proposition does not appeal with the same force as waste that writes itself in red figures; and now that coal is no longer as cheap as dirt but has taken on the dignity that comes with high prices, we naturally begin to think of careful use. Just as we learned with foodstuffs during the war we are learning now that the higher value must be both given to coal and won from it. Thus the opportunity has arrived for the fuel engineer to teach us thrift in coal.

Still more striking is the evidence that can be brought forward to show the coal saving possible through the larger use of electricity as the agency in applying the energy in coal to the aid of human labor. Again it is proper to note in advance that the steel industry is already motor-driven as probably no other industry is—indeed, the motors used by this industry aggregate nearly one-third of the power of all the motors installed in the United States. Without allowing for the great possible saving of coal by the full development of our water power, combined and co-ordinated with steam power in large systems of electrical generation and distribution, the contrast between present average practice and best practice in power generation is so great as to strain our confidence in the simple figures of coal waste.

The statistics of fuel consumption show that the average steam plant, which is a small one (about 200 hp.), uses eight times as much coal as is necessary in the largest central stations, where the profit payable to thrift is recognized — that is, assuming the same consumption as the average central station of the same size, our average-sized industrial steam plant would use 10 pounds per horsepower-hour. If to this initial saving of 7 pounds of coal out of 8 at the large electric power station are added the possible savings on the railroad and at the mine, the ratio between present average practice and present best practice becomes nearly 12 to 1. Even if this indictment of waste is discounted one-half, the power users of this country stand convicted of almost criminal negligence, for cheap power

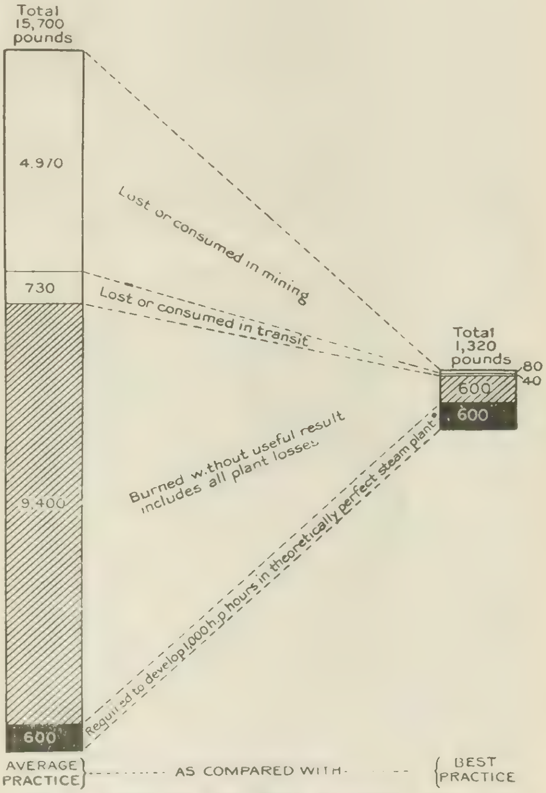


FIG 3 AVERAGE AND BEST PRACTICE COMPARED

These losses in average practice are based on data from the Bureau of Mines and the Super-Power Survey, and are calculated as in Fig. 2, except that in this case allowance is made for the additional loss due to bad load factor.

and plenty of it provide the only way to retain America's industrial leadership. For this reason both labor and capital are vitally interested in the power supply.

This contrast between the wasteful and the economical use of our coal resources is set forth in Fig. 3, which like Fig. 2 was compiled by my associate, F. G. Tryon. Starting with the 600 pounds of coal that contains heat units equivalent to 1,000 horsepower-hours, we find that the big electric station, with its modern steam turbine equipment, uses along with the 600 pounds of coal another 600 pounds from which it derives no return. This seems wasteful enough, but the little steam plant, with its poor load factor as well as much less efficient equipment, losing heat units up the stack, in the ash pit, through the steam pipes, and in the engine, wastes 9,400 pounds of coal for every 600 pounds it really utilizes — nearly a 16 to 1 ratio in favor of the big plant. So too, if railroads and mines were electrified and only 5 per cent of the coal instead of 30 per cent were left underground, 120 pounds of coal would mine and bring to the big plant the coal burned in generating 1,000 horsepower-hours, instead of the 5,700 pounds now actually required in serving the average steam plant with the 5 tons of coal it burns to get the same product of useful energy. The total cost of 1,000 horsepower-hours in terms of coal resources is therefore about two-thirds of a ton with efficient use, and nearly eight tons under the average conditions of waste at the little plant.

It is cause for general satisfaction, then, that in the first half of 1920 we find the power output of the central stations of the country increased more than 16 per cent over that of the corresponding period last year, while the fuel used seems to have increased not over half that percentage. In these public-utility plants the trend is decidedly toward fuel economy.

Coke Making and Byproduct Ovens

The use of coal in America for making coke dates back some eighty years, but the operation of byproduct ovens covers only one-third of that period, and indeed only last year did the output of byproduct coke first equal that of beehive coke. The field is thus divided between the old and the new practice, but two advantages of the byproduct ovens over the beehive ovens alone show how much the full substitution will mean to our country. First, the yield of coke in the byproduct ovens compared with that in the beehive ovens is 23 to 25 per cent greater with the low-volatile coals and 7 to 8 per cent greater even with the high-volatile Pittsburgh coal; and second, the recovery of 7 to 15 gallons of tar, benzol, toluol, and other oils, 16 to 30 pounds of sulphate of ammonia, and the surplus gas constitutes a great resource by itself. The recent consolidation of five great chemical companies calls attention afresh to the value of these wasted constituents of coal, for not only will this consolidation go far in making America industrially independent in the matter of dyes and other coal-tar derivatives, but the new corporation, which is one of the largest units in American industry, is founded chiefly on the profitable utilization of coal smoke.

Already fuel economy has reached so high a mark in the largest steel plants that the present practice gives gratifying results. Take, for example, such a plant with an annual fuel consumption equivalent to perhaps 4½ million tons of coal, and we find there the best by-product coke practice with utilization of the by-product gas and tar for melting and heating throughout the plant; also the waste gases from the blast furnaces are used in gas engines to blow the furnaces and generate electricity to meet the extensive demand throughout the works both to operate cranes, machine shops, etc., and in motors to drive not only the smallest but also the largest of our rolling mills.

But to picture the extension of this thrift in the use of coal as planning on a national scale demands, we are forced to supply some conditions that are not yet realized. This use of coal first as a raw material and next only in part as a fuel means the extension of byproduct practice until in no home or public building or factory will we find raw coal burned, but in its place either coke or gas, the other products having first been extracted to furnish the fuel for our motor cars, the dyes for our clothes, the surface for our roads, and even the drugs for our aches and pains. Several new methods of carbonizing coal are now being developed with the purpose of increasing the yield of valuable oils and of obtaining coke residues better fitted for domestic use—all looking forward to this much more general use of coke.

Unwarranted Optimism as to Reserves

The fact that more than half of the world's coal reserves are believed to lie within the territory of the United States has led too many of us into unwarranted optimism. The captains of the great industries concentrated along the Atlantic seaboard will do well to think less of the millions of millions of tons of coal that are said to lie awaiting their need in various parts of this continent-wide country of ours, but rather to ask for details as to where this coal is and how available it is for the use of this and the next generation. The total tonnage involves strings of figures hard for us to comprehend, but the tonnage remaining in the great producing fields of the East is so limited as to compel us to foresee their exhaustion within periods of the same order of magnitude as those which executives figure as the expectancy of life for industrial enterprises.

For example, the Pittsburgh bed in western Pennsylvania was estimated forty years ago as good for thirty generations, but the rate of mining has so greatly increased that now we must measure the exhaustion of this largest bed in the Keystone State by the span of a single generation. This is not an exceptional illustration of the shortened life due to unexpected increase in drafts upon our coal resources, for in the Georges Creek field in Maryland this same bed, there called the "Big Vein," was believed forty years ago to have a life of at least 150 years, but today the field is regarded as almost worked out. Even if you turn to a less nearly exhausted field, such as the Pocahontas, the earlier optimistic calculations of an expectancy of life of four or five generations are now reduced to three or even two. The lesson is that no matter how carefully the tonnage estimate of the coal reserve is made, no one seems able to estimate the rate of increase in demand in this growing country of ours. Not yet do we show any signs of slowing down in our industrial progress.

Another fact to be set down is that the best and most accessible coal is mined first, and even now we are skimming the cream from our coal resources. The truth should be stated even more plainly—we are mining much of the best coal with such disregard of the thinner beds in the same fields that we may be justly accused not only of carelessly skimming off the cream, but of throwing away the skim milk beyond any possible hope of recovery. We must therefore figure on increasing costs in the future, due to greater depth and longer hauls to market. This is another reason for delaying the exhaustion of our eastern coal fields by making full use of the coal we are now mining.

What Boiler Scale Does

Approximately 500 persons are killed and 800 injured annually throughout the United States by boiler explosions. Most of these accidents are preventable.

Of 376,822 steam boilers examined by the Hartford Steam Boiler Inspection Co., 184,635 were found defective, 19,219 dangerous and 1,122 uninsurable. The chief defect was a preventable one—scale.

Adhering scale caused 42,877 defective boilers, loose scale or sediment 28,212. Of the former, 1,612, and of the latter, 1,593 were found dangerous. Internal corrosion was the second chief defect, 19,008 boilers being found defective and 793 dangerous. External corrosion caused 10,968 defective and 814 dangerous boilers.

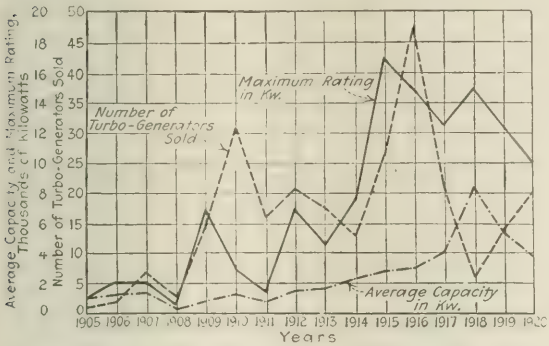
Scale is largely preventable; and so is corrosion. Scale and corrosion are different effects of very similar causes. Greater attention to boiler feed-water means safer, more efficient, longer-lived boilers, lower insurance rates and greater security.—*The International Steam Engineer.*

Power-Plant Equipment for Steel Mills*

The last five years of turbine development have been characterized by a rapidly increasing tendency toward the concentration of large capacities in single turbo-generators, by advances along the line of better economy and greater simplicity, by the use of higher steam pressures and superheat and by provision to obtain the full benefit of high vacuum.

From the curves in the figure it is seen that in 1905 the average capacity of turbo-generators installed in steel-mill power houses was about 1,000 kw., while in 1920 this has increased to an average of 4,000 kw. The maximum rating during 1905 was 1,000 kw., while today it seems to be in the neighborhood of 10,000 kw. The largest turbo-generator installed in steel mills is a machine rated at 20,000 kw. at unity power factor, at the plant of the Jones & Laughlin Steel Co. The average number of turbines sold in 1920 will be approximately twenty times that of fifteen years ago.

Although ten years ago the steel companies were buying low-pressure steam turbines to utilize exhaust steam from engines, the present-day tendency seems to be for larger high-pressure turbines. This selection of larger units is due to the almost unanimous opinion that the best practice is to have one or two central power plants to generate all the power and to equip all the apparatus in the plant with electric drive. This scheme is followed where new plants are installed, and the change from steam-engine units to electric units in old plants is taking place as rapidly as financial conditions will justify. It seems that it is only a matter of time until all plants become more or less completely electrified, at which time power houses of considerable capacity will be required and therefore specifications for turbines today should be made on this basis, which naturally results in the selection of units of comparatively large size to take advantage of the better economy obtained on large units.



TURBO-GENERATORS INSTALLED IN STEEL MILLS

CENTRAL-STATION POWER

During the war the rapid growth of many steel plants brought central-station power into prominence, but today it is a question whether this rapid growth will continue, owing to the rates charged by the central-station companies, troubles due to power failures and also to the fact that it is more economical to develop the waste heat available from blast furnaces, open hearths, etc.

The advantage of tying industrial plants to central-station lines or interconnecting various industrial plants has received considerable attention during the last five years. The Carnegie Steel Co. in the Pittsburgh district was the first to tie its power houses together and thereby was able to operate any one individual plant with less spare capacity and also to take advantage of the diversity factor of all the plants involved, which allows each one of them to operate at a more constant load with better economy. This system has been extended and now includes the National Tube Co.'s plant at McKeesport.

In addition to the foregoing the central stations that supply power to steel companies which do not operate their own generating equipment have been tying their power systems together so that the purchaser of power must now have circuit-breaker equipment to take care of the ultimate capacity of all the plants connected to the system instead of the individual power company contracted with. As systems are tied together, in order to be properly protected it is necessary for the steel companies to provide larger circuit-breaker equipment, use reactors and in some cases adopt the grounded-neutral system, as all these features tend to eliminate troubles that are otherwise not present on small generating systems. The large central-station companies have been forced to take these precautions, and now that the steel companies are installing systems which within a few years will be equal to the capacity of some of our present-day central stations they, too, will find it necessary to add these protective devices.

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*Abstract from the Association of Iron and Steel Electrical Engineers' Electrical Development Committee's Report, presented at the fourteenth annual convention, held at Hotel Pennsylvania, New York City.

Testing Welds*

By S. W. Miller, M. E.

The question of testing welds is one that has been considered more or less since welding was known, but especially during the last five years. Its importance has now become very great. There have been many failures in the past, many of them not having been explained and some of them having been very expensive. As in all other developments, welding first received its principal impetus from the practical man. Of late, however, the tendency has been to investigate more carefully and more fully and by means not available to the ordinary welder. This means that scientists of all kinds have been called into consultation and that almost every conceivable method of test has been suggested in order to determine what methods and materials would make the best welds from a standpoint of security, service and cost.

The welding of steel is frequently considered as not being especially difficult, and it is also sometimes considered that steel is steel and that no different treatment is required in the case of different qualities and varieties of steel. This idea is much less common today than it was several years ago, but it is still too prevalent for the good of the art. It is not as well known as it should be that a comparatively small difference in the percentage of carbon in the material being welded makes a very great difference in the results of either a bend or tensile test. If the carbon is 0.12 per cent or less, the material is soft, ductile and yields readily to any strain that may be put on it. Such material is frequently used for tanks and, because of its ductility and comparative freedom from damage by heating, is admirably suited for welding. Structural steel, bar steel and boiler plate contain about 0.15 per cent to 0.25 per cent carbon and have a tensile strength of about 60,000 lb., while the soft low-carbon material has only about 52,000 to 55,000. Ship plate is required to have a tensile strength of from 58,000 to 68,000 lb. and in the heavier sections requires as high as 0.30 per cent carbon. It has been found by experience that the higher the carbon, the more difficult it is to get a satisfactory weld and the more danger there is of injuring the metal being welded. It is also evident that a weld made with a given welding rod or electrode can have only a given strength. If this strength is greater than that of the material being welded, the test piece will always break outside of the weld. If, on the other hand, the weld is weaker than the material being welded, the rupture will always take place in the weld. An oxyacetylene weld made with ordinary low-carbon welding wire will have a tensile strength of about 52,000 lb. This is stronger than soft tank steel and weaker than the other materials mentioned. It is possible to get with alloy steel rods of proper composition a tensile strength in an oxyacetylene weld of about 50,000 lb. Neither of these materials will weld boiler steel, boiler plate or ship plate, so that the rupture will occur outside the weld when the section of the weld is the same as the section of the piece, and in making tests of welded pieces, it is necessary to know accurately the character of the material being welded.

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*Abstract from a paper read before the September meeting of the Chicago Section of the American Welding Society.

The method of test to be applied in any given case depends largely on the use to which the welded piece is to be put. If it is to be used in a pressure vessel, I believe that not only should a tensile test be made, but that an alternating stress test should be used because of the breathing of the tank due to changes of pressure. This latter test should also be applied where the weld is subjected to bending strain. There are no standards at present for weld tests, but it is advisable, wherever possible, to follow those of the A. S. T. M.

The best test, in my opinion, to determine quickly the general character of a weld, is to grind it off level with the surface of the pieces and clamp it on an anvil, with the center of the weld level with the top of the anvil, the bottom of the "V" toward the anvil so that the top of the weld is stretched when the projecting end is struck with a sledge. The blow should not be too heavy, and the number of blows and angle to which the piece bends before cracking are quite a good index of the value of the weld. It is true in this test, as in the tensile tests, that the quality of the material being welded has a great influence on the results. Stiff material throws more of the strain into the weld, while soft ductile material will itself take considerable of the bend. In the case of defective welds—that is, those not fused along the "V" or which contain slag or other inclusions—this test will at once develop the defects. If a welded piece were to be used in a place where it might become red hot such as, for instance, in a locomotive fire-box crown sheet, it would be entirely proper to test the welds at a good red heat by clamping them in a heavy vise or on an anvil with the center of the weld about half an inch from the edge of the vise or above the face of the anvil, heating them to a bright orange with the torch and then bending them as before as with a sledge.

If such welds are made in ½ x 2-in. bar steel, a 90-deg. single "V" being used, and they bend to a right angle cold without cracking on the outside, a welder may feel well satisfied with his work.

TESTING RAILS FOR HIDDEN DEFECTS

There has recently been developed a method for testing rails for hidden defects which was devised by A. M. Waring. It consists of deeply etching a polished surface of the material under test. For instance, a section of a weld might be cut out with a hacksaw, machined or filed to a true surface, and polished on various grades of emery paper, ending up with 00 Manning. It is then placed in a warm solution of 25 per cent hydrochloric acid and water for from one-half to an hour. The acid will eat away the defects, making the edges of the material at them taper, so that rather large grooves and pits will be visible where the defects prior to the etching would be only microscopic. The etching test I consider to be of the greatest value in ordinary shop practice where it is desired to find out rapidly and quite accurately the quality of the work done by the different welders.

These rough tests, while satisfactory for determining the general quality of the work, do not answer as a basis for design, and more refined tests must be used as before referred to. I believe that the most important of these are the tensile and alternating-stress tests. The tensile test can be made in any shop provided with the usual tensile testing machine. The alternating-stress test is not as yet standardized even for unwelded material. I am inclined to believe that the machine devised by the Quasi-Arc Company is of considerable value, although it does not give absolute results; that is, it does not give the amount of fiber stress to which the piece is subjected.

A great deal may be learned from the appearance of a weld. It is difficult to describe the appearance of good welds, but after they have been seen a number of times, an inspector can readily say whether the operator knows what he is doing. In gas welding, I would not accept a ripple weld in heavy material nor one which was narrower than about 2½ times the thickness of the sheet, because I have never seen a weld having these appearances that was properly made. The appearance in a gas weld of porosities on top indicates that the metal has been overheated, and the same thing is true in an electric weld. Inasmuch as I believe that the serious defects in welds are caused by oxides, it would appear wise in the case of gas welding to use no larger top than is necessary to produce thorough fusion. This means that the catalog speeds of welding are impossible if good welds are desired. The same thing is true of electric welds. The reason is that at the high temperatures of the steel caused by too large a tip or too heavy a current, the metal becomes overheated, and in that condition combines more readily with the oxygen of the air or with any excess oxygen in the torch flame, and produces oxides which are readily dissolved by the melted metal. As the metal cools down, these oxides are rejected in large part and pass to the grain boundaries, as do other impurities, so that it is perfectly natural that material that has been seriously overheated should be more brittle and weaker than the material that has been properly melted. In conclusion, I have found in a number of cases that very great improvements in the quality of the work were made by using regularly the bending test already described and by carefully instructing the welders until they were able to make welds that would meet this test with unfailing regularity.

The Mechanical Engineer the Heir of All the Ages

On Friday evening, Oct. 22, at the Morrison Hotel, the Chicago section of the American Society of Mechanical Engineers held its first dinner meeting of the season. The new chairman, H. S. Philbrick, professor of mechanical engineering at Northwestern University, was in the chair. He spoke of the spring meeting of the society which is to be held in Chicago at the Congress Hotel, from May 23 to 26. A request was made for suggestions on excursions, topics for discussion, and in fact any suggestion that might help make this meeting as great a success as the previous gathering of the same society sixteen years ago. Attention was called also to the next meeting of the Chicago section, at which Dr. George Otis Smith, of the U. S. Geological Survey, will talk on "Industry's Supply of Energy." Historical reminiscences of the society will be a feature of the meeting in commemoration of its founding forty years ago.

MR. FINLEY'S ADDRESS

W. H. Finley, president of the Chicago & Northwestern R.R., who was the speaker of the evening, took as his subject, "The Mechanical Engineer." Speaking from the railway viewpoint, he had always felt that the mechanical engineer did not get the appreciation that was due him, although in this regard times were changing. In the early days the great majority of engineers employed were of foreign extraction, with an odd American here and there. The technical schools of the country are now turning out engineering graduates in shoals, and many of them develop into excellent engineers.

In the early days of the railroad the engineer assumed knowledge on all kinds of engineering work and the officials expected him to do it. They were now beginning to realize that it was desirable to have experts in the different branches of engineering, although it was his feeling that even yet they had not employed the mechanical engineer enough. There were so many places where his knowledge would be of great benefit, such as in the conservation of fuel, the heaviest of railway expenses, development of the locomotive stoker, superheater and other mechanical appliances tending toward efficiency. The comparatively small oil supply and the limited amount of energy available from water left coal as the leading fuel. Devising efficient methods of burning this fuel and of conserving it were functions of the mechanical engineer, but this was only a small part of his duty. The mechanical era was just opening up and remarkable developments were to be expected. Even on the farm the mechanical appliances in use today were marvelous when compared to the equipment used by the last generation. The engineer must take his part in directing and guiding labor and in the elimination of the labor troubles so common in these days. To do this effectively he must know human nature, make himself better known to the public, take a greater interest in public affairs and with his knowledge back of him assume his proper sphere in the world's work. The mechanical engineer was the heir of all the ages. He was now passing the civil engineer as he had a bigger, broader field than any other branch of engineering.

In the speaker's opinion every branch of engineering needed an engineering society, and the discussion here should be limited largely to technical matters relating directly to the field. Only in this way would rapid development be assured. He did not favor the turmoil of the present day and the branching out into fields foreign to the profession, or at least, verging on the distant horizon. Civil affairs and subjects foreign to the field should not be mixed with the technical side of engineering.

Discussion

Colonel Henry A. Allen agreed that the engineer should take his place in public life, but said that he must be careful how he did it. The engineer was accustomed to systematic analyses from cause to effect so that he should be more logical than most men—one of the necessary qualifications for a leader. He believed that the time was not far distant when the steam engine would resume its place at the top of the mechanical field and be more efficient than any other type of prime mover. The theory of harmonics might play an important part in this development.

W. L. Abbot referred to the stampede of professors and technical instructors into commercial life, due to the higher salaries obtainable and the miserable pittance now paid them. At the same time there was a great increase in the number of technical students, and with the shortage of instructors it was necessary to group them into classes double the size that it was formerly recommended one professor should handle. With the teaching profession going into commercial life and the pupils per instructor so greatly increased the graduate engineers were not so good as they should be nor so good as they were previous to the war. In these days the cost to the student was comparatively high and a college course took the best four years of his life. Consequently, he was entitled to the best instruction obtainable. It was his earnest desire to see salaries in the teaching profession so increased as to encourage the best engineers to enter the field of teaching and to retain the best of those that were left.

Engineering Council Meets in Chicago

On Oct. 21 the Engineering Council spent the day in Chicago at the rooms of the Western Society of Engineers discussing the various matters which this body has had under consideration. There were progress reports from committees and incidental mention of other matters, but the discussion turned chiefly to the Patent Office situation, the proposed Department of Public Works and to the registration of architects, engineers and land surveyors. It was one of the usual meetings of the council held in Chicago to give Western members a better opportunity to attend. J. Parke Channing was chairman of the gathering.

On the classification and compensation of engineers the council had done some good work. It only remained to give publicity to the subject as well as to address communications to Government, state and civil bodies. A full report containing a complete review of the work of the committee as a whole for the past year was to be presented at the next meeting.

While the Water Conservation Committee had been extremely active, getting advice and data from the best engineers in the country on the regulation of water power, it was not ready to report at the present meeting. It was the general consensus of opinion that the council should favor this committee's making a report to the Water Power Commission, giving only general principles and leaving the details to be worked out by engineers retained by the commission.

Closer co-operation between civil and military engineers was proposed, and it was suggested that letters from the Military Affairs Committee be addressed to the heads of the several technical services of the Government.

A typical registration law for architects, engineers and land surveyors was finally approved by the council as remodeled by the License Committee. Before final adoption it is to be referred to the architects for their approval, as the desirability of co-operation between these two professions was recognized. While the council was not particularly in favor of registration it was realized that the progressive tendency of the day called for some such action. In fact, eleven states had already passed registration bills more or less radical in their requirements and differing one from the other. It was considered of utmost importance to have a model bill ready that could be sent out as a guide wherever legislation on the subject was pending. Such procedure would tend to insure uniformity and eradicate undesirable features. As it reads at present, the bill does not prevent anyone from practicing engineering or architecture provided he does not call himself an engineer or architect and does not use the word "registered," the latter term indicating that his qualifications had been passed upon by the proper official body.

Department of Public Works

M. O. Leighton made a strong appeal in behalf of the national Department of Public Works. While the campaign for the organization of the Government's engineering forces into one department had been successful beyond expectation engineers had lately shown apathy, and unless they rallied and gave strong moral rather than monetary support others outside of engineering would acquire the credit for the success of the first great engineering movement. The question was raised whether civil or military engineers should control the public works of the country. It was stated that the die would be cast at the next meeting of Congress so that if any action were to be taken promptness was a necessity. More of this will be given in detail on another page of this issue. The council decided to send out letters to all engineering societies in the hope of rallying engineers into a renewal of their enthusiasm for the movement.

Patent Office Reorganization

The proposed bill for the reorganization of the Patent Office had met with no obstacle except that the Senate had reduced the force in the department, although in the bill the fees had been increased to cover an addition to the force and increases in salaries. This additional help was badly needed in the Patent Office as the volume of work was very great, and the department was so far behind that it had almost ceased to function. It was considered the duty of the council to have the bill restored to its original form, and to this end all engineers will be requested to write their respective representatives.

It was agreed that the council should give its support to the placing of engineers in the public health service on the same footing as medical officers. There was also favorable expression toward giving all assistance possible to the Federal Power Commission by urging Congress to make the $476,000 appropriation requested as well as appropriations for research work, especially for the Bureau of Standards. It was agreed, however, that these matters might better be left to the successor of the council.

For engineer of the new shipping board the council suggested the following three men as possible candidates: W. H. Adams, of Detroit; Prof. Henry E. Riggs, of the University of Michigan, and Admiral H. H. Russo, of Washington. The first two seemed to be favored as they came from the Great Lakes District. All steps for transfer of the work and termination of the existence of Engineering Council were left to the next meeting, which will be held on Nov. 17 in Washington, D. C.

Black Coal Versus White Coal[*]

"The attention of the nation is now more than ever before directed to the need for coal conservation, cheaper power and development of our great unused water power assets." With these words Hon. Alexander T. Vogelsang opened his address before the convention of the Water Power League at Washington. He brought out clearly the acuteness of our national need for coal conservation and discussed in considerable detail the methods by which this problem must eventually be solved.

In the first place the speaker pointed out that the price of bituminous coal has increased about 175 per cent in the last seven years, and that the increase of population, of industrial activity, of necessity for food distribution, together with the constantly contracting ability of railways to meet the situation, causes a condition that calls most stridently for relief. This condition, however, is not due so much to lack of supply, as it is to improvident and inefficient use, the great distance between mines and industrial centers, and the consequent burdensome haulage of coal to the exclusion of other and more valuable merchandise and commodities.

In regard to the inefficient use of coal strong arguments were brought up to support the speaker's contention that the ordinary steam locomotive is decidedly wasteful. He said that it had been shown that one electric locomotive is as efficient as four steam engines. On the Butte, Anaconda & Pacific Ry. seventeen electric engines do the work of twenty-eight Mastodon-type locomotives. The practicability of this use, its economy and its efficiency have been conclusively demonstrated by the Chicago, Milwaukee & St. Paul R.R., in its mountain divisions using hydro power, and the New York, New Haven & Hartford using steam-generated energy. This, however, is but one of the many ways in which coal can be saved.

It is expected that the super-power survey of the North Atlantic industrial district, now in progress, will show that 30,000,000 tons of coal may be annually saved in that district alone; and on this basis it is fair to assume that country-wide efficiency in coal consumption will save at least 150,000,000 tons annually. It is estimated that this would liberate nearly 20,000 railroad cars for other uses. More efficient methods of burning coal, therefore, are needed not only to save the coal itself, but to relieve railroad congestion.

Our Water-Power Resources Distant from Population Centers

The railroad problem, however, is complicated by a condition peculiar to this country. While in Europe the water-power, or "white coal" resources are generally found lying close to great population centers, in our country just the opposite holds true. Seventy per cent of our "white coal" is located in the semi-arid West, far away from our population centers, and therefore far from the habitation of our labor supply. For instance, the State of Wyoming, with twenty times the area of Connecticut, ten times the water-power resources and enormous coal and gas reserves, has only 11 per cent of Connecticut's population and produces only 7 per cent as much energy in its public-utility plants. Wyoming has everything in the way of power resources and raw materials, but she has not the population necessary to large manufacturing enterprises. The question then is, Will the industrial centers be drawn by economic necessity to the source of power or will the haulage of raw material for power and manufacture continue indefinitely? The speaker expressed the opinion "that the pull of energy sources must prevail in the end." This, however, he regarded as rather fortunate than otherwise; for the West, which contains 70 per cent of our water-power resources, is the healthiest part of the country and, when present reclamation projects are completed, will have about 3,000,000 acres under cultivation. This land should support, directly and indirectly, a population of nearly 1,000,000. It is more than half expected, however, that 40,000,000 acres will be irrigated ultimately, and this should be enough to support upward of 13,000,000 people. The semi-arid West will in time be capable of supporting a population great enough to utilize its resources directly.

This western movement will make feasible and necessary the utilization of our "white coal" reserves. It will remove the chief obstacle to such development; namely, distance from the point of application, by bringing factories to the very source of power. Aside from the power that such factories will need, however, will be the ever-increasing use of it to run agricultural machinery of all kinds. Electric energy may be and is being profitably applied to almost every farm operation, from the plow of the field to the sewing machine in the household. A shining example of what can be done in this respect is in California, where the production of rice has been made possible through pumping by electric power. The value of the California rice crop of 1919 was $27,000,000, yet the cultivation of that cereal only began commercially in 1912. In California the farmer uses more electric energy than in all other states combined, and this is practically exclusively water-generated.

All this goes to show that not only the conservation of coal, but the progress of agriculture, of industry in general even, depends upon the utilization of our water-power resources.

What Foreign Nations Are Doing

Foreign nations are coming to a realization of these facts faster, apparently, than are we. One of the large American companies engaged in the manufacture of water-power machinery states that it is receiving three foreign inquiries for such machinery to one received from the United States, and that if orders shall be placed in proportion, its shops will be filled with foreign instead of domestic orders. It thus behooves us to be up and doing in this direction. In most foreign countries development will be undertaken by the government itself, but in Spain and perhaps other countries liberal concessions are offered to private enterprise. Some initial help should be given development projects of this kind, for they are generally designed to provide much more energy than is needed at the time they are built and consequently do not earn much at first. The harnessing of flowing water is very expensive. The initial outlay is very great, but maintenance and operation are comparatively low, and falling water does not go on strike nor cease operations for human reasons. The Government owes it to itself to provide aid in this matter, for the industrial primacy of a nation depends upon the extent and cost of its mechanical power, upon the economical production and transportation of manufactured goods and high value commodities.

New sources of power are now under very active development in California, where the demand still far outruns the supply. The Pitt River system, having a producing capacity of about 500,000 hp., is under present and vigorous attack, and it is safe to assume that in five years a large percentage of its potential will be flowing over the wires.

The Feather River system, of at least equal capacity, is likewise receiving intensive treatment and will shortly pour increased streams of power into the eager market.

Similar enterprise is manifest southerly in the Sierra region, so that we may expect in a few years to see the continuous hydro power of California doubled.

Fullest development of all of these sources will involve more or less use of public lands.

Effect of New Water-Power Law

The new water-power law has cleared the atmosphere of much fluff and dust put in circulation by many well-meaning though impractical folks, and it is a fair chart for enterprise and investment wherein the public interest has been well protected. The right of the states to regulate rates to consumers is recognized, and such regulation by carefully selected commissions has thus far had general public commendation. Indeed, with public control of financing, extension, and rates to yield only reasonable return upon cost, it would seem that in this day there can be but small cause for complaint.

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[*] Abstract of an address made by Hon. Alexander T. Vogelsang, First Assistant Secretary of the Interior, at the National Convention of the Water Power League of America, Washington, D. C., Oct. 7, 1920.

Unfortunately, detailed information of Alaskan water powers, which are known to be extensive, is very meager owing to lack of an appropriation for making investigation. It is hoped that Congress may immediately provide plans for a proper water-power survey in this land of large opportunity.

In closing his address, the speaker said:

No greater field for true conservation is open to the people of the United States than that of fuel preservation, and water-power development is its greatest possible conservator.

Let me conclude by expressing my full and free accord with the unselfish objects and purposes of the Water Power League of America. I am sure it will prove an invaluable aid and auxiliary to the Water Power Commission.

Perhaps its greatest usefulness may be found in the task of selling to the American public the conviction that cheaper power production is a national need, and selling that conviction in words and phrases devoid of technical terms and professional jargon so that all who hear may understand. This calls for hammering and rehammering upon the subject until the man in the street shall know as well as the expert that the use of falling water is the greatest and most important item in all the gamut of conservation.

The Need of a National Department of Public Works

Speaking before Engineering Council at the Chicago meeting of Oct. 21, M. O. Leighton, of the National Service Department, presented a strong argument in favor of the proposed plan for a National Department of Public Works. He mentioned two outstanding facts which evidently were not anticipated when the public-works movement took shape in Chicago in April, 1919. The first is that the engineers of the country in good faith started something which they do not seem inclined to finish. The second is that the scope of the movement and its ramifications extend beyond all limits written or spoken at the time.

No doubt the enthusiasm of many engineers has been cooled, and in some cases their active opposition has been brought about by the skillful campaign carried on by members of the Corps of Engineers, U. S. Army. No complaint is made of the activities of the army engineers, as their opposition to a public-works department was expected, and they have done only the very obvious things that civil engineers would have done if the situation were reversed. At any rate many of the civilian engineers counted on for support have been won over to the cause of the army engineers.

Efforts are now being made, however, to line up support behind the measure. Some weeks ago there was a meeting in New York City, attended by John T. Pratt, the head of the National Budget Committee; Herbert Hoover; Henry L. Stimpson, former Secretary of War; Paul Warburg and Major C. T. Chenery, at which matters of Government reorganization were discussed, and particularly the need for and the possibility of amalgamating all reorganization efforts under a commonly accepted and supported program. It was brought out that if the many organizations which are working for a National Department of Public Works conduct campaigns separately, each for its own particular project, the confusion created in Congress will probably result in no legislation; that is, each organization, while being unable to achieve its own ambitions, will, as a consequence of its activity, defeat the ambitions of every other. It was therefore decided to call a meeting of delegates from the several organizations advocating reform in the Government departments, for the purpose of organizing a Federal Reorganization Council, which would be the common body through which an accepted program would be carried forward.

These delegates met in New York on Oct. 14, at which time the nearly completed report of the National Committee on Governmental Economy was presented. That program provided for a general rearrangement of Government activities along functional lines, including the creation of a Department of Public Works by a reorganization of the present Interior Department, and an additional department to be called the Department of Education and Health, into which would be drawn such welfare activities as war-risk insurance, vocation and rehabilitation, pensions, etc. After discussion the idea of a National Council was tentatively adopted by the delegates with an agreement to report back to their several organizations for the purpose of securing adoption of the plan for a reorganization council and the appointment of delegates thereto. The meeting for final organization will take place on or about Nov. 15. The prospective field of such a council is not limited to the mere reorganization of Federal activities. It should, if properly conducted, become the authoritative unofficial body to engage in the work which will eventually lead to a distinct separation of the political features of our Government system from the conduct of departmental business.

When Congress meets in December the question will in all probability be settled for some time to come, so that the time is short and whatever action is to be taken should be commenced without delay. Mr. Leighton pointed out that although the principle of a Department of Public Works is thoroughly settled in the minds of the public and of a majority of the members of Congress, the important question remaining is the kind of department that we shall have. Shall it be civil or military? Shall the corps of military engineers be in command of all the Government's public-works functions, to the perpetual subordination of the civilian engineer; or shall they constitute, as was originally intended, a military arm of the Government and be given their training and experience by temporary assignment to positions in the civil work?

The civilian engineers of the country must decide, and if they are defeated in the forthcoming contest the fact will, in the opinion of the speaker, be an evidence that the military engineers deserve their success, for it will show that whatever may be their engineering qualifications and however severely their ideals may depart from those which are supposed to constitute the cornerstone of democracy, these men do, nevertheless, possess an essential characteristic which the great body of civilian engineers does not; namely, that they know men and are overvigilant in the exercise of their knowledge.

Federal Trade Commission Makes Recommendation on the Oil Situation

According to The American Petroleum Institute, the Federal Trade Commission has presented a report to Congress in which it makes recommendations to the effect that:

1. Those engaged in the oil industry in this country should be encouraged with all proper diplomatic support to develop production in foreign countries which have oil resources, in order to conserve our own supply.
2. In view of the excess of present consumption over production from domestic sources and increase in exports in spite of the deficiency, it might be advisable to restrict the exportation of domestic crude oil and its products.
3. Wasteful methods in drilling for oil should be studied with a view to discovering what remedies may be possible through state legislation or otherwise.
4. Appropriations should be made for a study of more economical methods of utilization, the possibilities of oil shale, and the availability of substitutes.
5. Information regarding changes in industrial and commercial conditions in the oil trade should be currently collected and reported for the use of Congress, the public and the industries.

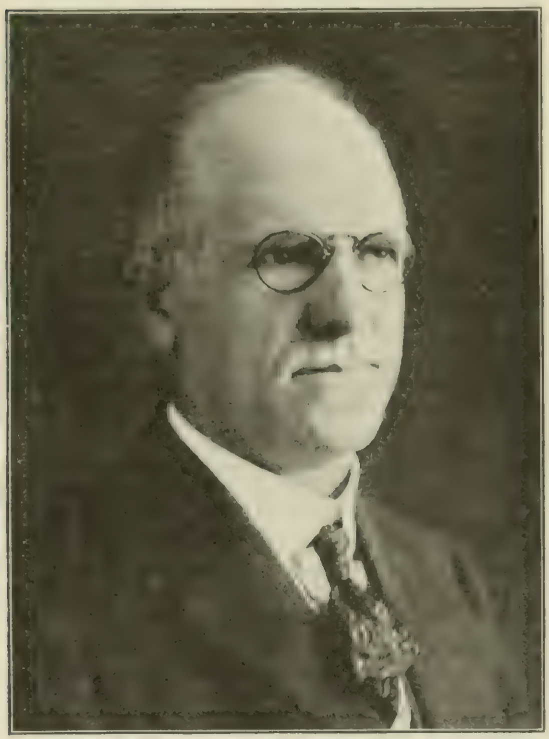
The United States Commerce Report for Oct. 15 contains an extended discussion of petroleum possibilities in Colombia. According to this report, "The Republic of Colombia is looked upon by prominent geologists as a promising field for the exploitation of petroleum resources. The world demand for petroleum and its products, the favorable reports of geologists, and the actual commercial production from several wells should prove an incentive to the development of the petroleum resources of Colombia."

Professor Allen Dies Suddenly

Professor John R. Allen, director of the Bureau of Research of the American Society of Heating and Ventilating Engineers, died suddenly on Oct. 26 in Pittsburgh.

His loss is a serious one to the engineering profession as well as to his friends; he has long specialized in the heating and ventilating field, and is responsible for a great part of the progress which has been made in this department of engineering activity in the last few years. His last important work along this line was in connection with the ventilating problems of the New York-New Jersey vehicular tunnel; he was consulting engineer on this work, and his comprehensive knowledge of the subject was of the greatest value in solving the difficult problems encountered.

Professor Allen was born July 23, 1869, in Milwaukee. After his graduation from high school, he entered the University of Michigan. He was graduated in 1892 with the degree of B. S. and was given his master's degree in 1896.



JOHN R. ALLEN.

His first position was with the L. K. Comstock Construction Co., where he remained for two years. At the end of this time he was appointed as instructor in the mechanical engineering department of the University of Michigan. His capabilities were recognized here, and by the time he left in 1911, he had become professor of mechanical engineering. His resignation was to enable him to organize Robert College, Constantinople, in which he was dean of the engineering department until 1913. He then returned to the University of Michigan as head of the mechanical engineering department.

In 1917 he again left the University of Michigan to become dean of the College of Engineering and Architecture, University of Minnesota. In 1919 he became director of the Bureau of Research of the American Society of Heating and Ventilating Engineers, in which he did some of his best work.

Professor Allen was active in a number of national engineering societies and was past president of the American Society of Heating and Ventilating Engineers, Michigan Engineering Society and the Michigan Chapter of the American Society of Heating and Ventilating Engineers. He was the president of the Minnesota Chapter of the American Society of Heating and Ventilating Engineers. In addition to these offices which Professor Allen held, he was an honorary member of the National District Heating Association, and a member of the British Institute of Heating and Ventilating Engineers, of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education and of the honorary societies, Tau Beta Phi and Sigma Psi.

Coal Operators Becoming Uneasy

Approximately one thousand soft-coal operators met in Cleveland on Oct. 26 to consider Attorney General Palmer's telegraphed request that steps be taken to eliminate exorbitant prices. This telegram, which was addressed to Colonel D. B. Wentz, president of the National Coal Association, was as follows:

> I am informed that you have called a meeting of operators of bituminous-coal mines throughout the country at Cleveland for the purpose of complying with my recent suggestion that the operators should reduce prevailing unreasonable high prices for bituminous coal and thus lessen the number of prosecutions to be instituted by the Department of Justice for violations of the Lever Act in charging unreasonably high prices. If the operators limit themselves at that meeting to discussing prices with the sole purpose of preventing unreasonably high prices and without any attempt directly or indirectly to fix prices, I would consider such action as an effort to comply with the Lever law. It would be particularly helpful to this department if in pursuance of the general purpose to reduce prices the operators could arrange for reports to me voluntarily made to our district attorneys in cases where any operators continue to charge unjust and unreasonable prices. You will understand, of course, that I assume there will be no effort directly or indirectly to hold prices up or to make them uniform for any of the producing or consuming regions, either by the operators at the Cleveland meeting or by any of their committees or representatives.

A committee appointed to consider this matter reported the following resolution:

> Whereas, An abnormal condition for some time past has existed in the bituminous-coal industry of this country, due to inadequate transportation facilities, labor difficulties and shortage and other causes beyond the control of the bituminous coal operators of the country; and,
>
> Whereas, The Attorney General has requested the bituminous-coal operators of the country to co-operate with the Department of Justice in bringing about the elimination of unreasonably high prices for coal where such exist; and
>
> Whereas, It is the sense of the bituminous-coal operators of the country that unreasonably high prices and unwise practices, where such exist in the industry be eliminated;
>
> Therefore, Be it resolved that the bituminous-coal operators of the country refuse to ask or receive unreasonably high prices for bituminous coal, and further that all unwise practices in the industry, where any such exist, be condemned and eliminated; and
>
> Be it further resolved that it be recommended to each bituminous-coal district in the United States that it immediately establish a committee in its district, and that such committee so established use every effort to co-operate fully with the Department of Justice and the United States Attorney in such districts to bring about an elimination of unreasonably high prices and unwise practices, where such exist, in order that the purpose and the object sought by the Attorney General throughout the whole country may be accomplished.

This resolution was unanimously adopted and was then forwarded to Mr. Palmer, together with a communication from Colonel Wentz, the chairman of the committee. Colonel Wentz notified Mr. Palmer of the passage of the resolution, and added:

> Operators from some of the districts are already holding meetings in Cleveland preparatory to arranging co-operation with your representatives in their respective districts, and other meetings between your representatives and operators will be held promptly throughout the several producing districts of the country.

New Publications

THE PRACTICE OF LUBRICATION. By T. C. Thompsen, B. Sc., M. I. Mech. E. Published by McGraw-Hill Book Co., Inc., New York. Cloth; 602 pages; 227 illustrations. Price $5.

This volume covers the lubrication problems occurring with all types of machinery and is probably the most complete treatment of this subject that has yet been published. Usually, a volume on an engineering subject must meet the needs of either the technical or the practical man; Mr. Thomsen has happily been able to collect and present material that is of vital importance to both classes of engineers. Regardless of the particular class of machinery under his supervision, every engineer will find here much information for his guidance in proper selection or use of lubricants. It is a volume that fills a decided need and should meet a welcome reception from the engineering public.

Personals

Gordon Fox is to take up work as electrical engineer for Freyn & Brassert Co., consulting engineers, at 645 Peoples Gas Building, Chicago, Ill.

Robert Craig, chief engineer of the American Sales Book Co., Niagara Falls, N. Y., has resigned his position and will make a visit to Scotland. Upon his return to this country he will locate in California.

W. D. Mann, formerly with the American Incandescent Heat Co., is now combustion engineer in the engineering department of the Petroleum Heat and Power Co., Boston, Mass., formerly Fess Rotary Oil Burner, Inc.

Thomas Durban, for years identified with the selling department of the Erie City Iron Works and first chairman of the Administrative Council of the Uniform Boiler-Law Society, has accepted a position with the Erie Forge and Steel Co.

Charles M. Reed has recently accepted the position of power engineer for the Portsmouth Cotton Oil Refining Corporation, Portsmouth, Va. He was formerly assistant to the steam engineer, American Sheet and Tin Plate Co., Pittsburgh, Pa.

Kenneth Watts, who for the last seven years has been in charge of the gasoline plants and producing properties of the Oklahoma Petroleum and Gasoline Co., of Tulsa, Okla., is to take charge of the operation of a large oil company in South America.

Society Affairs

The Cleveland Section of the Association of Iron and Steel Electrical Engineers will meet Nov. 8. Gordon Gage, of the American Rolling Mill Co., will discuss "Slip Regulators vs. Notchbacks." All Cleveland Section meetings will be held at the Electric League Club Rooms, Hotel Statler.

The American Society of Mechanical Engineers is to celebrate its twentieth anniversary on Nov. 5. For the first time since the special meeting of the society, held at the Panama Pacific Exposition in San Francisco, the president has called a special meeting of the society to be held on Nov. 5 in the Auditorium of the Engineering Societies Building in New York City. At the same time meetings are to be held in cities all over the country, and these will be considered supplementary to and part of the gathering in New York. The latest report indicates that meetings are to be held as follows: Connecticut, at New Haven; Waterbury Branch, in the Chase Company's office building, Waterbury, Conn.; Mid-Continent, Chamber of Commerce Rooms, Tulsa, Okla; Philadelphia, Smoker at the Hotel Adelphia; Pittsburgh, at the Chatham Hotel; Boston; Minnesota, at St. Paul Hotel, dinner preceding meeting; Washington State, at Faculty Club, University of Washington; Hartford Branch, at City Club, Hartford, Conn.; Providence, in Engineering Society Rooms; Atlanta; Columbus; Indianapolis; and Chicago, at the Morrison Hotel. The Baltimore Section will meet Nov. 4 instead of 5 at the Engineers' Club.

Business Items

C. W. Hunt Engineering Corp. has been organized with offices at 143 Liberty St., New York City, for the purpose of handling all sales entailing engineering in connection with the Hunt products and all engineering services previously performed by the C. W. Hunt Co., Inc.

An Industrial Information Bureau, which should be of interest to those who do, or desire to do, business in China, is to be established in February, 1921, by the Government Institute of Technology at Shanghai, China. This school is under Chinese government support and prepares engineers and railway administration men with a technical education equivalent to that of any engineering school. These men often are located away from the port cities and when they desire information regarding equipment find it difficult to obtain. To meet this need the school is about to open this bureau. Manufacturers who are interested are invited to send catalogs, specifications, designing data, approximate costs, samples or models. In case samples are sent an attempt will be made to place same in running order. No sales will be made or attempted. Impartial information alone will be offered. A member of the faculty is now in America on leave and he will be glad to communicate further with any who desire information regarding the China field. Address H. A. Vanderbeek, 5 Cammann Place, Somerville, N. J., until December, 1920, and Box 951, U. S. P. O. Shanghai, China, after that date.

Trade Catalogs

The Godfrey Conveyor Co., Elkhart, Indiana, has ready for distribution a new catalog of its coal carrying system. This apparatus is designed to unload coal to storage or bunkers, to reclaim it from storage to bunkers and to handle ashes, sand, crushed rock, gravel and similar materials.

New Construction

PROPOSED WORK

Mass., Springfield—The H. R. Huntting Co., 21 Besse Pl., is in the market for a 1 or 2 hp., 220 volt, 800 r.p.m. d.c. motor.

R. I., Providence—The Pub. Bldg Dept. will soon award the contract for a 3 story school including a steam heating system on Jastion Ave.

Conn., Hartford—The Amer. Sumatra Tobacco Co., Burnside Ave., plans to build a 6 story office building etc. on Commerce, Grove and Mechanic Sts. About $500,000.

Conn., Hartford—The Bushnell Memorial Association, 108 Gillett St., plans to build a 1 and 2 story auditorium on Trinity St. and Capitol Ave. About $500,000. A. R. Hillyer, Pres.

Conn., Winsted—J. Hannon, 3 Cherry St., is in the market for a 10 or 12 hp., steam boiler, with 80 lb. pressure. (Used, in good condition.)

N. Y., Brooklyn—The Bd. Educ., 500 Park Ave., New York City received bids for the installation of a heating and ventilation system, etc. in Public School 73 from Gillis & Geoghagan, 527 West Bway., $191.485; E. Reutzler Co., $193.976; J. C. Williams, 261 West 126th St., $197,447.

N. Y., Buffalo—The Buffalo City Service Corp. plans to construct an electric plant and distribute electrical energy in Buffalo, Niagara Falls, Lockport, Lackawanna, Batavia, Rochester, Jamestown, Syracuse, Dunkirk and other western New York municipalities. E. C. Randall, Iroquois Bldg., is interested.

N. Y., Creedmore L. I. (Jamaica P. O.)—The U. S. Government, Wash., D. C., plans to construct several hospital buildings here. A steam heating system will be installed in same. About $3,000,000.

N. Y., New York—The French Hospital, 450 West 34th St., plans to build a 7 story, 100 x 100 ft. hospital and Nurses Home, including a steam heating system, at 441 West 33rd St. C. P. Gilbert, 1 Madison Ave., Archt. and Engr.

N. Y., New York—The United Electric Light & Power Co., 130 East 15th St., will soon award the contract for a power house on 134th St. and the East River. About $4,500,000.

N. Y., Ossining—Charles F. Rattigan, Supt. of Prisons, Capitol, Albany, will receive bids until December 6 for a death house including a steam heating system at the Sing Sing prison, here. About $325.000. L. F. Pilcher, Hall of Records, New York City, Archt. and Engr.

N. Y., Rochester—The State Bd. of Armory Comrs., Capitol, Albany, will receive bids until November 11 for the installation of a steam heating system and equipment in the Cavalry Armory on Culner Rd., here. Captain John Coffey, Secy.

N. Y., Yonkers—The Bd. Educ., High School Bldg., plans to build a high school including a steam heating system. About $300,000. J. H. Claxton, Secy.

Pa., Harrisburg—The Penn Harris Hotel, 3rd and Walnut Sts., plans to build a 12 story, 50 x 200 ft. hotel addition including a steam heating system. W. L. Stoddart, 9 East 40th St., New York City, Engr.

Pa., Johnstown—The Johnstown Sanitary Dairy Co. plans an election December 10 to vote on an increase of stock from $100,000 to $300.000., to purchase the plant of the Sanitary Ice Cream & Cold Storage Co. and build an addition to same. W. D. Gerber, Pres.

Pa., Philadelphia—The Nazel Eng. & Machine Wks., 4041 North 5th St., is in the market for one 20 hp. general electric motor.

Md., Baltimore—The City received the lowest bid for a 3 story, 46 x 150 ft. public school including a vapor heating plant, etc. on Laurens and Calhoun Sts., from J. L. Robinson Constr. Co., 1130 West Lafayette Ave., $322,582.

W. Va., Parkersburg—The Monongahela Valley Traction Co., 16th St., plans to double the capacity of its large power plant here by making improvements and additions to the machinery and equipment including a 5,000 kw. turbine and new boilers with automatic stoker equipment.

Ga., Trion—The Trion Co. will soon award the contract for a 3 story, 25 x 40 ft. power house addition. Jackson & Moreland, 387 Washington St., Boston, Mass., Engrs. Noted Oct. 12.

Fla., Jacksonville—The H. J. Lynch & Son, Archts., Dolph Bldg., St. Louis, Mo., will receive bids about November 15 for remodeling the old peoples home, installing heating and plumbing and constructing 3 additions to boiler plant including two high pressure boilers, for the Natl. Benevolent Association. About $75,000. Noted July 7.

Ky., Harrodsburg—The proposition to install a municipal electric light and power plant and water supply system at a cost of $200,000 will be submitted to the voters at an election to be held November 2. The power plant installation will consist of three 72 in. x 18 ft. high pressure boilers, one 350 hp. engine, one 200 kw., 2,300 volt 3 phase, 60 cycle generator, two 200 hp. engines, direct connected to two 100 kw. generators. The design is in charge of Greeley, Pearce & Hansen, 39 West Adams St., Chicago.

O., Ashtabula—The Bd. Educ. received bids for the construction of a 2 story school including a steam heating system, from the Moore Lamb Co., 202 Stambaugh St., Youngstown, $273.000; George Kratt, Lorain, $278,000.

O., West Park—The Bd. Educ. plans to build two 3 story grade schools including a steam heating system. About $1,000,000. F. W. Featherstone, Clk.

O., Youngstown—The Stambaugh Memorial Association, Dollar Bank Bldg., plans to build a 300 x 300 ft. civic auditorium. About $1,000,000.

Ind., Fort Wayne—The International Harvester Co. is having plans prepared for a 1 and 2 story manufacturing plant including a steam heating system on Pontiac St. About $2.000,000. Day & Zimmerman, 611 Chestnut St, Philadelphia, Pa., Engrs.

Mich., Ann Arbor—S. E. Remey and C. M. Agree, Archts., Whitney Office Bldg., Detroit, plans to build a 4 story, 60 x 200 ft. dormitory building including a steam heating system. About $175,000. Owner's name withheld.

Mich., Detroit—The Michigan Stamping Co., Mack and E.E. Sts., is in the market for 2 air compressors, belt or direct connected, capacity 200 cu ft. per min. (new).

Mich., Oxford—H. A. Eaton, Village Clerk, will receive bids until November 16 for furnishing and installing two 500 gal. per min. centrifugal double service pumps, 70 lb. pressure, 30 hp. ac motor and one centrifugal fire pump, capacity 500 gal. per min., 100 lb. pressure, 75 hp. ac motor.

Ill., Chicago—Isaiah Temple, c/o Dr. J. Stolz, 4711 Grand Blvd., plans to build a temple and community house on 51st and Greenwood Ave. About $500,000.

Ill., Lincoln—The Lincoln Water & Light Co. plans to expend $50,000 for improvements, to include the installation of a 650 kw. General Electric turbo-generator also an addition of a switchboard and boiler not yet contracted for.

Wis., Hudson—The Burkhardt Milling & Electric Co., Burkhardt, plans to build an 18 x 23 ft. power house and repair dam on the Willow River. Holland, Ackerman & Holland, Inc., Monadnock Bldg., Chicago, Engrs.

Wis., Madison—The Sheboygan Dairy Products Co., 936 North Water St., plans to rebuild its 2 story, 60 x 150 ft. dairy products factory on West Wilson St. which was recently destroyed by fire. About $100,000. M. G. Douma, Secy.

Wis., Stevens Point—The Stevens Point Water Co., 526 North 8th St., Manitowoc, plans to improve water and pump station, here. Equipment will be installed in same. T. W. Gray, Mgr.

Wis., Tomahawk—The Tomahawk Pulp & Paper Co. is having plans prepared for several industrial buildings including a 50 x 354 ft. main building, 37 x 136 ft. engine room, 47 x 98 ft. boiler room containing 3 stoker type boilers and a 50 x 231 ft. machine shop.

Minn., Aitkin—The Bd. of County Comrs. plans to build a court house including a steam heating system. About $250,000.

Minn., Minneapolis—Kirchhoff & Rose., Archts. and Engrs., Majestic Bldg., Milwaukee, Wis., will soon award the contract for a 2 and 3 story, 115 x 180 ft. theatre on Hennepin Ave., for Martin Beck, 1564 Bway., New York City. About $500,000.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, is having plans prepared for a 4 story, 400 x 400 ft. library including a steam heating system on the State University Campus here. About $1,000,000. C. H. Johnston, 715 Capital Bank Bldg., St. Paul, Archt.

Minn., Northfield—Carleton College plans to build 11 college buildings including a steam heating system. About $3,150,000. D. J. Cowling, Pres.

Minn., Osakis—C. H. Millard, City Clk., will soon receive bids for the construction of a pumping station and the installation of equipment. About $10,000. C. L. Pillsbury Co., 805 Metropolitan Life Bldg., Minneapolis, Engr.

Minn., St. Paul—The Diocese of St. Paul is conducting a campaign to raise $5,000,000 for schools and colleges. The building plans include the construction of a power house at the college of St. Thomas. Mernan Park.

Kan., Wichita — The Standing Grain Thresher Co., Union Natl. Bank Bldg., plans to build a thresher factory here. About $250,000. C. S. Gibbens, Nickerson, Secy.

Tex., Dallas—The Oriental Rug. Co., 3907 Ross Ave., is in the market for a 15 hp. or more two phase electric motor (new or second hand.)

Tex., Hubbard—The Union Central Light & Power Co. is in the market for a 100 ft. x 6 in. cotton spiral conveyor, also sprocket wheels, shafting, etc., for operating same (new or second hand.)

Okla., Tulsa—The city is having preliminary plans prepared for 6 additional filter units, 10,000,000 gal. basin, two 300 hp. boilers, etc. About $150,000. Holway Eng. Co., 220 Lynch Bldg., Engrs.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C. will receive bids until November 18 for installing a heating system in the structural shop here.

Ont., Hamilton—The Provincial Bd. of Health has ordered the construction of an isolation hospital to cost between $750,000 and $800,000. X-ray equipment and a steam heating system will be installed in same. J. H. Pratt, Chn.

Ont., Kingston—The city plans to build an 8 or 10 story hotel including a vacuum steam heating system. About $150,000.

Ont., Ottawa—The Royal Securities Corp. and Harris Forbes & Co. plan to purchase $1,200,000 bonds of the Ottawa Light, Heat & Power Co. The proceeds of this issue will be utilized for the development of waterpower. T. Ahearn, Pres.

Ont., St. Catharines—The Bd. Educ. plans to build a 3 story collegiate institute. A vacuum steam heating system with an electrically operated mechanical ventilation system will be installed in same. About $400,000.

Ont., Toronto—The Welland Automobile Storage Battery Co., East 131st St. and St. Clair Ave., Cleveland, has purchased a 3 acre site on Weltshire Ave. and plans to construct a storage battery plant on same. About $500,000.

Ont., Windsor—The Bd. Educ. plans to construct a school including a steam heating and an electrically operated ventilation system. About $550,000.

CONTRACTS AWARDED

Mass., Brookline (Boston P. O.)—Charles A. Newhall, 1105 Tremont Bldg., Boston, will build an 8 story apartment hotel including a steam heating system on Beacon and St. Paul Sts. About $1,500,000. Work will be done by day labor.

Mass., Danvers—The Comn. on Mental Diseases, 36 State House, Boston, has awarded the contract for a 1 story, 57 x 137 ft. power plant at the State Hospital here, to the E. H. Porter Co., 13 Wallis St., Peabody, at $53,000. Noted Oct. 12.

Mass., Lynn—The Universal Tide Power Co., 69 Canal St., Boston, has awarded the contract for a hydraulic dam, to M. Seretto, 3 Tremont Row, Boston, at $300,000.

Mass., New Bedford—The Bd. Educ. has awarded the contract for the installation of a heating system in the proposed 2 story school on Mt. Pleasant St., at $74,371 and in the proposed 2 story, 170 x 250 ft. school on Rochambeau St., at $74,371 to M. A. Dame & Son Co., 90 Monroe St., Lynn. Noted Oct. 5.

Mass., South Hadley Falls (Holyoke P. O.)—The Hampshire Paper Co. has awarded the contract for altering the 1 story boiler house, to the S. M. Green Co., 293 Bridge St., Springfield, at $25,000.

Mass., Wrentham—The Commonwealth of Massachusetts, c/o Kendall, Taylor & Co., Archts., 93 Federal St., Boston, has awarded the contract for a 1 story, 50 x 70 ft. cold storage building at the State School here, to J. A. Munroe, Washington St., North Attleboro, at $50,000. Noted Oct. 12.

R. I., Providence—The city has awarded the contract for installing a steam heating system in the proposed 2 story school on Arthur Ave., to E. J. Sullivan, 51 Brook St.

N. Y., Brooklyn—The Colonial Mantle & Refrigerating Co. will build a 1 story 40 x 100 ft. addition to its factory including a steam heating system at 191 Dumont Ave. About $40,000. Work will be done by day labor.

N. Y., New York—The Seneca Holding Corp., 185 5th Ave., will alter the New York and Criterion theaters on B'way. and 45th St. About $500,000. Work will be done by day labor.

Pa., East Pittsburgh (Pittsburgh P. O.)—The Bd. Educ. has awarded the contract for a 2 story, 111 x 139 ft. school including a steam heating system, to the Hodder Constr. Co., Braddock, at $300,000.

Pa., Philadelphia—The General Carbonic Co., 847 North 3rd St., has awarded the contract for altering the present 1 story factory and boiler house to the Austin Co., Bulletin Bldg., at $10,000.

Fla., St. Petersburg—The H. R. McChessney Syndicate, Pittsburgh, Pa., has awarded the contract for a hotel including a steam heating system, to G. A. Fuller Co., 175 5th Ave., New York City, at $1,500,000.

Tenn., Chattanooga—The Mutual Enamel Wks. Co. has awarded the contract for a foundry and plant including a steam heating system, to D. P. Robinson, 125 East 46th St., New York City, at $800,000.

Mich., Detroit—The Detroit Packing Co., 40 Bushey St. has awarded the contract for a 2 story packing plant including a steam heating system on Springwells Ave., to the Patterson Constr. Co., 907 Ford Bldg., at $50,000.

Wis., Manitowoc—George Bros., 913 South 8th St., has awarded the sub-contract for the installation of a steam heating system in the proposed 3 story, 60 x 250 ft. theater on South 8th St., to G. H. Kallies. Noted Jan. 6.

Minn., Duluth—The Bd. Educ. has awarded the contract for a 2 story, 150 x 150 ft. school including a steam heating system on 28th Ave., East and 4th St., to McLeod & Smith, Sellwood Bldg., at $396,300.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, has awarded the contract for the installation of a heating, plumbing, ventilation and vacuum systems in the proposed 3 story addition to the chemistry building at the State University here, to M. J. O'Neil, 608 Exch. Bank Bldg., St. Paul, at $125,000. Noted August 3.

Minn., Sabin—The Village has awarded the contract for materials for an 18 mi. high tension transmission line from here to a point near Fargo, N. D., and for electric distribution system here, including meters, transformers, etc., to the St. Paul Electric Co., 145 East 5th St., St. Paul, at $25,000.

N. D. Hankinson—The city has awarded the contract for the construction of a water system to include two 500 gal. fire pumps, 2 deep well pumps, etc., to W. D. Lovell, 1415 S.E. 8th St., Minneapolis, at $151,000.

Ont., Elmira—The Elmira Creamery Co. has awarded the contract for a 2 story, 80 x 92 ft. addition to its creamery, to Charles Wilken at $100,000. A boiler and other equipment will be installed in same.

Ont., Smooth Rock Falls—The Mattagami Pulp & Paper Co. has awarded the contract for a 2 story pulp mill and store building including a steam heating system, to Carter, Halls, Aldinger & Co., Union Bank Bldg., Winnipeg at $490,000.

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For Every Business Want

See Pages 88 to 104

PRICES-MATERIALS-SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE –

Fire		50-Ft. Lengths
Underwriters' 2½-in		85c. per ft.
Common, 2½-in		30%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft	$0 60	$0.40	$0 30

Steam—Discounts from List

First grade	Second grade	Third grade
20%	30%	45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	30-10%		

LEATHER BELTING—Present discounts from list in fair quantities (½ doz. rolls):

Light Grade	Medium Grade	Heavy Grade
30%	25%	20%

RAWHIDE LACING
For cut, best grade, 25%, 2nd grade, 30%.
For laces in sides, best, 79c per sq. ft.; 2nd, 75c
Semi-tanned: cut, 20%; sides, 83c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	1 70
Duck and rubber for piston packing	1 00
Flax, regular	1 20
Flax, waterproofed	1 70
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1.50
Rubber sheet	.50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin. Ft	Thickness	Price per Sq. Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	45
4-in.	.60	2 -in.	60
3-in.	.45	2½-in.	.75
8-in.	1 10	3 -in.	90
10-in.	1 30	3½-in.	1.05

85% magnesia high pressure		List +5%
For low-pressure heating and return lines	4-ply	50% off
	3-ply	52% off
	2-ply	54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	8½	6.6	8@ 9	8½	13¼
Fiber or sponge	8½	8.6	12@15	8¾	20
Transmission	10	8.1	12@15	8½	20
Axle	.	4.8	6@ 6½	5¼	7¼
Gear	6¼	6.1	8@9	5¼	8½
Car journal	12(gal.)	4 7	23@25	8½	8½

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
White	15.00@17 00	13 00	16 00	11 00 to 14 00
Colored mixed	9.00@14.00	9 00 to 12.00	12.00	9.50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¾ x 13¾	13¾ x 20½
Cleveland	$55.00	$65.00
Chicago	41 00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$1.15	$1.75	$1.25	$1.92
5-gal. cans	1.30	1.90	1.50	2.07

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	15 50	17 00	13 00	14.50	15 50	13 00
25- and 50-lb. kegs	15 75	17 25	13 25	14.75	15 75	13 25
12½-lb. keg	16 00	17 50	13 50	15 00	16 00	13 50
1-lb. cans	18 50	20.00	15 00	16 50	15.00	15 00
5-lb. cans	20 50	22 00	16 00	17 50	16 00	16 00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel $\frac{7}{16}$ and smaller	List net	40%	30%
Tinned	List net	40%	30%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York.........$6.00 Chicago.. $5.73 Pittsburgh.......$4 50

Structual rivets, same sizes:

New York.........$7.10 Chicago $5.83 Pittsburgh $4 60

REFRACTORIES—Prices in carlots.

Bauxite brick, 56% alumina, f.o.b. Pittsburgh.	per 1000	$160
Chrome brick, eastern Shipping points	net ton	100@ $110
Chrome cement, 40@45% Cr_2O_3	net ton	55@ 60
Chrome cement, 40@45% Cr_2O_3, in sacks	net ton	60@ 65
Clay brick, 1st quality, fire clay, 9-in. shapes, Pennsylvania, Ohio and Kentucky	per 1000	55@ 60
Clay brick, 2d quality, fire clay, 9-in. shapes Pennsylvania, Ohio and Kentucky	per 1000	45@ 50
Magnesite brick: 9-in. straight	net ton	110
Magnesite brick: 9-in. arches, wedges and keys	net ton	121
Magnesite brick: Soaps and splits	net ton	134
Silica brick: Chicago district	per 1000	65@ 70
Silica brick: Birmingham, Ala	per 1000	56@ 61
Silica brick: Mt. Union, Pa	per 1000	55@ 60

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	80.00	90.00	49 00	70.00	45.00	60.00
Commercial	40.00	50.50	19.50	16.50	11 00	13 00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$6.36	$5.90	$6.00
Flats, square and hexagons, per 100 lb. base.	6.86	6.40	6.50

SHEETS—Quotations are in cents per pound in various cities from warehouse, also the base quotations from mill:

	Large Mill Lots	New York			
Blue Annealed	Pittsburgh	Current	One Year Ago	Cleveland	Chicago
No. 10	3.55-7.00	7.25@ 8.00	4.57	6.75	7.13
No. 12	3 60 7 05	7 30@ 8 05	4 62	6 80	7 18
No. 14	3 65 7 10	7 35@ 8 10	4 67	7 35	7 23
No. 16	3.75-7.20	7 45@ 8.20	4.77	7.45	7 33
Black					
Nos. 18 and 20	4 20 6 20	8 40@ 9 80	5 30	8 30	7 90
Nos. 22 and 24	4 25 6 25	8 45@ 9 85	5 35	8 35	7 95
No. 26	4 30 6 30	8 50@ 9 90	5 40	8 40	8 00
No. 28	4 35 6 35	8 60@ 10 00	5 50	8 50	8 10
Galvanized					
No. 10	4 70 8 00	8 90@ 11 00	5 75	8 50	8 25
No. 12	4 80 8 10	9 00@ 11 00	5 85	8 60	8 30
No. 14	4 80 8 10	9 00@ 11 10	5 85	8 60	8 45
Nos. 18 and 20	5.10-8.40	9.25@11.40	6.15	8.90	8.75
Nos. 22 and 24	5 25 8 55	9 40@ 11 55	6 30	9 05	9 15
No. 26	5 40 8 70	9 55@ 11 70	6 45	9 20	9 30
No. 28	5 70 9 00	9 85@ 12 00	6 75	9 50	9 60

WROUGHT PIPE The following discounts are to jobbers for carload lots on the Pittsburgh basing card

BUTT WELD

Steel			Iron		
Inches	Black	Galv	Inches	Black	Galv
¾ to 3	54 to 57½	41½ to 44	¼	15½ to 25½	-1½ to 11
			½	19½ to 29½	1½ to 11½
			¾ to 1½	24½ to 34½	8 to 18½

LAP WELD

2	47 to 50½	34½ to 38	2	20½ to 28½	6½ to 14½
2½ to 6	50 to 53½	37½ to 41	2½ to 6	22½ to 30½	9½ to 17½
7 to 12	47 to 50½	33½ to 37	7 to 12	19½ to 27½	6½ to 14½
13 and 14	37½ to 41				
15	35 to 38½				

BUTT WELD, EXTRA STRONG, PLAIN ENDS

½ to 1½	52 to 55½	39½ to 43	¾ to 1½	24½ to 34½	9½ to 19½
2 to 3	53 to 56½	40½ to 44			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	45 to 48½	33½ to 37	2	21½ to 29½	8½ to 16½
2½ to 4	48 to 51½	36½ to 40	2½ to 4	23½ to 31½	11½ to 19½
4½ to 6	47 to 50½	35½ to 39	4½ to 6	22½ to 30½	10½ to 18
7 to 8	43 to 46½	29½ to 33	7 to 8	14½ to 22½	2½ to 10½
9 to 12	38 to 41½	24½ to 28	9 to 12	9½ to 17	5½ to 2½

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	15 to 40	1½ and 1¾ in.	+20
2½ to 3¼ in.	10 to 30	2 and 2¼ in.	+10
2¼ in.	4 to 24	2½ and 2¾ in.	+1
1½ to 2 in.	+1 to 19	3 and 3¼ in.	11
		3½, 4 and 4½ in.	8

Standard Commercial Seamless	Per Net Ton	Cold Drawn or Hot Rolled	Per Net Ton
1 in.	$327	1½ in.	$207
1¼ in.	267	2 to 2¼ in.	177
1½ in.	257	2½ to 3¼ in.	167
1¾ in.	207	4 in.	187
		4½ to 5 in.	207

ELECTRICAL SUPPLIES

ARMORED CABLE

B & S Size	Two Cond M Ft.	Three Cond M Ft.	Two Cond Lead M Ft.	Three Cond. Lead M Ft
No 14 solid	$ [illegible] 00 net)	$138 00	$164.00	$210 00
No. 12 solid....	135 00	170 00	225 00	265 00
No. 10 solid	185 00	235 00	275 00	325 00
No. 8 stranded	285 00	375 00	520 00	500 00
No 6 stranded	400 00	500 00	560 00	

From the above lists discounts are

Less than coil lots	+ 5%	+ 15%
Coils to 1,000 ft	− 5%	List Net
1,000 ft and over	−10%	7%

BATTERIES, DRY—Regular No 6 size red seal, Columbia, or Ever-Ready:

	Each, Net
Less than 12	$0.48
12 to 50	41
50 to 125 (bbl.)	.38
125 (bbl) or over	35

CONDUIT, Price per 1000 ft ; **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
Size, In	Black 2,500 to 5,000 Lbs	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs	Galvanized 2,500 to 5,000 Lbs.
½	85.66	90.39	20 20	21 34	6 38	6 74
¾	113.62	119 99	26 58	27.83	7 44	7 85
1	167.96	177.38	39 35	41 56	10 63	11 23
1¼	227 24	239 98	50 10	52 80	13 82	14 60
1½	271.70	286.93	66 80	70 40	18 93	19 95
2	365.56	386 06	122 47	129 07	23 38	24 64
2½	577.98	610 39	200 41	211 21	31 18	32.85
3	755.82	798 20	534.43	563.23	44 53	46 94
3½	936 38	987 52	1.180 20	1,243.80	66 80	70 40
4	1,131.20	1,191 81	1,363.91	1,437 41	89 07	93 87

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
3/16	250	$0.05½	
¼	250	.06	
⅜	250	.09	
½	200	12	1000 ft and
⅝	200	15	over .. 40% off
¾	150	18	Coils .. 30% off
1	100	25	Less coils, 20% off
1¼	100	33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities

CUT-OUTS, PLUG

S. P. M. L	$0 12	D. P. D. B	$0 43
D. P. M. L	.21	T. P. to D. P. S. B	.26
T. P. M. L	.33	T. P. S. B	.38
D. P. S. B	.23	T. P. D. B	.64

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp	60-100 Amp.
D. P. M. L	$0 50	$1 30	$1.68
T. P. M. L	.70	1.70	2.40
D. P. S. B	63	1 60	
T. P. S. B	1.15	2 40	
D. P. D. B	1.10	3 00	
T. P. D. B	1 90	5 40	
T. P. to D. P. D. B	1.30	3 80	

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$25 00
No. 16 cotton twisted	29 00
No. 18 cotton parallel	32 00
No. 16 cotton parallel	39.50
No. 18 cotton reinforced heavy	43.00
No. 16 cotton reinforced heavy	50.00
No. 18 cotton reinforced light	37.50
No. 16 cotton reinforced light	43.00
No. 18 cotton Canvasite cord	30 00
No. 16 cotton Canvasite cord	33.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp	100	$0.25
35-amp to 60-amp	100	35
65-amp. to 100-amp	50	.90
110-amp to 200-amp	25	2 00
225-amp. to 400-amp	25	3 60
425-amp. to 600-amp	10	5 50

600-Volt	Std Pkg	List
3-amp to 30 amp	100	$0 40
35 amp to 60 amp	100	60
65 amp to 100 amp	50	1 50
110 amp to 200 amp	25	2 50
225 amp to 400 amp	25	5 50
450 amp to 600 amp	10	8 00

Discount Less 1-5th standard package	15%
1-5th to standard package	28%
Standard package	45%

FUSE PLUGS, MICA CAP—

0 30 ampere, standard package	$5 25
0 30 ampere, less than standard package	6 00

LAMPS—Below are present quotations in less than standard package quantities

Straight Side Bulbs Mazda B—				Pear Shaped Bulbs Mazda C—			
Watts	Plain	Frosted	No in Package	Watts	Clear	Frosted	No. in Package
10	$0 40	$0 45	100	75	$0 75	$0 80	50
15	40	45	100	100	1 10	1 25	24
25	40	45	100	150	1 55	1 70	24
40	40	45	100	200	2 10	2 30	24
50	40	45	100	300	3 15	3 40	24
60	45	50	100				12
				500	4 60	4 90	12
				750	6 50	6 90	8
				1,000	7 50	7 95	8

Standard quantities are subject to discount of 10% from list Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.28
Composition 2-piece attachment plug	36
Swivel attachment plug	20
Current taps	45

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$11 00	$14.00	$16 50	$27.50
12	14 96	18 50	21 45	35.00
10	20 62	24 75	28 05	46.00
8	28 90	33.30	38 50	66.00
6			58 75	...
4			80 75	...
2			111 00	...
1			154 00	....
0			181 50	....
00			220 00	......
000			265 00	....
0000			330 00	..

Prices per 1000 ft. for Rubber-Covered Wire in Following Cities:

	Denver			Birmingham		
No	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13 50	$18 00	$34 10	$12 36	.. .	$38 64
10	22 25	25.75	53.95	27 60	.....	48 30
8	28 75	33.50	80 00	38.74	. ..	87 33
6	51 00	53.30			$77.34	..
4	70 00	72.25			107.42	.
2	98 00	100.00			138 46	
1	133 00	136.75			178.62	
0	197.00	197.05			217 09	.
00					263.57	.
000					320.44	

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap			⅜ In. Cap		
Key Each	Keyless Each	Pull Each	Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0 60	$0.39	$0.36	$0.66

Less 1-5th standard package	+50%
1-5th to standard package	+20%
Standard package	—15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	55c. lb
No. 18 B. & S. regular 1-lb. coils	56c. lb

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 56c. lb., 100 lb. lots	52c. lb
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c. lb
Wire solder, less 100 lb. 47c. lb., 100 lb. lots	42c. lb
Soldering paste, 2 oz. cans	$1.50 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

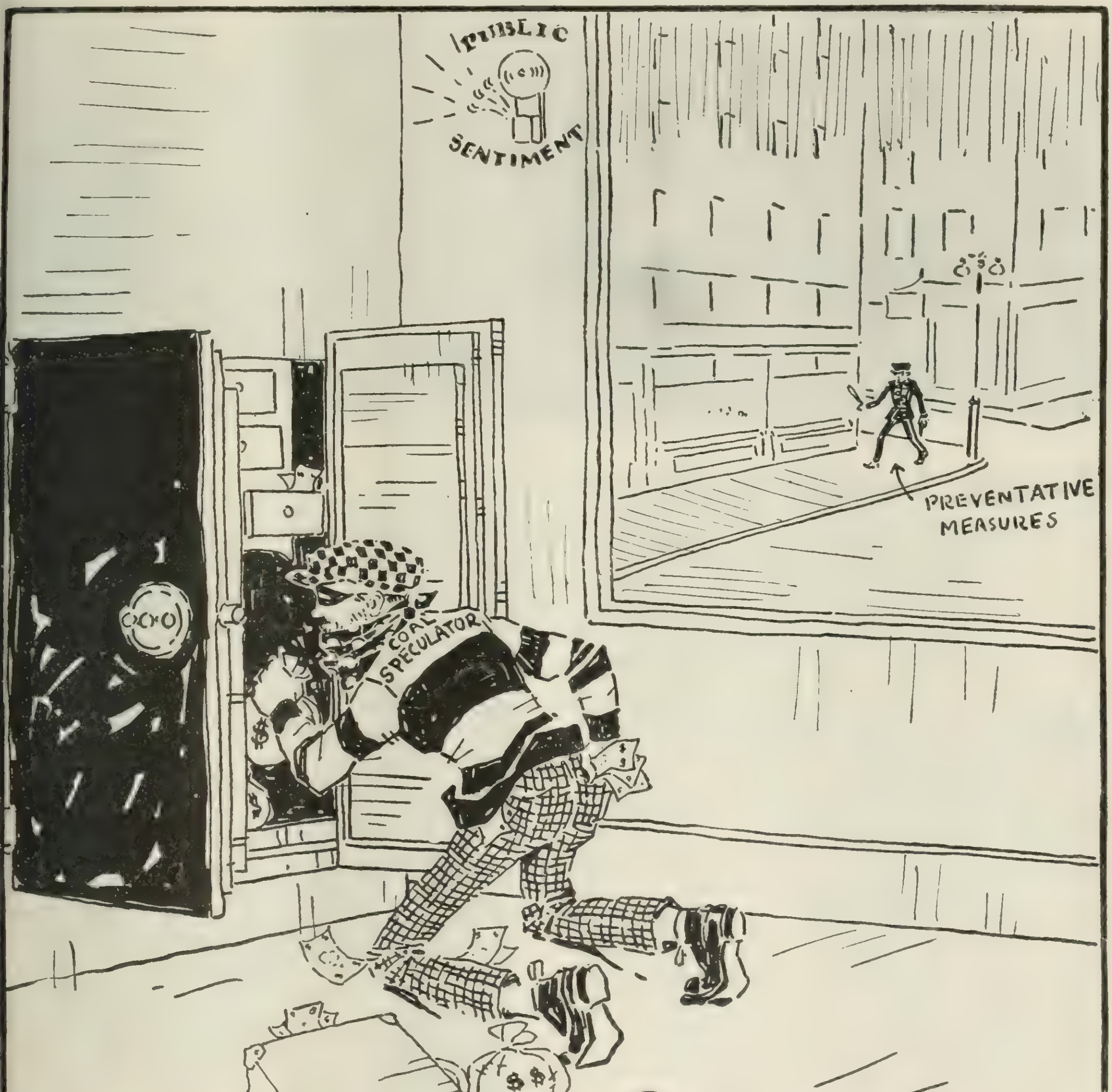
Size, Amp	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	.70	1 06	1 60	2.12
60	1.18	1 80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6 76	10.14	13.50

Discounts:

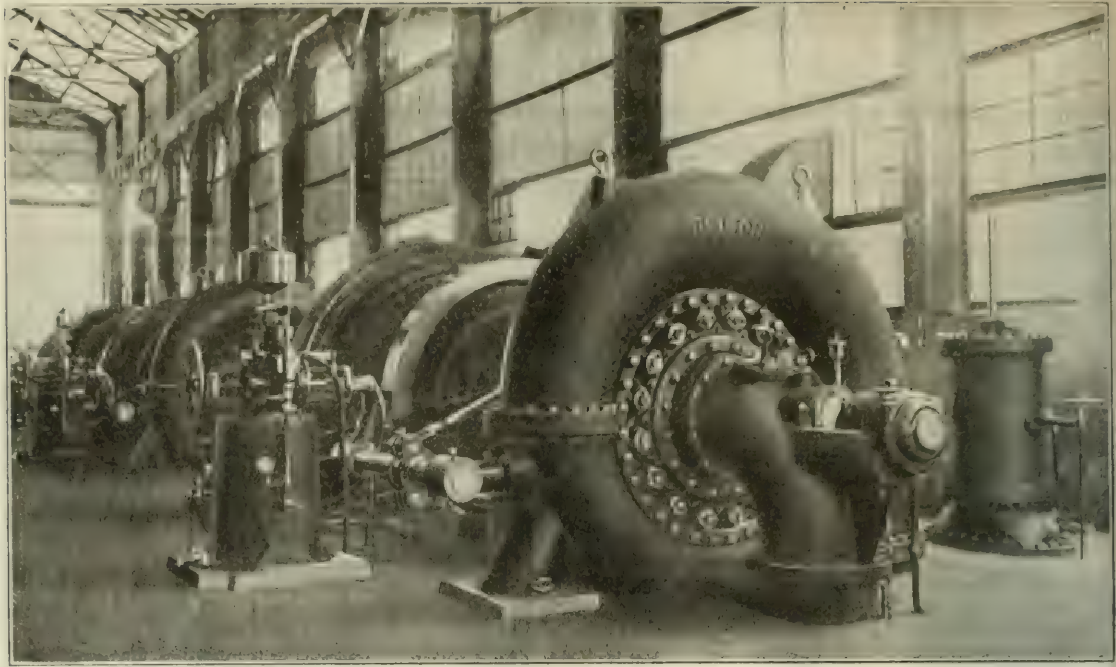
Less than $10.00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+ 5%
$50 to $200 list value	—10%
$200 list value or over	—15%

POWER

Volume 52 New York, November 9, 1920 *Number* 19



Get While the Getting is Good



Braden Copper Company's Power System in Chile

Two Hydro-Electric Plants Supply Power to Copper Mines—One 22,500-Kw. Plant Operates Under 1,550-Ft. Head—The Other Plant, 15,000 Kw., Operates Under 440-Ft. Head—Large Amount of Silt in Water Causes Serious Operating Problems—Substation Cut Out of Solid Rock 4,000 Ft. Under Ground

SITUATED on the eastern slope of the Andes Mountains, at an altitude of about 7,000 ft., is the Braden Copper Company's copper-mining plant in Chile. It lies within the province of O'Higgins about 65 miles from the City of Santiago and about 125 miles from Valparaiso, which is the principal accessible seaport. Access to the property is by means of the company's own railroad to Rancagua, 43.5 miles in length, which connects the main plant at Sewell with the railroad leading to Santiago and Valparaiso. The situation of the property with reference to power supply is fortunate, since near-by streams afford ample opportunity for hydro-electric development.

In this section of Chile the run-off of rivers is naturally poorly regulated since the watersheds are practically barren. During the summer season, when the principal source of water is from glaciers and melting snow and, in some cases, springs having a relatively constant discharge, the flow is more nearly constant. On account of the barren character of watersheds large quantities of refuse and glacial silt are present during high-water periods. The solid matter carried by these streams during high water seriously interferes with the operation of intakes, gates, sand traps, etc.

Of very serious consideration is the intake problem. To secure the best results it is absolutely essential to resort to designs whereby the flow into the intake is in such a direction relative to the main stream as will prevent solid matter from entering the intake in large quantities. Experience has shown that prac-

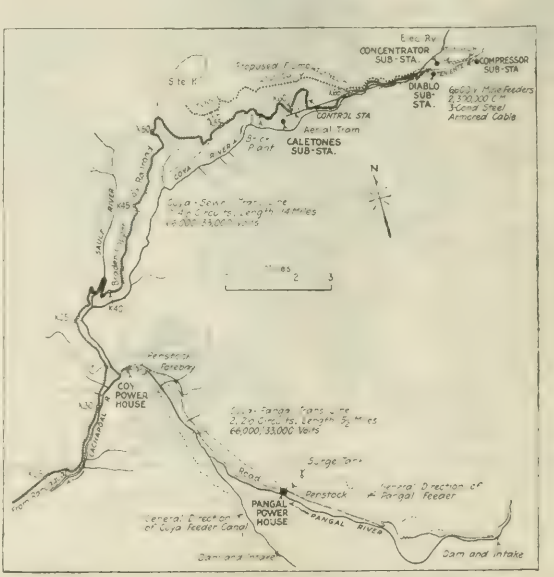


FIG. 1. LOCATION OF POWER HOUSES AND MINES

tically all forms of intakes with a flow in the same general direction as the stream becomes seriously obstructed in a short time. To secure satisfactory results liberal provision must be made for grizzlies and removable screens as well as for sluicing out sand and other solid material as fast as it is deposited in the intake channel.

Some unusual features are presented in the operation of the company's plants, which are due largely to the topography and character of the country traversed by the flow lines and the character of the water as regards silt. The flow lines of both plants are located almost entirely on sidehill cuts in the mountainsides, which in general are relatively steep.

Open canals must be protected against large quantities of surface water during certain periods, and in the case of both the Cachapoal canal and Pangal pipe line account must be taken of sliding material, loose rocks and boulders. Considerable protection against the latter feature has been necessary for the wood-stave pipe line, in the form of wood covering and sheds, while a considerable portion of the line has been covered with earth fill with outer cover of stone riprap.

The natural formation of the adjacent country affords but little opportunity for the construction of settling basins. During high-water periods it is impossible to prevent large quantities of solid matter from going through to the wheels, resulting in unusually rapid cutting of parts of equipment subjected to water at high velocities. Wheel runners, gates, nozzles, etc., can therefore be counted upon for but relatively short life in service. This condition is to be expected in this section of Chile, and the only solution of the erosion problem to date appears to consist of a liberal spare supply of wearable parts, which must be kept on hand if satisfactory continuous operation is important.

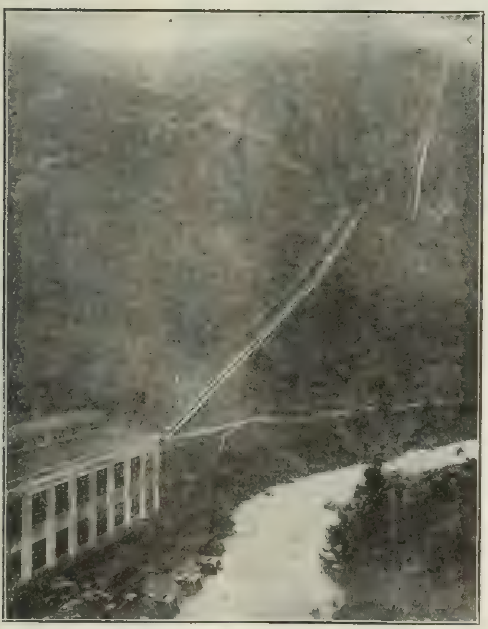


FIG. 2. PANGAL POWER HOUSE AND PENSTOCKS

In 1910 a 5,000-kw. power development with necessary substations was constructed for the operation of the company's plant. The capacity of this original station was increased first to 7,500 kw. and later to 10,000 kw., but has now been outgrown by the continual development of the mine to increase daily tonnage. To meet requirements for power on the basis of 10,000 tons of ore per day to which the plant capacity is being raised, extensive additions and betterments to the power system are now nearing completion.

The extent of the new power system and the location of power stations, substations and transmission lines are shown on the map reproduced in Fig. 1. At the present time power is generated at Pangal and Coya stations at 2,300 volts three-phase 60 cycles. Voltage is stepped up to 33,000 volts three-phase 60 cycles for transmission. Pangal power is transmitted 5½ miles over double-circuit steel-tower lines to Coya, from which point the combined output of both plants is transmitted fourteen miles over double-circuit steel-tower lines to Sewell, where power is required for mining, ore treatment, smelting, etc. A tap from both of the Coya-Sewell lines supplies power for the new smelting and melting plant at Caletones. Provision is made in the design of stations and transmission lines for raising the voltage to 60,000. The capacity of the Coya station has been further increased by the addition of a new vertical unit and reconstructed to permit of raising the voltage from 33,000 to 66,000. The Diablo substation shown on the map will ultimately be replaced by the new concentrator substation.

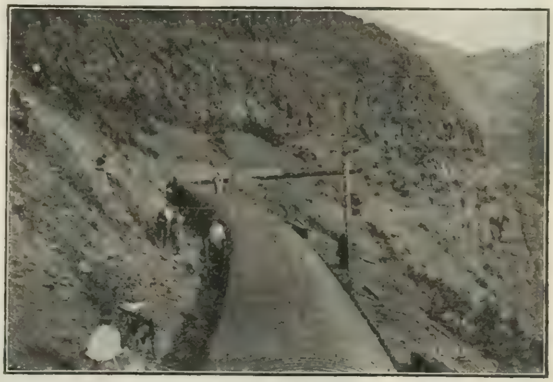


FIG. 3. SECTION OF PANGAL PIPE LINE

The Pangal development, recently completed, uses water from the Rio Pangal River at an average net effective head of about 1,550 ft. By means of a dam and gate tower, water is delivered to the flow conduit. This gate tower is about 50 ft. present height, of octagonal form, about 36 ft. in diameter and provided with seven inlets protected by steel grizzlies. At the bottom of the tower is a cylinder gate about 100 in. in diameter connecting with the feeder conduit. For cleaning the intake tower, sluice valves are provided which connect with an auxiliary pipe under the dam and below the main feeder conduit. Two sets of stop logs are provided for each of the seven inlets, and there is a stiff-leg derrick on top of the tower for the convenient handling of the stop logs and racks. The flow line consists of about 37,000 ft. of 80-in. wood-stave and riveted-steel pipe laid to a uniform gradient of about 15 ft. to the mile. This conduit terminates in a differential surge tank 129 ft. present height, located about 4,000 ft. from the power house, and shown at *X*, Fig. 2. A

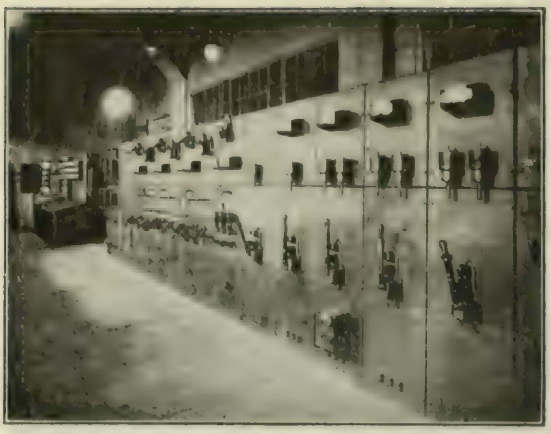


FIG. 4. SWITCHBOARD, PANGAL POWER HOUSE

typical view of the flow line is shown in Fig. 3. The surge tank is also provided with a connection for the penstock system, which, starting with a single 78-inch line, branches to two 46-in. lines. Each 46-in. line then branches to two 30-in. lines for connection to the four units in the power house. Valves are provided in the 30-in. lines where they branch from the 46-in. lines, also at the end of the 30-in. lines in the plant. Provision is made throughout for raising the head an additional 70 feet.

FIG. 5. TRANSPORTING SECTION OF MAIN PANGAL GENERATOR

While the ultimate plant will consist of four 5,600-kw. units, two units only are connected for operation at the present time, with No. 3 under construction. The waterwheels are of the horizontal tangential impulse type direct-connected to 2,300-volt three-phase 60-cycle 360-r.p.m. generators with direct-connected overhung exciters. Each exciter has a capacity sufficient for exciting two of the generator units. Fig. 2 is a general view of penstocks and exterior view of the plant. Only two of the penstocks are in place.

The transportation of the heavier pieces of machinery to this plant presented some difficult problems on account of steep grades and sharp turns encountered on the road leading to the site. Fig. 5 gives a view of a half-section of one of the main generator stators being worked into position for making a hairpin turn, which it will be noticed is being accomplished by driving the animals well up on the mountainside.

The Coya development utilizes water from the Rio Cachapoal at a net effective head of 440 ft. This plant has a flow line about 40,500 ft. in length. It is composed entirely of open canal except for short sections of tunnel and wood flume. The intake arrangement is located at one end of the dam and is controlled by means of standard vertical sliding gates opening into the canal. Just below the intake is a sand box approximately 50 x 80 ft., 6 ft. deep below the normal canal bottom. The bottom of this sand box is provided with numerous sluicing outlets which empty into pipes that conduct the water and sluiced-out material to the river.

The diversion dam is equipped with a rolling gate in the form of a steel-plate cylinder about 22 ft. long and 8 ft. in diameter. This steel cylinder is placed between concrete piers and slung on steel cables which connect with a power-operated hoisting arrangement above and to one side of the gate. This form of gate has been found to be free from operating troubles due to material piled up behind the dam, and to operate satisfactorily under all existing conditions. It serves the joint purpose of relieving the spillway during high water and of making adjustments at other times. The canal terminates in a small forebay from which separate penstocks lead to the five units in the plant below. Of the present units four consist of horizontal turbines direct-connected to 2,300-volt three-phase 60-cycle generators having a normal capacity of 2,500 kw. each, while the fifth is a vertical turbine-driven unit rated at 5,000 kw., making a total normal generating ca-

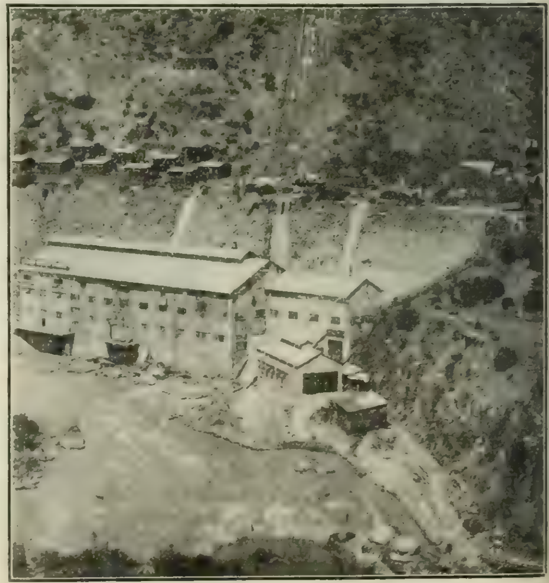


FIG. 6. EXTERIOR VIEW OF COYA POWER HOUSE

pacity of 15,000 kw. This includes some spare capacity, the normal output averaging somewhere between 12,000 and 14,00 kw. Three-phase transformer units are used at this station, also at the Pangal station and at all substations to raise and lower the voltage. A general exterior view of the Coya plant is shown in Fig. 6, and an interior view in the headpiece.

Continuity of operation in these plants is of the utmost importance on account of the character of the load. The load factor is very high, approximating 100 per cent throughout the day, so that equipment must be maintained in first-class operating condition at all times. By means of synchronous condensers at the concentrator substation and synchronous motors at other points later described, it is expected to maintain between 90 and 95 per cent power factor at the generating stations at practically all times.

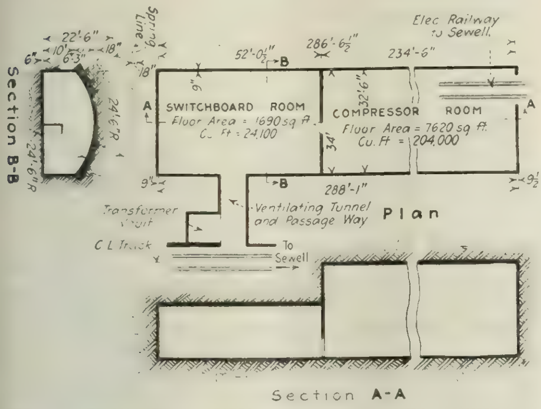


FIG. 7. SECTIONAL VIEWS THROUGH MINE SUBSTATION

The transmission lines from Pangal to Coya and from Coya to Sewell are both of double-circuit steel-tower construction, having two circuits of 00 and 0000 copper conductor respectively.

The power facilities at the new Caletones smelting and melting plant now under construction will consist of an outdoor substation with steel structure for switching equipment and two 5,600-kw. three-phase outdoor-type water-cooled transformers which will reduce the line voltage from 33,000 volts to 2,300 to feed the main busbars of a combined indoor distribution substation and machinery house.

In this building there will be three 1,700-hp. and three 800-hp. synchronous-motor-driven turbo-blowers operated at 3,600 r.p.m. for the supply of air to furnaces and converters. Two 500-kw. motor-generator sets will supply direct current at 250 volts to the yard railway and certain cranes requiring direct current. Two 1,000-kw. 2,300-volt to 550-volt three-phase water-cooled transformers are used for the general supply of power to motor-operated auxiliary equipment. The power supply for the entire Caletones plant will be controlled from this substation.

The concentrator substation, which is the principal center of distribution at Sewell, supplies power for crushing, milling, mineral separation, shops, townsite, etc. One of the novel features of this station is the arrangement of incoming line supports which was found necessary, in order to obtain sufficient clearance from previously existing structures. These are clearly shown in the upper left-hand corner of Fig. 8. Equipment at this station consists of two 5,600-kw. three-phase transformers and two banks of 2,500-kw. single-phase water-cooled transformers for the supply of power for crushing, milling and auxiliary equipment at 550 volts, and two 5,000-kw. three-phase transformers which feed the mine substation and local townsite distribution at 6,600 volts. There are also two 2,500-kva. synchronous condensers for power-factor correction and one 1,000-kw. motor-generator set used jointly for power-factor correction and for the supply of direct current at 275 volts for operation of the mine railway.

One of the principal problems in connection with the station's design was the arrangement of outgoing feeders to the mill, requiring, ultimately, nearly 15,000-kw. 550-volt three-phase 60-cycle current. Underground tunnels were finally adopted as representing the most satisfactory solution, as this plan had the advantage of permitting the use of a large amount of cable formerly run overhead on poles, but which was not in satisfactory condition for installation in underground conduits. Overhead feeders proved to be out of the question on account of their obstruction to valuable yard space and because of difficulty in taking care of dead-end stresses at the mill end.

The mine substation presents some unusual features from the standpoint of location and construction difficulties. The space occupied by this station, which is underground about 4,000 ft. inside the mine, was excavated out of solid rock. This was accomplished by first excavating throughout the entire length of the station a tunnel of such proportions and at such an elevation as would permit of concreting the roof, to seal in place and prevent rock from falling during further construction operations.

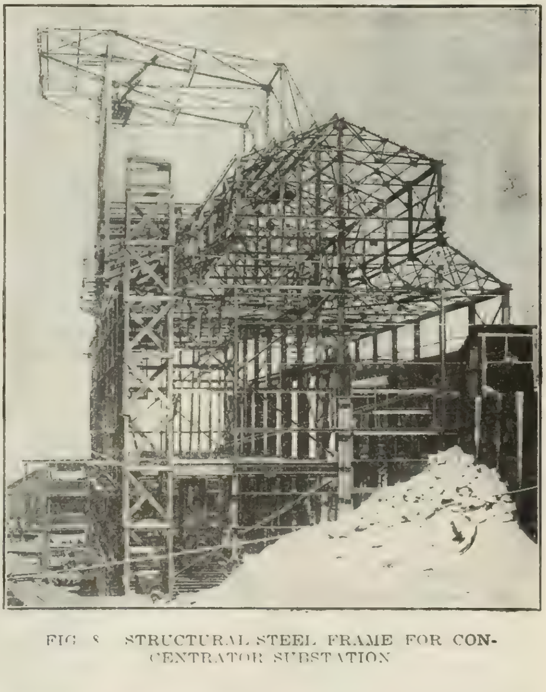


FIG. 8. STRUCTURAL STEEL FRAME FOR CONCENTRATOR SUBSTATION

The roof having been completed, the floor of the original tunnel was gradually lowered by taking out material until the floor elevation was reached and the concreting of the side walls completed. The general dimensions of this station and the extent of excavation involved may be seen upon reference to the sketch shown in Fig. 7.

Primarily, the mine substation supplies compressed air for mining purposes. It also supplies direct current for the mine railway and alternating current for mine hoists, auxiliaries and lighting. This substation equipment consists of two 2,500-kw. 6,600-volt to 2,300-volt three-phase water-cooled transformers, two 4,000-cu.ft. compressors driven by 900-hp. 2,300-volt three-phase synchronous motors, two 100-kw. motor-generator sets for exciting the synchronous-motor fields and one 500-kw. and one 200-kw. motor-generator set for the supply of direct current to the mine railway at 300 volts. Power supply for this station is by means of two three-conductor steel-armored cables about 9,000 ft. long from the concentrator substation.

Duplex Unaflow Pumping-Engine Water Valves

Considerable interest has been created by the performance of a unaflow simplex pumping engine under test. It is the first of its type and was installed at the Porter Avenue water-works pumping station, Buffalo, N. Y. A paper regarding this unit was presented at the meeting of the American Water Works Association at Albany, N. Y., October, 1919, and again at the Sept. 8, 1920, meeting at Holyoke, Mass. The steam end consists of a 13½ x 21-in. Unaflow steam cylinder, the water end being fitted with a new design of valve and is double-acting, having a 9-in. plunger and operating at a speed of 210 r.p.m. with a normal capacity of three million gallons per day.

During the test the only station pressure available varied from 200 to 225 lb. gage and superheated 10 to 20 deg. A summary of a number of tests is shown in the table.

At the high speed at which this engine is run, it is evident that the ordinary type of water valve would not prove satisfactory, and that in order to take advantage of the most economical speed an improvement in valve construction would be necessary. The design of valve used in the pump is shown in Fig. 1. A soft-rubber valve seat, *A* is reinforced by the copper ring *B*. The metal valve *C* is made saucer-shaped with a spring pressure on one side working against the water pressure on the other. As the valve is of spider design, the discharging water not only escapes past the outer edge of the valve, but also finds a passageway through the opening between the outer and center portion of the valve. As the valve seal is tapered, the water is discharged through the valve at an easy angle, which reduces the friction. The path of the water is shown in Fig. 1.

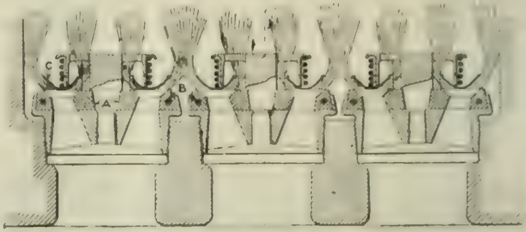


FIG. 1. DESIGN OF PUMP VALVES AND VALVE DECK TO OPERATE AT HIGH SPEED

The Monongahela Water Co., of Elizabeth, Pa., has purchased a 15 and 15 and 7¼ x 16-in. duplex unit, Fig. 2, having a capacity of three million gallons per 24 hours at a speed of 193 r.p.m. Dry saturated steam at 150 lb. gage will be used.

SUMMARY OF TESTS OF UNAFLOW PUMPING ENGINE

	Date of Trial		
	Aug. 25		Aug 28
Steam pressure at throttle, lb. gage	205.0	209.0	216 0
Steam temperature at throttle, Deg. F.	426.0	428.0	430.0
Superheat at throttle, deg. F.	36.0	36.0	36 0
Vacuum, inches mercury	26.5	26.3	25.8
Total head, feet	249.5	302.5	366.7
Rev. per min.	210 0	207.5	208 0
Duty million foot-pounds	128 3	131.5	132.0
Average m.e.p. pounds	39.3	46.0	57.8
Indicated hp.	118.8	137 8	173.5
Steam per 1 hp.-hr. (lb.)	13.6	13.5	13.3
Efficiency, per cent	88.0	90.0	87.2
Capacity per minute, (plunger discharge)	164.6	1,630 0	1,633.0

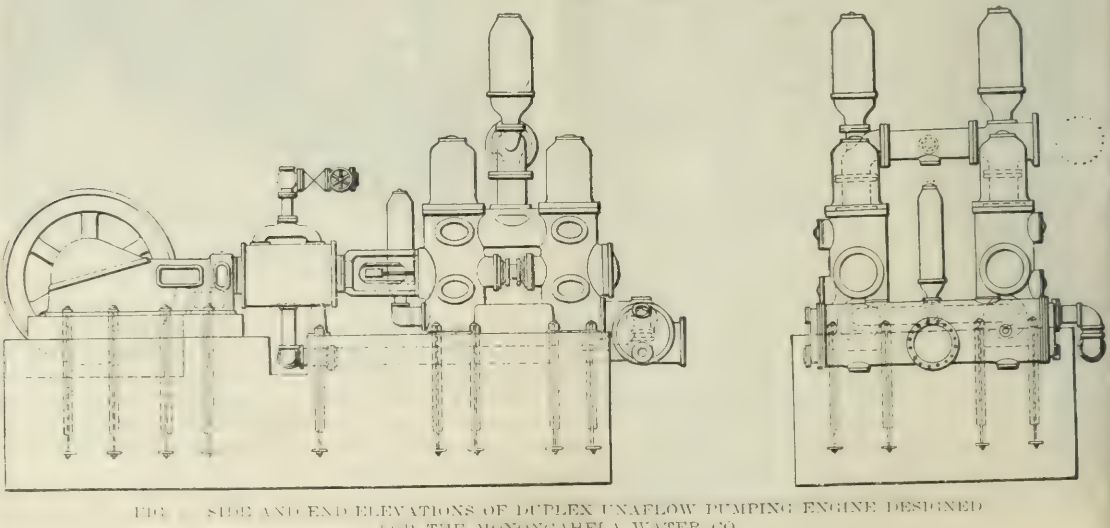
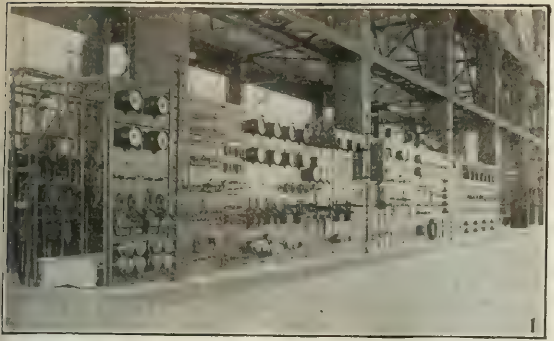
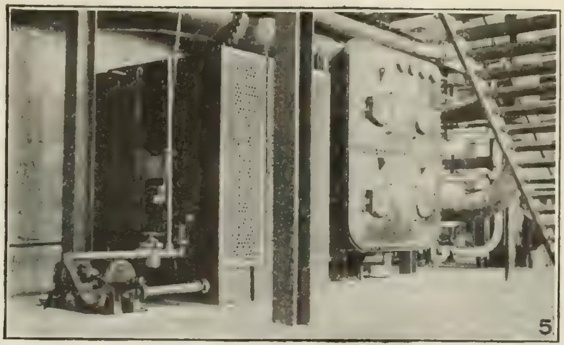
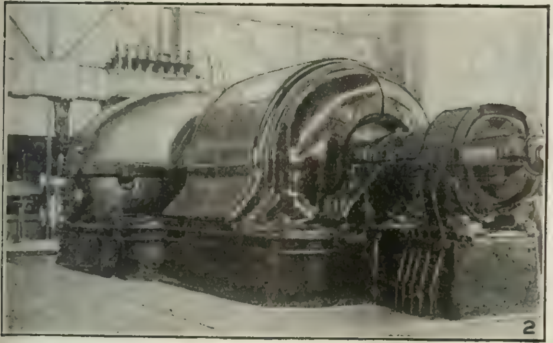
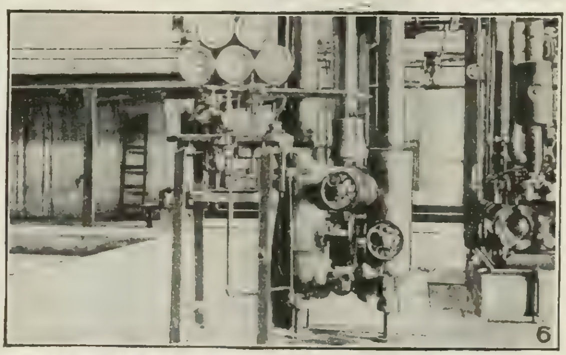


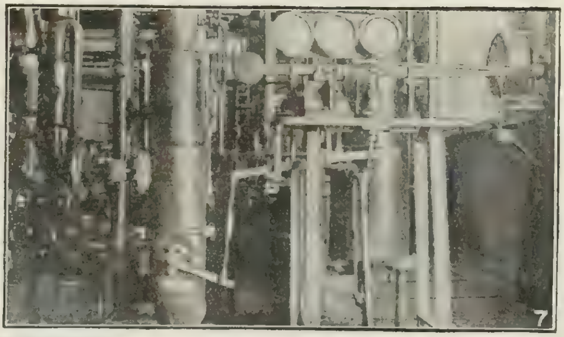
FIG. 2. SIDE AND END ELEVATIONS OF DUPLEX UNAFLOW PUMPING ENGINE DESIGNED FOR THE MONONGAHELA WATER CO.

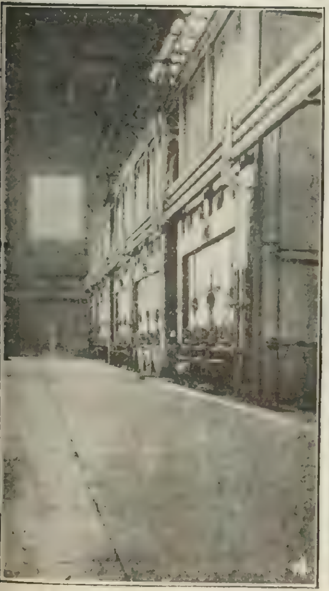


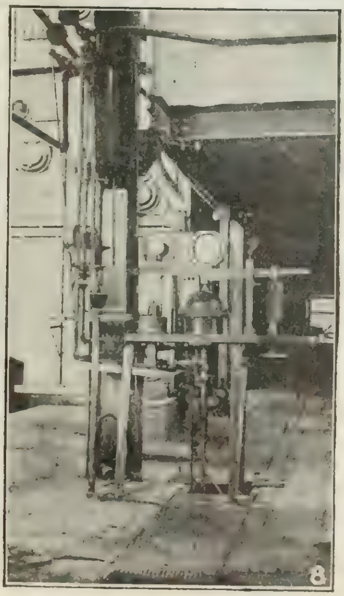












Views of the Power Plant of the New Cornelia Copper Co., Ajo, Ariz., a Notable Oil-Burning Plant

FIG. 1. MAIN SWITCHBOARD

FIG. 2. CURTIS 7,500-KW. TURBO GENERATOR

FIG. 3. COOLING POND, 150 x 400 FT

FIG. 4. BOILER PLANT SHOWING FUEL OIL AND ATOMIZING STEAM HEADERS ATTACHED TO BOILER FRONTS

FIG. 5. AIR WASHER FOR TURBO-GENERATOR

FIG. 6. FUEL-OIL REGULATOR

FIG. 7. ATOMIZING STEAM REGULATOR

FIG. 8. DAMPER REGULATOR

Application of Induction Motors—II

Current Taken During Starting Periods—Capacity Supplying Motor Sufficient To Take Care of Starting—Will Motor Operate at Its Full Rated Load?—Heavy Overloads and Severe Mechanical Shocks—Plugging of Motor

BY FRAZER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

FIVE features were taken up in the previous article (Oct. 26 issue), namely: What is the motor to drive? Kinds of rating. Will the motor have sufficient torque to start its load? If starting conditions are severe, how much actual torque is required to start the load? What will be the length of the period of acceleration? In this article five more of the sixteen points on motor installation outlined in the first installment are considered.

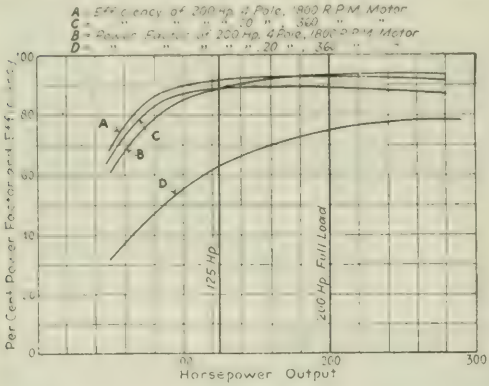


FIG. 1. COMPARATIVE CURVES OF HIGH-SPEED AND LOW-SPEED INDUCTION MOTORS

6. IF THE MOTOR IS OF THE SQUIRREL-CAGE TYPE, WILL EXCESSIVE LINE CURRENT DURING THE STARTING PERIOD BE OBJECTIONABLE?

Sudden large demands for power from a system of relatively small capacity as compared to the motor tend to create line disturbances that may be objectionable. If the source of supply feeds a power load, a lighting load or both, sudden large fluctuations in load, such as may be caused by the starting of a squirrel-cage induction motor, create fluctuations in the voltage provided there is no form of automatic regulator in the field of the generating equipment. The variations in these fluctuations will depend to a great extent on the relative capacities of the motor and the generating equipment, also on the load and power factor of the load already being carried by the generator. The variation in voltage may become great enough not only to cause a violent flickering of the lights on the circuit, which may be objectionable to the point of being prohibitive, but also to knock out other induction motors already connected to the system.

If there is sufficient capacity supplying the motor to take care of the starting period, but if the relative ratio of motor size to generator size is small, better and more stable operation may be had by the use of a voltage regulator in the fields of the generating equipment. If, on the other hand, the voltage cannot be kept within reasonable limits even with the regulator, some other type than the squirrel-cage motor will have to be considered.

Another feature in connection with the large current taken by the squirrel-cage motor during the starting period is that the line copper or the feeder copper may be of such size and length as to create an excessive voltage drop at the motor terminals, thus reducing the starting torque value to the point where the motor is unable to start its load effectively.

7. IS THERE SUFFICIENT CAPACITY SUPPLYING THE MOTOR TO TAKE CARE OF THE STARTING PERIOD?

As has already been brought out, the squirrel-cage motor in starting draws a large current at a very low power factor. If the size of the motor is relatively large as compared to the prime-mover equipment, it is possible that the generator will be unable to hold up its terminal voltage even though the ideal condition of no drop in speed could be maintained.

In order to alleviate starting disturbance, it is sometimes possible to make use of certain mechanical friction clutches, magnetic clutches, etc., while pumps, fans, compressors, etc., can easily be arranged for the proper kind of unloading device. The use of such devices allows starting of the motors on lower taps with less current and with the ultimate result of less line disturbance. In any event the question of connected load in relation to prime-mover capacity should be fully considered.[1]

8. WILL THE MOTOR OPERATE AT ITS FULL RATED LOAD?

As the power factor of the average induction motor drops off rapidly as the load falls off, and if there are a number of such machines operating at greatly reduced loads, it is seen that a condition prevails making for a power demand at excessively low power factor.

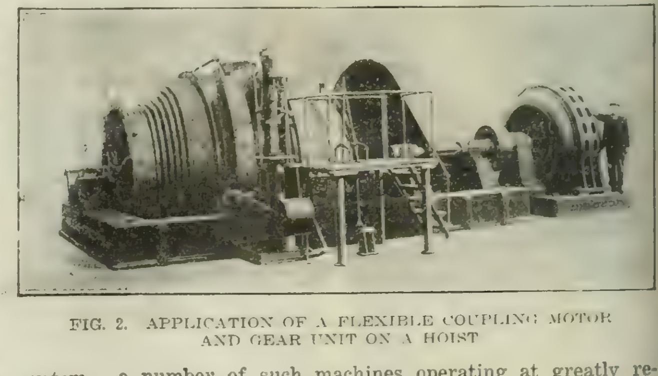


FIG. 2. APPLICATION OF A FLEXIBLE COUPLING MOTOR AND GEAR UNIT ON A HOIST

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[1] For a fuller discussion on this point see article, "Connected Load Versus Generator Capacity," by the author, *Power*, Aug. 3, 1920.

The inherent characteristics of induction motors of different speeds is not often fully appreciated and realized. Fig. 1 shows the curves for motors of two entirely different speeds, namely: 1,800 r.p.m. and 360 r.p.m., a 4-pole and a 20-pole motor respectively. The slow-speed motor, owing to its large magnetizing current and high reactance, is a machine of poorer characteristics than the high-speed motor. The efficiency curves for either the high-speed or the low-speed motor are more or less flat over the range of load from ½ to 1¼, so that working at reduced loads does not make a large difference in efficiency. On the other hand, the effect of working at, say 125 hp., instead of the normal load of 200 hp. shows a large falling off in the power factor, which is much greater for the slow-speed motor than for the high-speed motor. It is therefore advantageous to work motors as near to their full rated load as possible, not only to obtain the greatest true energy output from the generating apparatus, but in cases where power is bought, to avoid being penalized by higher power rates due to the low power-factor condition.

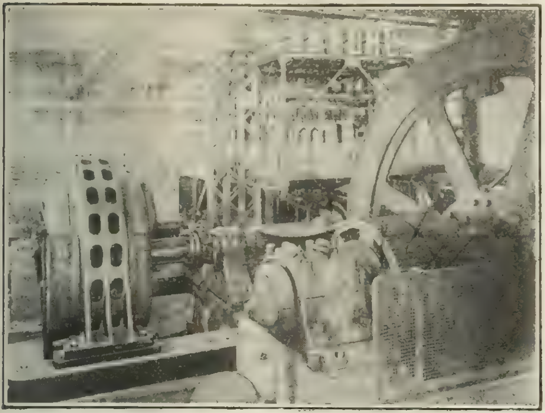


FIG. 3. APPLICATION OF CHAIN DRIVE BETWEEN MOTOR AND DRIVEN MACHINE

When squirrel-cage motors are operating underloaded, great care must be taken to make certain that the use of smaller machines in place of underloaded machines will deliver the proper amount of torque for starting the load. Oftentimes squirrel-cage motors have been installed that were larger than necessary for the running-load conditions in order to take care of the starting conditions, but in such cases the use of smaller slip-ring motors would appear to be a much more desirable procedure, since they could easily meet the starting conditions.

9. WILL THE MOTOR BE SUBJECT TO HEAVY OVERLOADS AND SEVERE MECHANICAL SHOCKS?

Because of its peculiar inherent characteristics, the induction motor is a machine having a relatively small air gap; that is, the clearance between the rotor iron and the stator iron is small compared with that of other types of rotating electrical machinery. The greater the air gap is made the lower the power factor becomes, so that the clearances are made such that from an electrical standpoint the power factor remains high, while from a mechanical standpoint the operation is absolutely reliable. This clearance is usually measured in thousandths of an inch, so it is important that the proper tolerances in the bearings be maintained and that the rotor be kept central with respect to the stator at all times.

For the foregoing reasons any load action with a tendency to injure the bearings should be given special consideration. For instance, the use of gear pinions mounted directly on the motor shaft, on the larger sizes of motors, say 100 hp. and above, is not only likely to affect the bearing tolerances, but the severe and continual mechanical vibrations of the load and the gears themselves will in time tend to crystalize soldered joints, loosen screws, cut through insulation, loosen laminations, etc. A flexible coupling, Fig. 2, interposed between the motor and the gear unit, has been found to obviate the troubles otherwise likely to occur.

On the other hand, the use of a chain driving from a pinion mounted directly on the motor shaft, Fig. 3, even for rolling-mill work, has been found to work out satisfactorily. In such a drive the severe load shocks and jolts are absorbed by the flexible chain and the proposition is entirely different from that of the gear.

Again, any driven machine having a side or end thrust when under the load should never be rigidly coupled to the motor unless provision is made outside the motor for taking care of this thrust. As a matter of fact it is always advisable, as in Fig. 4, to interpose a flexible coupling between the motor and the driven machine when the two are direct-connected.

If the power demands require heavy peak loads of short or long duration, the motor must be capable of taking care of these without dropping its speed on account of insufficient torque. If the nature of the load is more or less regular and fairly well known, it is often possible to effectively use a flywheel and cut down on the size of the motor and incidentally to reduce the power bill where energy is bought on a maximum-demand basis.

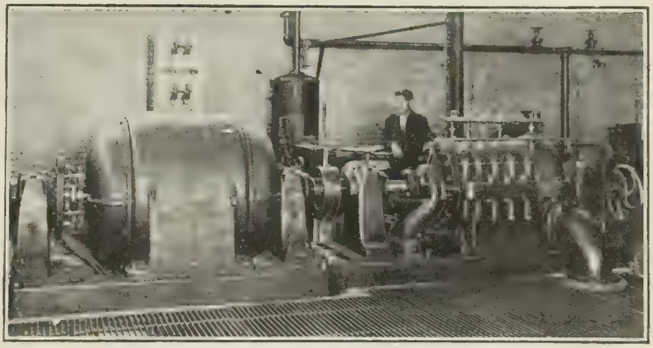


FIG. 4. APPLICATION OF A FLEXIBLE COUPLING BETWEEN MOTOR AND PUMP

The effect of such an arrangement is shown by Fig. 5, the full lines denoting the power demand and motor load without flywheel, the dotted lines denoting the motor load with flywheel. The straight-lined portion represents the energy given up by the wheel, which is approximately equal to the cross-sectioned area representing the power necessary to bring the wheel back up to speed. The use of the wheel reduces the peaks and averages up the load, thus relieving the motor. The flywheel can be used only under conditions where the load is definitely known to fluctuate between a maximum and a minimum value for definite periods of time, with definite periods of no-load or light-load conditions allowing suitable time for restoring energy to the wheel.

10. WILL THE MOTOR BE "PLUGGED"?

Oftentimes the service, while of a highly pulsating and intermittent nature, such as to be found in rubber mills, balanced hoists, steel mills, etc., is such that continuous rated motors are used. This service frequently requires the motor to be "plugged"—that is, reversed from full speed in one direction to full speed in the opposite direction—and this, combined with the maximum torque feature so frequently needed, requires a more or less special motor to suit the conditions involved, but one classified under the general heading of continuous rating.

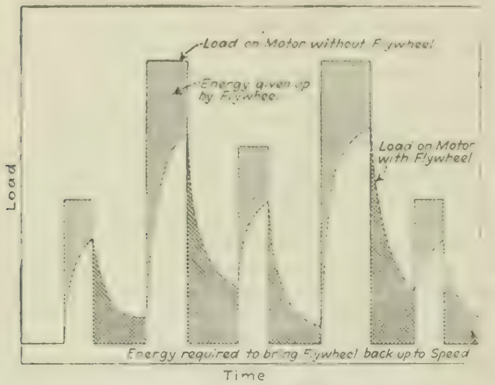


FIG. 5. CURVE SHOWING GENERAL EFFECT OF A FLYWHEEL ON THE LOAD TAKEN BY A MOTOR

Induction motors used for reversing service are subjected to very different electrical and mechanical stresses from those used only for continuous-duty service in one direction of rotation. Ordinarily, motors when operating in one direction, upon being brought to a distinct stop and then started up in the opposite direction of rotation, are not subject to any greater stresses than the continuous-running motor. The only difference is that the repeated starting and stopping subjects the motor to more frequent electrical stress than is otherwise obtained. If, however, the motor is reversed while running at normal speed in one direction to full speed in the opposite direction, the conditions are entirely different.

In the rolling of steel it frequently happens that a cold billet will stick, thus necessitating either the stopping of the motor before backing out or immediate "plugging." In rubber mills as also in the steel mills, "plugging" is used as a precautionary measure to safeguard human life and prevent an operator being drawn into the rolls if he should become caught in the material or tables leading to the mill. For hoist work the ideal condition is always one of coming to a full stop before reversing, but emergency conditions and the inching back and forth to obtain correct levels are the equivalent of "plugging" service.

"Plugging" is also used extensively for bringing apparatus having large inertia, such as flywheel motor-generator sets, quickly to rest. Not only is it a desirable operating feature, but when it is considered that such apparatus will often run for an hour or more when disconnected from the source of supply before coming to rest, the question of a quick stop necessitates this means as an emergency method if for no other reason. What would otherwise take an hour or more can be accomplished by "plugging" in the space of ½ to 2, 3 or 4 minutes, depending largely on the inertia and on the limits to which the reverse torque is confined.

Consider first the electrical stresses. It is generally known that a slip-ring type induction motor has a voltage across the slip rings of its rotor, which is a maximum at standstill and a minimum, or zero, at synchronous speed. This is shown by the curve *AB*, Fig. 6, and represents the dielectric stresses in the rotor under the most prevalent and usual method of operation found in practice.

If the motor is running at full speed in one direction of rotation and is reversed, or "plugged," by changing the primary connections the dielectric stresses in the rotor are doubled, curve *BC*, Fig. 6, so that it is now seen that the rotor insulation is subjected to a much greater stress than when working under ordinary conditions. Recognizing these conditions, the American Institute of Electrical Engineers, in their standardization rules, call for dielectric tests which meet the need for additional insulation for this particular kind of service. The rule given is as follows:

> The secondary windings of wound rotors of induction motors shall be tested with twice their normal induced voltage, plus 1,000 volts. By normal induced voltage is here meant the voltage between slip rings on open circuit at standstill with normal voltage impressed on the primary.
>
> When induction motors with phase-wound rotors are reversed while running at approximately normal speed, by reversing the primary connections, the test shall be four times the normal induced voltage, plus 1,000 volts.

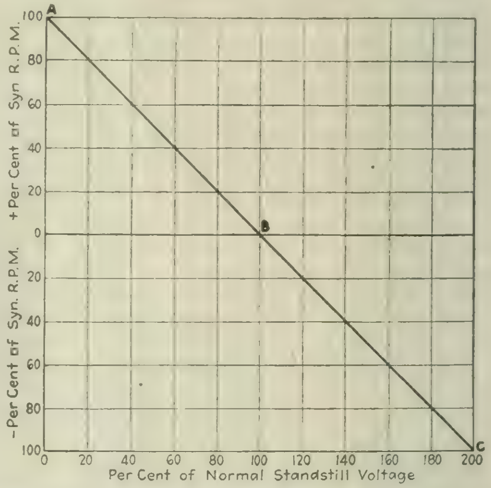


FIG. 6. CURVE SHOWING EFFECTS OF PLUGGING SLIP-RING TYPE MOTOR

"Plugging" service therefore requires motors having specially insulated rotors in order to safely withstand the severe service conditions as well as the dielectri test conforming to the standardization rules of the American Institute of Electrical Engineers.

Consider, secondly, the mechanical stresses. It is self-evident that reversing from full speed in one direction to full speed in the opposite direction imposes strains not ordinarily encountered. For this reason it is sometimes necessary, especially on the larger units, to double-key the rotor spider to the shaft, dowel or key the end heads that support the rotor coils to the spider, and to protect to a greater extent that portion of the rotor coil lying in the slot portion of the core against mechanical injury. It is also necessary in most cases to support the stator coils against mechanical movements and weavings due to the stresses set up, and where possible the air gap is made larger than usual on account of the severe service to which the bearings are ordinarily subjected. The nature of the work to be accomplished is such as to demand a motor of more rigid mechanical construction than is otherwise ordinarily required.

[*The next and last installment will consider the location of the motor; connection of the motor to its load; power requirements; local fire-underwriters' requirements; protection of motor; and selection of motor.*—EDITOR.]

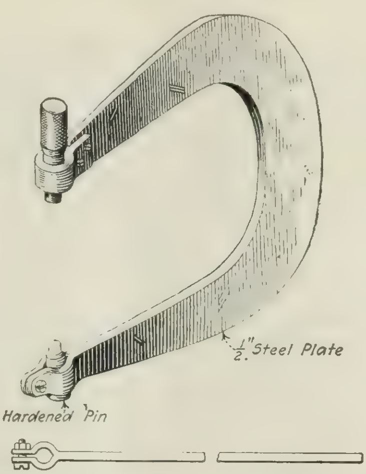
Alignment of Oil-Engine Main Bearings

In the manufacture of the modern oil engine the bearings are made up of babbitt-lined semicircular shells. These shells rest in housings formed in the engine frame. It is the practice to bore all the housings on a horizontal boring mill at one setting. They are then checked by a special fixture. The work is usually performed in a painstaking manner, and seldom does any housing show more than a few ten-thousandths out of alignment. The housings are filed and scraped until they test true. The bearing shells are all made of equal thickness, and, after being bedded in the housings, are checked for alignment by a test shaft. If any error appears, it is corrected by scraping of the babbitt.

After the engine is installed in a power plant, the bearings begin to wear. No matter how excellent the lubricating system may be, the wear starts as soon as the engine turns over. Since the babbitt linings in the several bearings are never of equal density the wear is by no means uniform. Varying pressures in the engine cylinders tend to increase the discrepancy in the rate of bearing attrition. If the flywheel weight is supported or partly supported by one of the end main bearings, this bearing will probably show a more rapid wear than the others. Oil-engine operators should recognize these facts and take proper steps to maintain the bearing alignment. Too many allow matters to drift until one or more bearings start to run hot. In most instances it is then too late to save the babbitt lining.

Just as there should be a regular schedule in grinding valves and pulling pistons, the engineer should test the bearings at stated intervals. It is difficult to give a rule as to the length of time elapsing between inspections; the operator is not unduly active if he arranges to examine the bearings every six months. To remove the bottom half of the bearing, it is only necessary to lift off the top half and turn the flywheel. The revolving shaft will draw the lower bearing from the housing. The thickness of the shell should be measured at both ends and at the center; several measurements should be taken at various points. If these measurements are the same, it is evident that the wear on the particular bearing has been uniform. If the measurements check with readings taken on the other bearings, the main bearings are in alignment. If one bearing shows that it is low, the engineer must decide his course of action. It is possible to shim up under this low bearing until it is as high as the other. If the difference is marked this is the best procedure; sheet steel make the best liners. If the variation is less than five one-thousandths of an inch, probably the best scheme is to scrape the other bearings, removing an amount of babbitt to compensate for the variation between the highest and lowest bearings. In cases where all the bearings vary, scraping is the only remedy.

Few engineers are equipped with a micrometer having a gap deep enough to take the length of a main bearing. In fact, no manufacturer carries such an instrument in stock, but a very serviceable one may be made in any machine shop. A piece of $\frac{1}{2}$-inch boiler plate is cut to the form illustrated. At the base a hardened pin is turned up and inserted in an eye formed out of the steel plate. To the upper end of the plate is riveted and soldered the shank of a one-inch micrometer. The distance between the two arms of the yoke should not exceed three inches. This micrometer actually measures differences, but the results desired when measuring bearing shells are differences and not exact thicknesses.



MAIN-BEARING MICROMETER

That more attention should be given to bearings is evidenced by a recent crankshaft failure on a 500-hp. Diesel. On examination the shaft showed marked crystallization. When the alignment of the bearings was checked one was found to be $\frac{1}{32}$-in. lower than the others. The shaft had been unsupported between two of the cranks, and at each power stroke of these two cylinders it had bent. This bending, continuing for months at the rate of 350 times per minute, resulted in crystallization and final failure. In this breakage a loss of some $7,000, plus loss of operating time, is traceable to misalignment of the main bearings.

In the description of the Miami Oklahoma Diesel plant *Power*, Oct. 19, page 615, the horsepower rating of the engine was given as 385 hp. This was an error and should have been 500 hp.

Preventing Emulsification in Oil-Circulation Systems

By R. E. Langston
Lubrication Engineer, Wayne Oil Tank and Pump Company

THE value of a complete system that permits the recovery of used oil, its purification and its delivery in a continuous stream, is recognized as the extreme limit in lubrication economy. The merits of a central oiling system depend altogether upon the recovery of the used oil and the ability of the apparatus to get it back into a usable condition.

In handling the lubrication to engines, turbines or high-speed power units, lubrication engineers have had to give considerable study to the problems arising from the emulsification of oil and water. We often hear it said that oil will not mix with water. This expression is common. But engineers know that oil will readily mix with water under favorable conditions. How permanent the mixture will be depends much upon the chemical composition of the oil, its degree of refinement and the mechanical action to which the oil and water are subjected.

Emulsified oil is not a good lubricant. That friction-reducing film cannot be maintained with an oil-and-water mixture. The formation of sludge is the product of an emulsion. It is a mixture of incorrect oil with water, dirt and mechanical impurities. Emulsification and sludge are responsible for more bearing trouble than is generally realized. An emulsion often becomes so thick that oil pipes are clogged and cause a failure of the oil supply. Water in the oil is not an aid to lubrication; it is a dangerous impurity which must be kept out, just as dust or dirt.

Central oil-circulation systems in modern power plants are coming into extensive use as a means for producing economy in oil consumption. The author discusses the kind of oil to use in such systems to avoid forming an emulsion.

A good mineral oil does not wear out mechanically and may be used over and over again. If it has been properly purified and all foreign impurities removed, it usually remains as good as new oil in every respect. But it must be carefully filtered and rid of water.

Entrained water, not free water, is the most troublesome impurity contained in used oil and offers the most difficulty to separation. More or less water is sure to find its way into the oil from the leaking stuffing boxes, cooling coils, or seals, etc., of the lubricated machinery. This water mixes with oil under conditions that are correct for the formation of an emulsion. The kind of water used, boiler compounds, speed and temperature of journals, as well as kind of oil, each has its effect upon emulsification. Conditions in the steam turbine are the most ideal for an intimate mixture, for here water and oil are churned at an excessive speed, during high temperature, and under heavy pressure. Because the steam turbine possesses such excellent emulsion-forming conditions, it is important that turbine oil should be of such character that it will rapidly separate under right treatment from the entrained water.

Nevertheless, any oil that possesses even a high resistance to emulsification will mix with condensation around a steam engine. The presence of heat and motion will cause the oil to unite with moisture. However, if these mixtures are permitted to remain in a state of rest, at a temperature sufficient to keep the viscosity of the oil greatly reduced and for a period of time, entrained water will settle out of the oil and make a complete separation. The proportion of water settled out of the oil in a given length of time is the measure of its resistance to emulsification.

In the selection of an oil to be used in a plant for bearing lubrication, and particularly one to be used in an oil-circulation and filtration system, care should be taken to specify an oil possessing a high demulsibility test, as well as the other necessary physical properties. A plant with a circulatory system, and means for recovery and using the oil indefinitely, can afford to use the best oil obtainable. The cost of the small amount of oil necessary to keep the system filled is nothing compared to the benefits that are obtained, such as economy in power and economy in operation of the system. Resistance to emulsification is just as much of a physical property to be demanded in specifications as is viscosity or flash point. It is a property given the oil by the manufacturer. An oil that is highly refined or is thoroughly purified will have a high demulsibility test which serves as the best proof of its degree of refinement. As a general rule a "pale" lubricating oil has been filtered more than a "red" oil and will not emulsify as readily. A good oil is distinguished not necessarily by its lightness of color, but by the amount of filtering given it in the refinery. The elimination of waxes from oil by more complete refining causes a decided increase in the ease with which the oil will separate from the water. Some oils become acid with long-continued use because of impure refining or because of absorbing acid from the metal with which they come in contact. The presence of acid will cause a rapid decrease in demulsibility. Other oils remain neutral and continue to be free from that emulsion-forming property.

The cause of this intimate mixing of oil and water is explained by various theories. Milk is a natural emulsion, composed of globules of butter fat coated with casein and suspended in water. In mayonnaise dressing the globules of oil are coated with the yolk of egg and suspended in vinegar. The object of the pharmacist in making permanent emulsions is first, to thoroughly divide the oil into globules and then surround each globule with an adhesive envelope to prevent them from reuniting. The lubricating engineer, on the contrary, desires that there shall be no substance present in the oil which might form an adhesive envelope in case the oil becomes finally divided. In other words, if nothing but pure oil and pure water are present any emulsion that might be formed will not be permanent.

To aid in the separation of the entrained water, an oil filter must be used which is so designed that the body of oil to be treated is held in an approximate state of rest and at a temperature sufficient to thin it and permit the spheres of entrained water to settle. With the assistance of a properly designed filter a good high-grade oil may be kept free from entrained water and other impurities and may be used a long time.

The need for a standard emulsification test has been of great importance, not only to the lubrication engineer, in the comparison of this property of oil, but to every operating engineer who uses a continuous oil-circulation system. If more oil was purchased according to specifications and each batch tested before accepted, it would not be so easy for an engineer to get an inferior grade.

The United States Bureau of Standards has anticipated this need of a standard emulsification test and has devised one that will give more uniformity to a laboratory analysis. But for an engine-room comparison of oils, the ordinary operating engineer may take 20 c.c. of oil and 40 c.c. of water in a small bottle, shake it vigorously, at a temperature of about 130 deg. F. for about five minutes, then let the mixture settle. If the samples are all given the same treatment, the comparison will be just as good for his purpose as an elaborate test. The highest possible demulsibility will be obtained if all the oil, 20 c.c., settles out in one minute; which, expressed in cubic centimeters per hour, equals 1,200.

$$\textit{Number of c.c. of oil settled out} \times \frac{60}{\textit{time in minutes}} = \textit{c.c. per hr.} = \textit{demulsibility.}$$

For example, if a demulsibility of 400 is specified, and the oil has not settled out in three minutes, it has failed to meet the requirements.

During a test with the best non-emulsifying oils there is apparently no true emulsion, but only a kaleidoscopic movement of bubbles. The test is one that any engineer can make and will be a wonderful help to the selection of a proper oil. Taken as a whole, according to their demulsibility, the majority of the oils on the market are either very good or very bad. For a non-emulsifying turbine oil, a demulsibility test of 300 is a good specification.

Engineers should protect their oiling systems against those conditions which cause choked oil pipes and the disastrous effects of insufficient circulation by eliminating all chances for the formation of an emulsion and sludge. Sludge is the "Jonah" of every turbine operator. It is caused by the emulsification of an incorrect oil with water and other impurities or the continued use of an oil without purification. Every circulatory oiling system is affected sooner or later by sludge if the impurities are not continually removed from the oil by means of a good filter. Every precaution should be made to prevent this danger, trouble and expense caused from emulsification, by combining the use of a better grade of oil with that of an efficient filtration system. Better lubrication will be obtained, maintenance trouble will be reduced to a minimum, and less oil will need to be purchased, for the life of the oil will be so greatly increased, and less evaporation losses will be had.

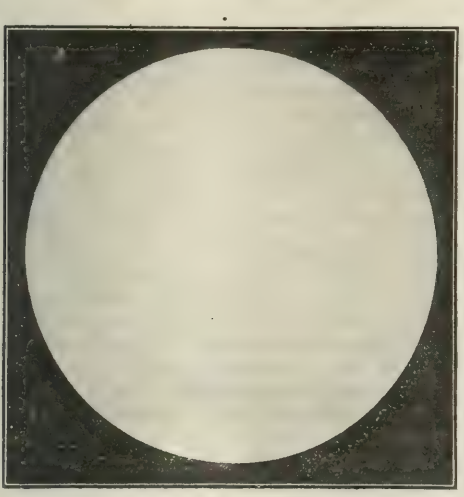


FIG. 1. CLEAR, FRESH OIL

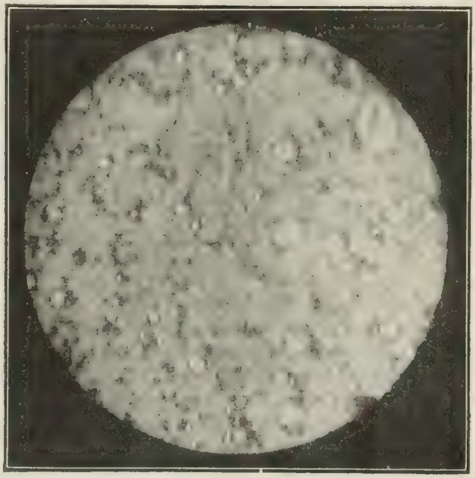


FIG. 2. EMULSION OF OIL AND WATER

MICRO-PHOTOGRAPHS OF LUBRICATING OILS, FIVE HUNDRED DIAMETERS

A good, reliable oil filter is the heart of a circulatory oiling system and will prevent sludging and dangerous emulsification.

Fig. 1 specimen is new unused oil. Fig. 2 specimen is used oil from a circulatory system, showing the sludge formation, the result of the emulsion of oil and water. The oil-coated water globules are shown entrapped in the oil.

After purification in a reliable oil filter this dirt and water will have been removed and the condition of the oil restored to that of the new unused oil. The photomicrographs show oil drops magnified 500 diameters.

The British Board of Trade and the Privy Council have appointed special committees to make an investigation of available "white coal" resources. An official Water Power Resources Committee has already examined and reported favorably upon nine separate schemes of water-power development in the Scottish Highlands. These nine schemes, it is estimated, would yield an aggregate of 183,500 hp, at a cost much below that of generating power in Scotland by the use of coal.

Motor-Driven Ice Plants—Electrical Consumption Per Ton of Ice

By JOHN E. STARR[*]

THE cost for power alone per ton of ice made, as distinct from the total cost, is a subject that admits of fairly close analysis, especially in view of the large amount of statistics now available from electrically driven plants where the power output can be daily accurately measured.

Variation in cost lies mainly in cost of operating auxiliaries, and the load factor. Under usual conditions of pressures, loads, temperatures, and volumetric efficiency, 48.5 kilowatt-hours per ton of ice is the usual good result as found. The compressor should have a separate current meter. The cost of operation varies with the seasons, especially where cooling-tower water is used.

With coal, oil or other source of power the results are not so easily arrived at on account of the great variation in quality of coal, methods of firing, cost of labor, etc. The increasing use of electricity from central stations renders the cost in kilowatt-hours in actual practice easily obtainable, and if one knows the kilowatt-hours used, he has only to reckon the local rate for electricity to get at the cash cost. The variation in cost lies mainly in the cost of operating auxiliaries, and the load factor, which latter includes the time of operating the machine, whether on a steady monthly load for a certain period, the time of year of the period and the weekly load factor. For, with electricity, the charge is usually based on the maximum load occurring during the week computed from short-time meter reading taken by the electric company—all of which argues for a low weekly maximum demand, a full load for each month while the plant is running at all and a run of the largest number of months possible at full load.

POWER IN KILOWATT-HOURS PER TON OF ICE

Suction Pressure Head Pressure	5 lb. gage Kw.-hr. per Ton		10 lb. gage Kw.-hr. per Ton		15 lb. gage Kw.-hr. per Ton		20 lb. gage Kw.-hr. per Ton		25 lb. gage Kw.-hr. per Ton	
Gage	Refr.	Ice	Refr.	Ice	Refr.	Ice	Refr.	Ice	Refr.	Ice
145	35 52	54.6	30 07	46.24	25.68	39.5	22 87	35 16	20 259	31.16
150	36.5	56.1	30 9	47 5	26.4	40.65	23 6	36.2	20.9	32.4
155	37 4	57.6	31 7	48.8	27.2	41 8	24.3	37.35	21.6	33.55
160	38 4	59.1	32 55	50 2	28.0	42.9	25.1	38.46	22.3	34.7
165	39 35	60.6	33 4	51 5	28 8	44.05	25 8	39.6	23.0	35.85
170	40 3	62.0	34 2	52.9	29.55	45.2	26.5	40 7	23 65	37.0
175	41.3	63.4	35 2	54.2	30.35	46.3	27 2	41 85	24 3	38.2
180	42 2	65.05	36 1	55.5	31.15	47.4	27 95	43.0	25.0	39.35
185	43.2	66.5	36.9	56.9	31.9	48.5	28.7	44 1	25.7	40.5
190	44 1	68 0	37 8	58.2	32.7	49 7	29.4	45.2	26.4	41.7
195	45 1	69.4	38 6	59.5	33 45	50 8	30.1	46.3	27.05	42.8
200	46 05	70.9	39 5	60 8	34.2	51 95	30 85	47.4	27 7	44.0
205	47 04	72 43	40 368	62 16	35 04	53 088	31 58	48 57	28 40	45 12

Much depends on the local conditions as to water supply, both as to temperature and quality.

At 185 lb. gage head pressure and 30 lb. absolute, or about 15 lb. gage back pressure, and the average volumetric efficiency obtaining in good practice, and assuming that the ice is made regularly on a good weekly load factor, it takes, as shown by the table 48.5 kilowatt-hours to make a ton of ice. If conditions such as sufficient tankage and cannage will allow, 20 lb. gage back pressure and 185 lb. gage head pressure may be used. The kilowatt-hours by this increase in back pressure can be reduced to 44.1 per ton of ice for the machine alone. If electricity cost 1½c. per kw.-hr., the saving by increased back pressure would amount to $6.60 for each 100 tons of ice made, or a gain of about 9 per cent as to this item alone. If in the cooler months the head pressure be reduced to, say, 145 lb. and the back pressure held at 20 lb. gage, the machine electrical input per ton will be reduced to 35.16, and so on. But the power cost to run the compressor is not the total power cost. It takes electricity for water pumping, for lighting, for cranes and for air and brine agitation, and these are as much the power cost of ice as is the machine cost. It is, of course, well to have a separate meter on the machine alone and so facilitate the analysis of power costs and the separation of the machine cost from the balance. In this case the table is directly usable as it stands, as far as machine costs go.

Where one meter for the entire plant is used, a percentage, which will vary with the circumstances in each case, depending on the water used and its temperature, the amount of lights, etc., must be added to the table.

The cost of operation also varies with the season, especially where tower water is used, as this will be colder in the spring and fall months than in the summer, and therefore the head pressure will vary.

The combined operation of five plants using tower water varied from 27.7 kw.-hr. per ton in December to 50.6 in July for all purposes, including short storage and lighting, and the average for the year was 41.6; 18 plants averaged 51.12 for the year.

One plant averaged 57 kw.-hr. per ton for the year, another 58.8 kw.-hr. and a smaller one (50 tons max.) 62.2 kw.-hr per ton for the year. Another plant in 1914 made 15,000 tons at a low suction of from 12 to 15 lb. and brine temperature of 8 to 12 deg. F., operating from June to October, and averaged 55.0 kw.-hr. per ton, running as high as 66 kw.-hr. per ton for one month for all purposes.

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[*] Starr Engineering Co., New York City.

In the following year the tank surface and can ratio was increased and a higher back pressure of 22 lb. with brine at 18 deg. F. was used, with a result of 40.5 kw.-hr. per ton for the whole year, and 47.7 kw.-hr. per ton for August. This consumption was for all purposes, including auxiliaries. The higher back pressure made a gain of about 9 per cent in operative cost.

The load factor, both annual and weekly, has a big effect on the amount of current used per ton. A plant making 30,000 tons, with a good productive factor of 82½ per cent in ice, averaged 41.78 kw.-hr. for the year, and ran up to 48 kw.-hr. in July.

The figures given in the table are practical figures representing average good practice and are based on the pounds of ammonia that must be evaporated to produce a ton of refrigeration and the resulting cubic feet at the evaporator. To this is added the usual losses caused by cylinder heating, which "swells" the gas during compression. The figures can be and have been beaten by actual test by about 10 per cent, but is taken as an average good result in practical every-day operation. It is further assumed that the electricity paid for delivers 80 per cent of its power to the gas, or an allowance is made of 20 per cent for all losses in transmission and friction between the wire and the gas. It is then assumed that 65 per cent of the refrigerating power will manifest itself in ice made.

SOME LOSS IS INEVITABLE

Certain losses are inevitable, such as the cooling of the water (raw-water ice) from, say, 70 to 32 deg., also the loss by heat entering the ice tank, and the meltage from the can, and the heat to raise the ice from the tank temperature to 32 deg. These losses can be reduced only by a small percentage. So on the whole the figures cannot be beaten much over 10 per cent by the most expert and careful manipulation.

It is interesting to note the effect of increasing back pressure on the power costs. Only slightly better than the figures given in the table has been done under exceptional circumstances. These high results were obtained by experts in the (now classic) Eastman Kodak tests and are here given. In these tests the machine was turned up to its highest mechanical perfection. If, therefore, any plant owner is approximating the figures shown in the table, plus cost of operating auxiliaries at the pressures given, he is doing about the best he can do as to power and could not improve the efficiencies over 10 per cent at these pressures. Of course the head pressure may be higher than it ought to be by reason of air or "foul" gas or insufficient condenser surface, but that is another story. Often actual production is of more moment than production cost per ton. It may be better to produce 125 tons at a higher power cost per ton than 100 tons.

Above all it is necessary to remember that the power cost is but one portion, although an important one, of the entire cost to get the ice to the ultimate consumer or even to deliver it on the platform. The power cost is largely dependent on the back pressure available, for as far as power cost alone is concerned, it is better to manufacture at the highest back pressure, that is, the highest temperature, possible. Profit is dependent on the proper ratio being struck between the power cost and the salable production.

The clearance, as shown by cards, was practically negligible. The friction was reduced to a minimum, and the tests were conducted by such practical experts as Louis S. Moose, A. Winborg, Luther Bond, H. R. Fisher, R. T. Whitehouse, La Ramsay, William Stair, F. X. Kuhn and C. E. Allison on behalf of Yorke Co., and the reports were signed by Louis Block for the De La Vergne Co., A Winborg for the Yorke Co. and W. S. Lucey for the Eastman Co. The tests were witnessed also by such men as Dr. C. E. Lucke, Prof. E. D. Thurston, W. D. Monks and E. Dettmar in the De La Vergne interests, and Messrs. Cole, Lucey, Lindsay, Gapin and Tallinger, of the Eastman Company.

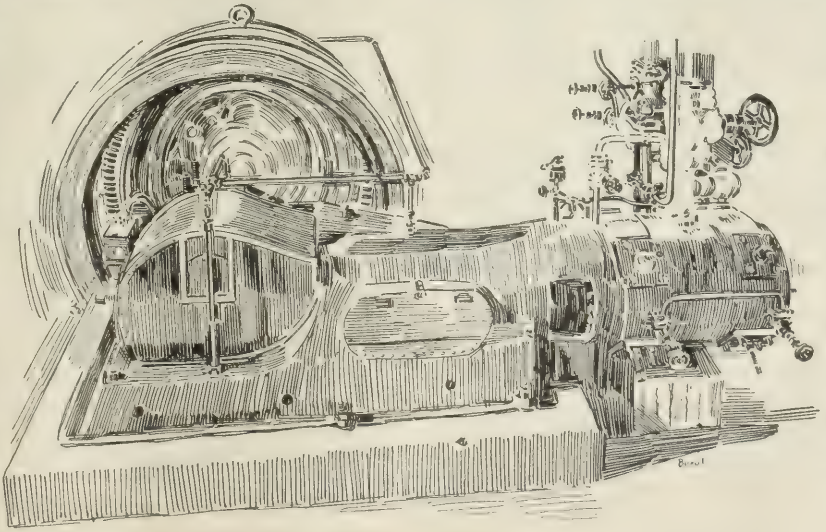
The final results of these tests at 185 gage head pressure and 20 gage back pressure were as follows:

Test No.	I. Hp. per Ton Refrigeration	Test No.	I. Hp. per Ton Refrigeration
1	1.418	4	1.422
2	1.427	5	1.425
3	1.389	6	1.439

Average of all, 1.42 hp. per ton refrigeration, or 26.42 kw.-hr per ton refrigeration or 39.01 kw.-hr. per ton of ice on a 65 per cent basis.

The table gives 44.1 kw.-hr. for ice for 185 and 20 lb. The test made by the best experts in America on a machine especially prepared for the test, therefore, showed only $\frac{44.1 - 39.01}{44.1} = 11.3$ per cent better than the table:

The best test result (No. 3) was 13.8 per cent better and the worst (No. 6) was 10.2 per cent better than the table. Hence under ordinary circumstances in the run of commercial work the results shown in the table should be considered satisfactory and can be beaten fractionally only with the utmost care, as the Eastman tests were very near the utmost possible theoretically.



Power Development in the Future

Effects Power Development in Its Various Forms Has Had Upon Industrial Progress Limitations of Our Present Methods of Power Generation and Distribution—Central Stations and Isolated Plants—Superpower Plants and Recovery of Byproducts in Coal—Utilization of All the Products in Coal Imposes Itself in the Near Future

BY LAZAROVICH-HREBELIANOVICH

THE labor of nature expressed in energy in all its forms of power has become today one of the most indispensable of marketable products, the parent of all production. The history of the progress of mankind all the way down to modern industry, is the story of the development of power, from the application to man's use of the crude forces, down to the gradual unlocking of the energy stored up in the world's making. Through the long ages, up to the very doors of modern life in the Eighteenth Century stretched the period of the primitive knowledge and use of power. This period, the period of wind and water, is marked by the limited, local and individual character of its industries.

THE INDUSTRIAL REVOLUTION

When men began to liberate the energy of coal and use the power of steam as a motive force, the old world order passed away and the so-called "industrial revolution," a hundred years ago, ushered in the formative period of modern industry and of the new world order now dawning. The use of steam freed power from geographic restrictions inherent in hydraulic power, opened the coal fields and the oil wells and created and developed transportation and industry as they are today.

Present industry has been developed on the basis of the distributive use of coal. Although the possible expansion of industry is unlimited, the means of bringing to it energy in the form of coal, requiring a relatively enormous and superfluous bulk, has well-nigh reached the limit of transportation capacity. Since not over 20 per cent of the energy contained in coal is made available from the fuel under the boilers in the most favorable conditions, a more complete utilization of coal has become imperative. This situation signals practically the end of the formative period of industry, and the opening of the reign of the new motive force, "electricity."

Electricity, virtually energy itself, is free from substantial form, devoid of bulk, practically abolishing time in its transmission, and to a great extent distance, capable of subdivision and distribution, easy of application and adaptable to a vast range of utilization. All these capacities and characteristics make it possible to measure, buy, sell, distribute and use energy, whereby power is a marketable product. With the coming in of this new article of commerce, human industry in all its branches enters the era of unlimited possibility.

DEVELOPMENT OF CENTRAL POWER STATIONS

The following figures, covering the development of central power stations in the United States, show the rapid increase in the use of electric energy in the form of power and light: Electric energy generated for sale in 1907 was 10,621,407,000 kw.-hr.; 1912, 17,585,622,000 kw.-hr.; 1917, 27,000,000,000 kw.-hr.; and in 1920 it will be over 40,000,000,000 kw.-hr., which shows an increase of around 300 per cent over the production that was obtained in 1907.

Electric energy is generated either by water power or by the use of coal or oil. At present the hydro-electric power production is equal to the use of about 40,000,000 tons of coal, whereas over 400,000,000 tons, or two-thirds of the total coal production in the United States is yearly consumed to produce steam and electric power.

The total water power developed at present in the United States amounts to about 9,823,000 hp. (Water Power Committee with Electric Light Association), of which about 4,500,000 hp. is commercial power. The potential water power is estimated at about 200,000,000 hp., of which about 20,000,000 hp. is capable of immediate development. Of the aforementioned total potential water power 60,000,000 hp. could be used without special provisions for storage. About 13 per cent (report National Electric Light Association) of the readily available water power and 3 per cent of the total open to development under arrangements for water storage have been developed.

Approximately 600,000,000 tons of coal is required annually in the United States, and the mines can furnish about 750,000,000 tons per annum, but the railroads are unable to handle normally more than 550,000,000 tons, the failure of the roads to do so being attributable to lack of motive power, car shortage and delay in unloading.

TRANSPORTATION FACILITIES REQUIRED TO HANDLE COAL FOR POWER

It has been said in the foregoing that the power production in this country—steam and electric power together—consumes about 400,000,000 tons per annum, the moving of which requires about 10,000,000 carloads, at 40-ton car capacity. In 1917 there were in the United States 950,000 coal cars in use. In addition there has also to be moved about 160,000,000 tons of coal for heating and coke-making purposes, the transportation of which requires another 4,000,000 carloads. Thus the total annual hauling requirement for coal is 14,000,000 carloads.

Let it be assumed that the water power at present not utilized but economically immediately available for the generation of electric power amounts to 20,000,000 electric horsepower. On an average it requires about 15 tons of coal to generate one electrical horsepower year, hence these 20,000,000 hp. of water power represent about 300,000,000 tons of coal, which by the utilization of that water power could be saved, relieving thereby the means of transportation, which would then not be taxed above their capacity.

In spite of the growing use of electricity practically no change has been effected in the method of using coal, and only a small fraction of the available water power has been developed, although electricity has rehabilitated the use of water power, making available for generating purposes the two main sources of energy; namely, fuel and water.

CENTRAL STATION VERSUS ISOLATED PLANT—THREE POSSIBLE SOLUTIONS

In the United States for over twenty years a controversy has been going on between the advocates of central stations and those of private or isolated plants, as the most economical means of power supply. The respective merits of each of these systems have been put forward, certain salient points being acknowledged by both sides. The central-station or public-utility field includes a host of establishments where the installation of isloated plants is not warranted, as also the isolated plant is an economic necessity in certain types of buildings and in certain manufacturing establishments in which heat and process steam are of prime necessity.

This situation caused a third school to come forward and to advocate as a solution of the problem the making available of the commodity by a co-operation of central stations with isolated plants. To this school must be added the plan of a further utilization of the fuel by developing a central-station service of heat and steam, which service in concurrence with gas and electric current is in practice in some cities.

However, the advocates of central-station supply and those of private isolated plants, and those who would find a solution of the problem in a co-operation of these two supply methods, as well as those who propose further utilization of fuel by a central-station service of steam and heat, concern themselves only with coal, oil or gas as direct fuel, forgetting that at best only about 20 per cent and frequently only about 6 per cent of the energy content of coal is transformed into the marketable product, power.

SUPERPOWER PLANTS AND MULTIPLE PRODUCTION OF POWER AND BYPRODUCTS FROM COAL

The use of electric power today is a product of such increasing demand that the issue is of a general power problem and not one of hydro-electric power or steam-electric power, or of central stations or isolated plants. Transmission lines 100 miles in length are common today and lines 200 and 300 miles long are in use, hence power can be transmitted long distances and the question is whether it be more advantageous to transport generated power or to transport energy in bulk; that is, fuel to generate the power. This question in itself indicates that the basis of the problem is economy in material and human effort, which requires the fullest utilization of the sources of energy.

Coal, besides being energy in material and bulky form, is also the source of innumerable products of great economic value. More than one thousand coal products, as vital to the community as fuel, are today in use. The full utilization of the whole range of values, including energy, today still transported in the form of coal, imposes itself in the near future. This utilization, at present confined to the coke and gas industry, which can still be described by the term of "byproduct production" as it takes only half the field, must broaden itself and become an economic force covered by the term of "multiple production." There lies the future and the only great future for what we call the "gas industry."

The meaning of "multiple production" becomes apparent when it is remembered that one ton of bituminous coal gives 10,000 cu.ft. of illuminating (or fuel) gas, 20 lb. of ammonium sulphate, 2½ gal. of benzol and 8⅓ gal. of tar, which represent only the primary products; while other chemicals, drugs, dyestuffs, etc., could be extracted. The illuminating gas and the benzol are, one a perfect fuel and the other an equivalent of gasoline as motor fuel. Multiple production will make both gas and benzol important sources for power generation.

ENORMOUS WASTE OF COAL DUE TO POOR BOILER-ROOM PRACTICE

It has been estimated by the Fuel Administration that between 10 and 25 per cent of steam coal is at present wasted when burned under the boilers, caused by poor boiler-room practice. About 420,000,000 tons of the annual requirements of hard and soft coal in the United States is used to generate power, half of which is used by industry and the other half is consumed by the transportation lines. Reckoning on the basis of a 12 per cent avoidable wastage gives a minimum annual wastage of 50,000,000 tons of steam coal.

Although electric power generation and transmission has made headway, multiple power production is yet to be generally adopted, its importance not yet having been grasped. Yet both are the most important economic forces of molding influence on the present industrial order. The principle of multiple power production as an economic force is bound to cause a revision in popularly accepted ideas of economics.

BRITISH COAL CONSERVATION PLAN RECOMMENDED BY RECONSTRUCTION COMMITTEE

Numerous plans are advocated representing solutions of the industrial-power problem. The most radical solution, involving the principle of multiple power production, is perhaps the plan advocated by the British Coal-Conservation Committee, of which the following is an abstract:

> The subcommittee of the Reconstruction Committee in Great Britain recommends that the present inefficient electric-service system should be superseded by a comprehensive system divided into about sixteen districts in each of which there should be one authority dealing with all generation and main distribution. Sites for electric generating purposes should be chosen on important waterways outside, not inside of towns. Plans to be prepared to construct on these sites large superpower plants, capable (1) of supplying energy to a comprehensive electric power-distribution system; (2) of supplying electric energy at lowest possible price for all processes and manufacture. Such plants should be designed so that, as methods are perfected for extracting byproducts from fuel before using it for the purpose of production of electrical energy, the byproduct plant can be combined with the power plant. Power available from surplus gas or waste heat should be turned into electrical energy in local plants, which should feed into the main distributing system. Coal which does not warrant transportation away from the mine should be used at the spot for power generation. With a view to carrying out this policy a board of commissioners should be appointed with the following powers: (a) to stop the extension or multiplication of uneconomical stations for public supply; (b) to arrange for the handing over on equitable terms of the generation, transmission and main distributing system in each of the areas into which the country is to be divided; (c) to standardize for each area the frequency and voltage of the main transmission and distribution systems; (d) to select for each area the authori-

ties to work under adequate control as regards limitation of dividends, etc.

Alternative types of electric organizations are described in an appendix. In reference to these alternative types the subcommittee emphasizes the need of initiative and resource in management of electric service organizations and the freedom of range and keenness which are distinctive of private enterprise, as such things are highly conducive to the best success. Here is a superpower central station plan based on coal as source of energy combined with the application of the principle of multiple production.

In the United States and elsewhere all plans which follow the idea of superpower stations and of multple production, take into account the necessary development of available water power as the source of energy for those regions lacking coal. The British superpower station plan and those following that idea offer the sole solution taking into consideration the principle of multiple production and with it the replacement of steam as power by internal-combustion (gas or benzol) engines and electric energy.

The Sale of Electric Power

Electric plants were first established to furnish current for lighting. The operating costs and the profits of the enterprise were borne by these consumers. Soon it was found that the plant could be operated cheaply during the daytime, provided the light consumers continued to bear the burden of the operating costs, the sale of power generated during the day representing net gain. This was the starting point of the methods of selling electric power. With the increased use of electric light and power and electric energy becoming a salable product, innumerable systems of determining a just and logical rate charge were put forward and came into use.

In accord with the general tendency toward standardization and simplification, certain simplified tariff systems have in late years been proposed, systems that are said to be suitable in any area of supply and whose principle is the abolishing of the "diversity factor" as well as the "load factor." The most characteristic of these suggested systems is the so-called "postal plan" of selling power to industry and any other consumer of electric energy.

Postal Principle of Selling Power

The postal principle of selling means a fixed charge per kilowatt-hour independent of maximum demand and number of customers served, taking only into account the number of kilowatt-hours sold, the plan being based on the idea that a two-cent stamp will carry a letter anywhere—the two cents representing the sale price of the postal service for a given unit of weight of letter. If the average cost of generating electric energy is two cents per kilowatt-hour, a uniform rate per kilowatt-hour could be established, say a two-cent rate, independent of class of service, lighting, power or traction load and independent of the quantity of service that is required.

The question is whether such a plan is feasible with conditions as they are at present in the central-power-station industry. Today what mostly handicaps its development, whether the power is produced from coal or waterfalls, is the necessity of providing means of transmission and distribution, which require a great initial investment with high costs of maintenance.

The postal service is that of a common carrier of the public utility order, and in applying to the selling of energy the principle of selling service for a given unit of weight for a fixed standard price, we will have to adopt the common public-carrier system for the transmission of electric energy. The British superpower-station plan recognizes that necessity and provides for the standardization of frequency and voltage of the main transmission and distributing systems and for an authority to deal with generation and distribution. A universal standard tariff system, like the postal plan of selling energy, would certainly have an enormous influence on industry and give a tremendous impetus to the use of electric energy. Power would then really become a salable product, cheap, staple and of even more general use than at present.

Co-ordination of Interests Urged

The prime function of industry is service to the community, to be rewarded commensurately with that service. Power is the basis of industry; without it industry cannot exist. Hence, power is a force of prime necessity to the welfare of the community and should be dealt with in that sense. The criterion in the generation and sale of power, therefore, should not be primarily or exclusively the stockholders' profits in that specific enterprise, but should have regard to the interests which the country and community at large have in the generation and sale of power; that is, in the availability of cheap and unlimited power—a coördination of the interests of the community and of capital.

It must not be forgotten that the world order around us, especially in is economic bearings and the position of industry, has not yet fully emerged from the formative period ushered in one hundred years ago by the so-called "industrial revolution." Present-day economic procedure is still mainly the product of a period when the nature of energy resources was only imperfectly known and the technology of the employment of energy only crudely developed.

In the old and still lingering order men worked with the idea that the resoures of nature were inexhaustible, and their undeveloped methods and conditions were inadequate and impotent, unable to avoid large wastes, which are not only inexcusable with the modern means at hand, but which are responsible to society, being directly connected with economic and social questions at the base of general well being.

Avoidable Waste and Loss

There is still lack of the application of improved methods in the mining of coal, and the production of oil, both cases causing avoidable waste and loss, the consequences of which are more serious in regard to oil—the ultimate exhaustion of it is in view—than concerning coal, which is still abundant. Only a fraction of the hydro-electric resources capable of replacing coal and oil is developed.

The anomaly of the situation is seen of coal being hauled across the whole continent to move trains across the Rocky Mountain Divide, where ample hydro-electric power is close at hand. The transportation of coal means waste of effort and material. The present utilization of coal allows only a very low recovery of its energy content, in addition to which one-quarter more coal, on an average, is burned in power production than is necessary. The utilization of oil is efficient only in the refined products, but most wasteful in the crude as it is utilized in many cases at present.

Wastefulness in production in any branch of industry is not necessarily considered an evil, but rather as an asset to profit. It is found that the public can be relied upon to pay any price as long as the production cost is high enough to prevent the profits from appearing extortionate. The expense of waste in industrial production is passed over to the consumer. Prices are maintained by the willful reduction of production, which is kept below the level of demand. The majority of industries use only half of their equipment, or otherwise stated, work half-time. There is lack of co-ordination, lack of proper media of distribution, with the result that commodities are burdened with costs that are far in excess of the costs of production. To sell the product costs more today than to produce it—obviously this is not economically correct.

The waste of labor and material, the inadequacy of distribution and the inelasticity of credit form a group of causes intimately connected and mutually reactive upon one another, making impossible the attainment of 100 per cent production either from industry or the utilization of the soil. The result is directly due to the lack of co-ordination between resources, technology and economic procedure.

In the realm of advance preparation free operation and full individualistic endeavor are desirable, as competition has proved itself an effective means of progress and development at that stage. In the realm of full utilization competition fails to give adequate results, and its effect is rather harmful and must give way to constructive mutual consideration and co-ordination in the interest of the community as a whole.

A NEW WORLD ORDER DAWNING

The "industrial revolution," which brought in the formative period now passing away, was in close interrelation with a general world upheaval. Today the world again is in travail, out of which will arise a new world order, economic, political and social, in which co-ordination of all human activity toward economy of material and human effort will be the fundamental basic principle.

The "formative period" has been the age of coal as fuel and steam as power. The new time is already outlined as the era of coal fully utilized and water as sources of energy, and electricity as power.

The inherently local nature of the generation and use of steam power prevented it from ever becoming a salable product. The contrary is true in regard to electric power. The characteristics of electric power constituting it a true article of commerce, the fact that it can be generated in bulk and sold at retail, the ease and flexibility of its transmission to a distance from its point of generation by means which can be extended at will, make natural the centralization of its generation. That centralization makes possible industrial efficiency with economy in material and human effort which is becoming more and more a necessity.

These results are attainable only through co-ordination of resources, technology and economic procedure, necessitating a co-operative organization of the whole industry of power production, for the efficient employment of energy sources, their production and full utilization—multiple production—the generation of energy, its transmission and distribution, on the principle of service to the community.

VITAL QUESTION IN POWER PRODUCTION AND DISTRIBUTION

The vital question is whether such an organization so based on the principle of the general good, is to come into being, or whether the power industry, which is already in the hands of large amalgamated interests, shall become more and more centralized in those hands until it constitutes an absolute monopoly upon which the entire industrial and other power requirements of the country will depend. An alternative, urged by some, would provide for the public control of the sources of energy, its production, generation, transmission and distribution.

Whether the control, private or public, should take the form of an organization covering superpower stations, combined with byproduct plants and transmission and distribution systems, following the plan outlined by the Hon. F. K. Lane when he was Secretary of the Interior, or whether the result should be obtained by means of co-operation between central power stations, isolated plants, coke and gas plants, and a separately organized power transmission and distribution system, whether the management of the power production, fuel-utilization plants and power-transmission and distribution systems should be in the hand of the state or in the hand of semi-public, state-financed, public-utilities corporations, or should be left to private corporations under public supervision—these are questions beyond the scope of the present discussion and will be left for future consideration.

However, one thing is clear—in the new economic world order now arising, the principle of electricity as a marketable product, the principle of common public carrier applied to the transmission of power and the principle of multiple production for the utilization of energy sources will be the most important, if not the basic, economic force in the industrial order and in the life of the people itself.

Selection of Babbitt Metal

By L. D. STAPLIN

Manager Merit Metal Department, Great Western Smelting and Refining Company, Chicago

TWO phases of the bearing-metal question that are of prime importance to the user are: First, selection of the grade giving the highest efficiency, meaning greatest durability at least cost; second, proper application. The application is more important than is the grade itself, but since the metal must be selected before it can be applied this article will give information that may help in the choice and use of the right kind of metal.

A babbitt metal must possess sufficient "body" or structure to carry the load upon the bearing with a margin of safety; otherwise, rebabbitting and delays will result. As tin and copper are added to a babbitt base the structure of the material is made harder and generally tougher. Since these metals are the most costly ingredients it is folly to use an alloy containing more of them than the bearing necessitates, since nothing but compression strength is gained from their presence.

Many are of the opinion that antimony should be the chief hardening agent in bearing metals. This may be true if the metal is to be used only where the load carried is constant or light and the speed low. Experience has proved that a babbitt metal must contain a material quantity of tin (and it should also carry copper) if it is to be used generally on machinery bearings, because only then does the alloy possess the required "body." Without these ingredients the metal is so soft that it crushes beneath the load and wears out quickly.

Silver is a better conductor of electricity than copper, but copper is used because it is good enough and costs less. Mr. Staplin applies the same principle to babbitt metal, and explains how to select the cheapest babbitt that will do the work. In a later article he will take up the application of babbitt, including the design of bearings and the saving of metal.

In some cases efforts have been made to increase the percentage of antimony and in that way make the metal hard enough to carry average heavy loads at high speeds; but although antimony is a positive hardener, these attempts have not succeeded for the reason that such alloys are extremely brittle. If cast when overheated the grain is coarse and in "packing" beneath heavy or even moderate pressures clearance is created. This action has the same effect upon the life of the bearing as though the natural wear had reduced the thickness of the liner just that much. The writer, therefore, does not consider alloys of lead and antimony alone nor alloys of lead, arsenic and antimony as good babbitt metals for general purposes, as they have not given suitable or safe service when used upon any but light work.

Since the user gets hardness and toughness through the addition of tin and copper, and since these ingredients are costly and nothing is gained when they are used to excess, it follows that the careful and progressive consumer should know how to judge his selection of babbitt metals, so that he will not be wasting money by purchasing material more costly than necessary for the particular purpose for which it is to be used If a ten-pound sledge is laid gently upon a glass desk top nothing will happen; but if the sledge is lifted an inch and then let drop the glass will be shattered. So it is with bearings and bearings metals, and the point to determine is the nature of the service. During its operation, is the bearing subjected to jars, jolts, sudden loads and shocks or extreme strains, or is the load that is carried even and constant? If the service is of the latter variety it is safe to use babbitt metal of inexpensive grade. The tin and copper contents should be increased with the severity of the service. The character of the service, therefore, is to be considered first and foremost when deciding upon the alloy to use for any specific kind of bearing.

When machinery is exposed to dust, as in cement and clay working, the dust acts as an abrasive and destroys the liners. Durability depends upon the hardness and density of the lining metal and is increased in ratio with the amount of tin and copper carried. Reliable tests that may be used for guidance have confirmed the foregoing contention. Considering babbitt metals to be used by a builder of machinery, selection of bearing alloys possessing ample margins of safety under actual operating conditions should be based on exhaustive tests rather than on theory and imagination. Only then will the manufacturer know definitely that he is delivering to his trade value received.

With babbitt metals to be used by an industrial concern for repairs to machinery best results are had when the selection of babbitt is limited to two grades—one lead-based and one tin-based. Discretion is necessary in choosing their proper places, and care must be used in their application.

In general, there are two classes of bearing metal—tin-based and lead-based. First-quality tin-based babbitts cost about double the price asked for lead-based metal of the first quality. As a rule bearing conditions in the plant machinery vary, and it is not uncommon for 20 per cent of the total bearings to need tin-based metals, while the remainder can be durably and more economically served with a lead-based metal of good grade.

When there is a wide range in bearing needs it becomes necessary in working with two grades only to use at times a metal that is actually better than required for a particular bearing, but, notwithstanding, it has been found preferable in the average plant to use two rather than five or six different kinds of metals, to eliminate confusion. Getting down to two established standardized grades and then intelligently listing the equipment's needs has worked out most satisfactorily in practice.

In selecting these two grades, the writer's choice would be a tin-based material of the finest quality containing fully 89 per cent of "Straits" tin and no lead and a lead-based metal containing not less than 10 per cent of tin and between ½ of 1 per cent and 1 per cent of copper, with not more than 16 per cent of antimony.

The word "tin" does not mean much in a specification. There never was a babbitt specification which could not be so beaten by the maker (if he desired) as to reduce the material's service value far out of proportion to the saving effected by buying the cheapest bid material. There are many grades of tin and they vary in cost. Some grades depreciate the service value of the babbitt. "Straits tin" are two safe words to use in the specification. And even then, how many are there who can tell afterward whether or not the material was made of Straits or No. 3 Chinese tin? The buyer depends upon either the veracity and standing of the maker or upon his own laboratory.

A laboratory analysis is not a safe basis for judging the relative value from a service viewpoint of two babbitt metals. It will tell the percentages of ingredients, but will not give details of workmanship and service value. Therefore, when buying babbitts for service where the conditions are extreme and where something a little better is worth more than a small difference in price, it is economy for the buyer to use judgment as well as quotations as his guide toward a good selection. The final and deciding data are, of course, results in service.

When selecting babbitt metals for installation in important bearings, where the production from that machinery creates the firm's profits, a purchasing agent makes the wrong move when he puts that business upon a competitive basis and thus invites bids so low that the makers have a temptation to skimp. Instead, he would do better to select the highest-grade branded metal, in which the manufacturer is interested in maintaining a rigid standard and standing, as it is known that only service value can build for a lasting demand. Such metal can be had within a few cents per pound of what is asked for specification metal. It is the better choice.

Were the author a consumer of babbitt metals it would be his policy to place his conditions squarely before a dependable metal manufacturer and then leave the selection largely to him. If he has integrity and the ability to furnish good metal, the confidence will not be misplaced. Results from practice will show that the honest specialist is able to make the better selection of metal.

Storage of Coal

By W. D. LANGTRY*

In this article, which is the fourth on the storage of coal, Mr. Langtry deals with several factors which lead to coal fires.

For coal to catch on fire after it is in storage means a money loss to the owner of greater magnitude than ever before, so that every precaution should be taken.

TABLE I—LOSS IN HEAT VALUE OF COAL FROM STORAGE

Coal Stored during 1918:		Same coal stored 2 yr.:	
Dry ash	14.33	Dry ash	14.17
Dry B.t.u.	12,393	Dry B.t.u.	11,668
Average of 472 cars:		Same coal stored 1 yr.	
Dry ash	14.33	Dry ash	14.52
Dry B.t.u.	12,393	Dry B.t.u.	12,200

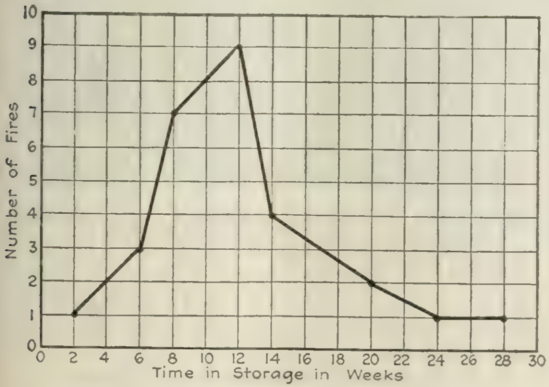


FIG. 1. STORAGE GRAPH SHOWING FIRES AT DIFFERENT INTERVALS

There is no great loss in the heat value of the coal when it is in open storage, and when under water the loss is negligible. In Table I the analysis of fresh coal and that placed in storage may be of interest. The depth of this coal in storage was about 7 to 8 ft. Table II, taken from Bulletin No. 116, Illinois Engineering Experiment Station, also shows slight deterioration.

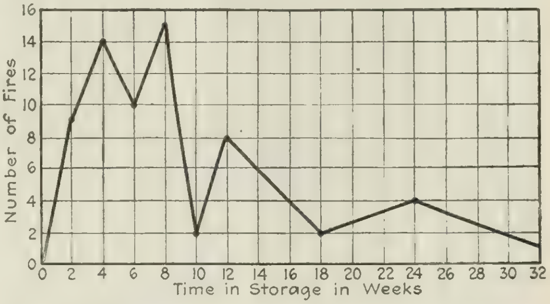


FIG. 2. NUMBER OF FIRES VS. WEEKS OF STORAGE

The coal in storage 18 months was piled 10 or 12 ft. high and the pile was about 150 ft. long and 25 ft. wide, bulkhead with wooden anchors running into the pile.

TABLE II—DETERIORATION OF COAL IN STORAGE

	Coal from Boiler Room (or Fresh Coal) Per Cent Commercial	Coal in Storage 4 mo. Per Cent Commercial	Coal in Storage 18mo. Per Cent Commercial
Moisture	10.25	12.44	11.89
Ash	9.08	9.16	7.98
Volatile	33.18	33.12	33.28
Fixed Carbon	47.49	45.28	46.85
B.t.u. (moisture ash and sulphur free)	14,816	14,761	4,713

It was reported that the temperature was at no time more than a few degrees over 100 deg. F.

Usually the greatest number of fires take place during the first ninety days of storage. By this time much of the coal that catches on fire from spontaneous combustion will have shown evidences of overheating. The accompanying two graphs from Bulletin No. 116, which were plotted from a wide range of data, tend to confirm this assertion. A fire in a coal pile is usually detected long before it gets to the serious stages. Probably by studying some of the views presented deductions may be drawn as to the causes of trouble and how to avoid them.

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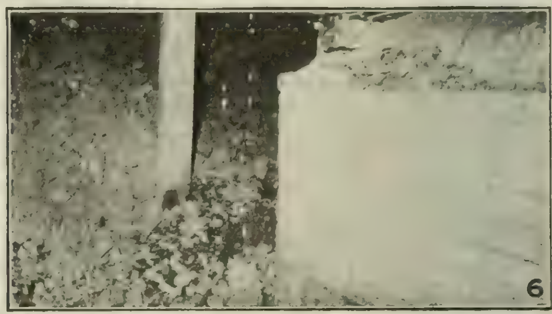
*President, Commercial Testing and Engineering Co., Chicago.

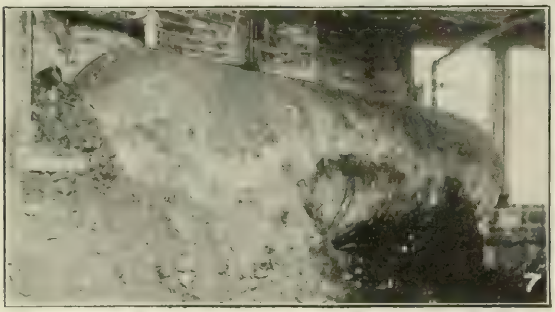
Fig. 3 shows a large coal yard which fired. No attention whatever had been given to the manner of piling the coal, nor to the presence of wooden timbers, which in some instances were completely buried. It is easy to see how air could follow the wood to the inside of the pile where it found a susceptible spot to work upon. Fig. 4, from the same yard, shows very clearly the timbers buried in the coal. In Fig. 5 a pile is shown where a number of boards were allowed to remain at the bottom of the pile. The protruding ends of these boards afforded easy access to the air. Heat transmission is shown in Figs. 6 and 7 the former being from a furnace in a flat building and the latter from a hot water tank. It is seldom that lump coal catches on fire from spontaneous combustion, for the reason that usually there is no fine coal to give it a start, but when a neighboring pile of screenings fires and spreads its hot gases, even lump coal will ignite.

When placed adjacent to coal, a steam pipe trench is a dangerous heating agent, as is evident from Fig. 8. Here the heat from the steam pipes ignited the coal dust which had settled into the trench. The fire spread to the adjoining pile.

To dig down into a coal pile to locate a fire and find a buried bulkhead is nothing unusual. This is a frequent occurrence and a contributing factor in a large number of fires.

And so it goes. Carelessness, thoughtlessness and ignorance—all contribute to spontaneous combustion. Coal is blamed, whereas in many instances the fault really lies elsewhere. If proper care and thought had been given to storage, each and every one of these fires might have been avoided. Coal can be stored successfully if done intelligently.





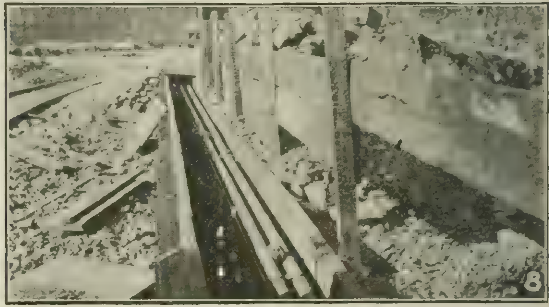


FIG. 3. ENTIRE COAL YARD ON FIRE. FIG. 4. EMBEDDED TIMBERS THAT STARTED FIRE IN FIG. 3. FIG. 5. PLANKS EMBEDDED UNDER COAL ADMITTING AIR TO INTERIOR OF PILE. FIG. 6. HOT FURNACE WALL STARTED FIRE IN BASEMENT OF FLAT BUILDING. FIG. 7. EMBEDDED HOT-WATER TANK ORIGINATED FIRE. FIG. 8. STEAM PIPES STARTED FIRE IN COAL

Timing Relays With a Cycle Counter

To Time Protective Relays Automatically Is the Function of the Cycle Counter—Construction and Operation Explained—Problems Worked Out To Show the Application to Making Tests

BY VICTOR H. TODD

BEFORE the introduction of the cycle counter the generally approved method of determining the time delay of a protective relay was to use a stop watch, starting the watch simultaneously with the application of overload and stopping it at the instant of tripping. With the older relays, having a time delay of several seconds, this method gave satisfactory results, but with the more modern relays, designed with watt-hour meter accuracy and capable of being set within a fraction of a second, it is obvious that the stop-watch method is not at all suitable.

A stop watch at best cannot be relied upon closer than about one-fifth of a second, and when to this is added the personal error of starting and stopping, it gives a possible error almost as great as the time between various sectionalizing relays. It is not at all unusual to set sectionalizing relays in a radial system only one-half second apart.

To measure the time delay of a protective relay accurately and automatically is the function of the cycle counter. This instrument is shown in Fig. 1, while two interior views are shown in Figs. 2 and 3. The cycle counter consists essentially of a self-winding clock in which the escapement wheel or pendulum is replaced by a polarized relay. The diagrammatic scheme of parts is shown in Fig. 4. The regular escapement wheel is shown at *W*. Attached to this wheel is the indicating pointer moving over a suitable scale, Fig. 1. The escapement bar *B* allows the wheel *W* to move one tooth per oscillation in the regular manner. Rigidly attached to the bar *B* is an iron armature *A*, polarized by the permanent magnets *D* and *D*. Part of the magnetic circuit is formed by the two electromagnets *E* and *E*, which are capable of attracting and repelling opposite ends of the armature *A*. The action is as follows:

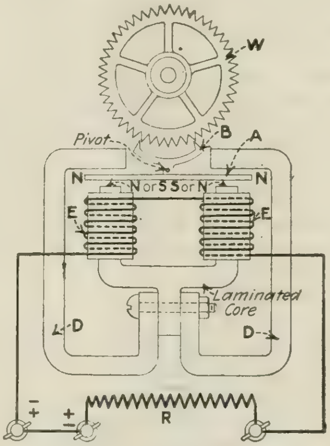
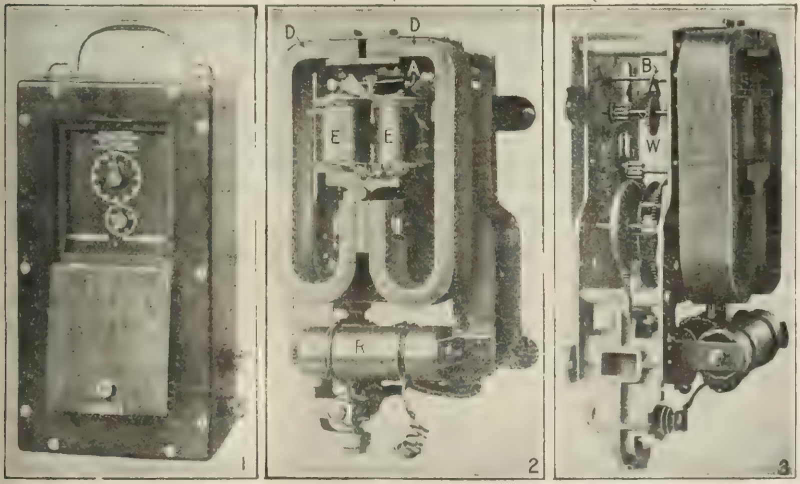


FIG. 4. SCHEMATIC DIAGRAM OF CYCLE COUNTER



FIGS. 1 TO 3. EXTERIOR AND INTERIOR VIEWS OF CYCLE COUNTER

Assume that during the first cycle of applied voltage, the current flows from the ± to the ∓ terminal. This will produce an N pole on the armature end of the right-hand electromagnet and an S pole on the corresponding end of the left-hand electromagnet. As both ends of the armature *A* are polarized *N*, the right-hand end will be repelled and the left-hand end attracted. During the second half of the cycle the current is reversed, and now the right-hand end is attracted and the left-hand end repelled, which naturally results in one oscillation of the bar *B* and the escapement of one tooth. From this it will readily be seen that the wheel moves one tooth per cycle as long as the electromagnets are energized. A small electric motor automatically rewinds the main clock spring, when it has unwound a certain amount. This keeps an even tension on the escapement and the electromagnets are thus not depended on to drive the mechanism, but simply to regulate its speed. Determining the time delay now becomes a problem of energizing the electromagnets simultaneously with the application of load and de-energizing them upon the instant of tripping. This is most easily done by temporarily disconnecting the relay from the circuit and connecting to a test circuit with connections as shown in Fig. 5, using a lamp bank or other suitable resistance for the load and a switch by which this load may be quickly applied. While adjusting the load, it is best to disconnect the lead at *A*, to avoid unnecessary wear on the counter. A single-pole switch may be provided for this purpose, as shown. After adjusting the load, the main testing switch is opened, the relay allowed to fully reset, and the cycle-counter pointers set on zero. Then the switch is closed, thus applying load and potential to the relay and counter. The counter revolves, one tooth per cycle, until the relay contacts close, when they short-circuit the escapement electromagnets and thus stop the counter instantly.

The number of cycles indicated, divided by the normal frequency of the testing circuit, will give the time delay in seconds. For instance, if used on a 25-cycle circuit and the counter indicates 50 cycles, the time will be 2 seconds; if 30 cycles, then the time would be 1$\frac{1}{5}$ seconds, and so on. It is common practice not to reduce the cycles to seconds, but on the testing reports and curves to give the time delay directly in cycles, thus giving units that are more easily handled than fractions of a second.

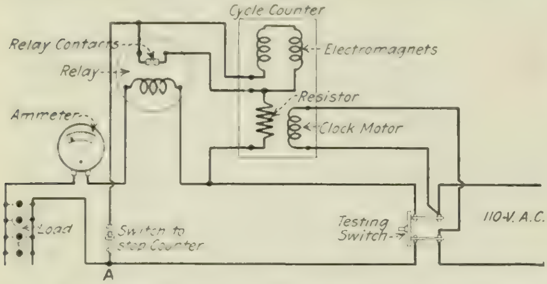


FIG. . CONNECTIONS FOR TESTING CIRCUIT-CLOSING RELAY WITH CYCLE COUNTER

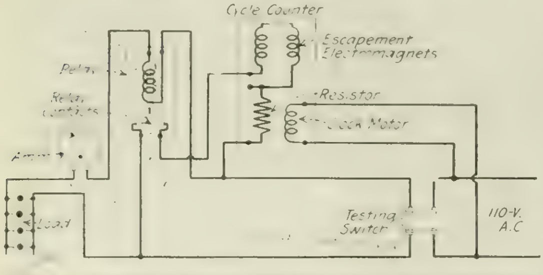


FIG. 6. CONNECTIONS FOR TESTING CIRCUIT-OPENING RELAY WITH CYCLE COUNTER

In determining the time delay of a circuit-opening relay, it is simply necessary to connect the escapement solenoids in series with the relay contacts, as shown in Fig. 6. Closing the main testing switch energizes both the relay and counter simultaneously, and the counter stops the instant the contacts open.

To make allowance for the time taken by the breaker or oil switch and its auxiliary equipment to open the circuit, it is sometimes preferable, in a closely set system, to time the whole combination as a unit. To do this, a load must be arranged so that it can be quickly thrown directly on the line, with connections similar to those indicated in Fig. 7. The counter is connected to the load side of the switch. It is energized at the same instant that the load is applied and is de-energized the instant the breaker or switch opens.

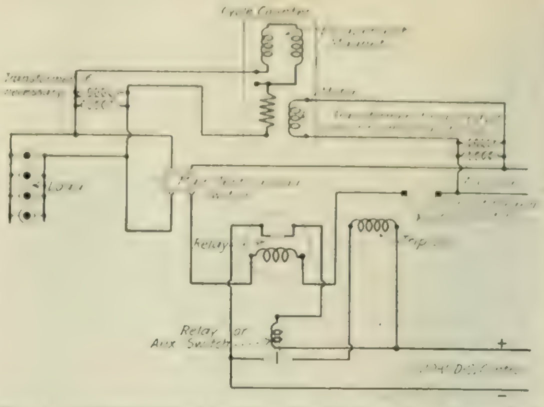


FIG. 7. CONNECTIONS FOR TESTING COMPLETE CIRCUIT-OPENING EQUIPMENT

This not only gives the time delay between instant of overload and opening of circuit, accurately and automatically, but also insures that all protective apparatus is functioning properly.

Semi-Diesel and Hot-Bulb Engine Suggestions

When installing an oil engine, have a foundation of sufficient size. Many engines are damaged from severe vibrations which would be eliminated by using more foundation material.

In placing the engine on the foundation, the engineer should be very careful about getting the engine level. The top surface of the bearing housings are always planed true. The spirit level can be placed on these surfaces.

In those engines where the air is drawn from under the base cement dust will often be drawn into the crankcase. After grouting the engine, a couple of gallons of linseed oil poured under the base will prevent cement dust.

In adjusting the main bearings, always leave a play between the shaft and top bearing of 0.01 inch.

There is always a side play of the shaft. If this exceeds $\frac{1}{32}$ in., it must be taken up. The best way is to put in new air-seal rings between the crank throws and the bearing ends. If new air-seal rings cannot be secured, a thin brass sheet can be sweated onto the worn ring.

Never run the crankpin bearing as snug as with a Diesel. A clearance of 0.01 inch is not excessive. If the brass can be moved a slight amount with a pinch bar, the play is ample. Examine the crankpin bearing bolts often. There are many cases of broken crankcases and pistons resulting from neglect of the bolts.

Never let lubricating oil collect in the crankcase. It mixes with the crankcase air and enters the cylinder, causing a smoky exhaust. If in large amounts, it will cause the engine to race since it will burn the same as fuel oil.

EDITORIALS

Power Development of the Future

ONE of the paramount problems in the minds of men today is the economical generation of power and the conservation of natural resources. Never before have these questions been so seriously considered, or such effort made toward their satisfactory solution. Almost every nation of any consequence has under advisement some power-generation scheme of national proportions. Even in those countries which have been most seriously handicapped by the war and which are today lacking the means to purchase sufficient food with, appropriations have been made to investigate the nation's power possibilities. Such countries as Norway, Sweden, Finland, Switzerland and Italy are considering the development of their water powers on an extensive national scale. England, who will always have to depend upon her coal fields as her chief source of power, is working out a system of districts to be supplied from superpower stations economically located in these districts. In our own country the tendencies are illustrated by the extensive interconnection of power systems until they now cover areas hundreds of miles in extent. The superpower schemes now projected for the North Atlantic seaboard and for the Pacific Coast are illustrative of what the future holds.

Before the war labor in Europe was cheap, consequently many of the processes done in this country by machinery were performed on the other side of the Atlantic by hand. But, during the war wages increased to such proportions that competition in the world's markets no longer can be met by pre-war methods, and countries that previously depended very largely upon hand labor in their industries are being forced to resort to mechanical processes. Where power-driven machinery was used on a large scale before the war, conditions have forced an even greater use of machinery, in other words a greater number of horsepower per employee. All this has resulted in giving an international importance to power development.

In this issue is published an article on "Power Development of the Future," by Lazarovich-Hrebelianovich, a well-known Czecho-Slovakian engineer and economist, who for a number of years has been interested in engineering and economic problems in this country. In this article the author has considered the problem from a national standpoint and shows that the development of power generation, formerly of interest only to the few, has become of vital importance to every individual in the community. Utilization of our national resources in the past has been done very largely on the basis that they were inexhaustible. But within recent years a realization that this is not true has been brought home to us by the fact that the exhaustion of two of our important sources of fuel is already in sight, with the prices of all fuels soaring to undreamed of heights, and even at these values very difficult to obtain in many cases. The fuel shortage and the inadequacy of transportation facilities have emphasized the necessity of an intelligent national power-development program, and the question now is what form this program shall take. Many different schemes have been advocated and are now under consideration. Mr. Hrebelianovich in his article emphasizes the necessity not only of water-power development, but also of a fuller utilization of our fuel, to the extent of obtaining the byproducts wasted by present methods. When it is considered that under the most favorable conditions, in power plants, only twenty per cent of the energy in the coal is utilized, the remainder being lost along with all the byproducts, the desirability of a more efficient method is obvious. The author has considered power production from a broad economic view and has pointed to many phases of vital interest to power engineers.

The Broader View

IN *Power* of October nineteenth a correspondent discusses Engineers' License Laws. His arguments are familiar; we have used them ourselves. License laws are passed for the general good of the public, not for the special good of the engineer. Any effect which they may have in improving the social and pecuniary condition of the members of the craft must be incidental to their operation for the public welfare. The only concern of the state is for the safety of its citizens. It has the right to protect them against danger from boiler explosions and other industrial accidents, but it has no right to insist upon the engineer's knowing any more than will qualify him from that point of view.

This is the older view. Public and legislative thought upon this subject has been through two phases and is entering upon a third and broader view.

When governmental supervision was proposed which would restrain users from putting in anything for a boiler that would hold water, running it at any pressure that they pleased and putting it in charge of a husky whose only qualification was the brute strength necessary to keep its furnace full of coal, alarmed proprietors put up a strenuous opposition. Such a measure was denounced as paternal, as an unwarranted interference with private enterprise. The employer saw in it a dangerous subterfuge on the part of working engineers and firemen to restrict the labor supply, the farmer and lumbermen were led to believe that they could not operate their threshing machines or portable sawmills without a licensed and uniformed attendant. Visions of overbearing and grafting inspectors, of boilers ordered out of service for non-compliance with trivial regulations were conjured up, and it was years before any considerable number of states or municipalities adopted any regulatory legislation.

The second phase came with the inevitable recognition of the economic importance of industrial accidents. Safe and hygienic conditions were impressed upon the owners and managers of industries by the establishment of industrial safety commissions, factory-inspection departments and employers' liability laws. Boiler-inspection departments have been established in many of the states and provisions for examining and certifying the men in responsible charge of boilers and power-plant machinery in a few. No catastrophe and no general inconvenience to industry has resulted. The number of boiler explosions has without doubt been kept down by the better design, construction and operation insisted upon; how much, it is impossible even to estimate in the absence of statistics as to the number and character of boilers in use. When all the states have boiler-inspection departments and the National Board, composed of the heads of these departments, evolves a uniform system for registering all boilers in use and reporting all accidents to them, we shall have some real information. The average intelligence and efficiency of the operating engineer in states requiring examination and license have been raised through the elimination of the unfit and the self-improvement of the others through study to qualify for higher degrees of license, but there has been no restriction of available labor in this field, and the more the men qualified to assume responsibilities the more they identified themselves with the executive class. In this phase the public and legislative minds adjusted themselves to the theorem that the state not only has the right but is in duty bound to safeguard its citizens against ignorance, neglect, or willingness to take a chance on the part of users of power-plant apparatus.

In this second phase the stress was put upon public safety, and safety was insisted upon as the only warrant for governmental intervention. Our correspondent is in this phase and reiterates its aphorisms and arguments. A state inspector may satisfy himself that an applicant for a license is a safe man to trust with the responsibilities that he seeks to assume, but has no right to examine him with regard to his ability and efficiency as an engineer nor to refuse him a license because of his ignorance of engineering except in the rudimental essentials to safe operation.

As the public consciousness became accustomed to this phase, it began to realize that a boiler explosion is more than a local disaster, that it is a communal loss, a set-back in the national struggle for industrial supremacy and the human struggle against environment, an impairment of the efficiency with which human labor seeks to improve the condition of the race. In the last analysis it means increased cost which many people who will never hear of the explosion have to pay for many things at first sight only remotely involved.

And then comes the thought that leads to the third phase upon which we are just entering. If a boiler explosion is a matter of public concern, not only because of the loss of life and physical suffering which it involves, but because of waste of resources and impairment of efficiency, why is not continuous and avoidable waste, amounting in the long run to many times the loss concentrated in the spectacular destruction of an exploding boiler, equally if not still more a matter for the attention of the public economist? We are beginning to get glimpses of a coalless world. Has anybody the right to hasten that impoverishment by burning two pounds when one will do? Has he the right to wilfully waste the resources of the nation and pass the cost on to the buyer of this product? May we not contemplate the time when it will appear just as reasonable to insist, upon the ground of general well-being, that the man in responsible charge of the use of the nation's fuel and power be qualified to use it efficiently as well as safely?

The Engineer as a Writer

THIS is an age of striving toward efficiency in the world at large and more forcefully in the power plant. Many times, dealing with antiquated equipment, thousands of engineers have felt that if they could but secure more modern machinery or accessories, the battle for efficiency would be more than half won. Unfortunately, the average engineer is handicapped at the start, since he is unable to present his ideas on paper in a clear and convincing manner. If he does attempt to put recommendations in written form, its appearance is often so slovenly and unattractive as to defeat its purpose.

The practical engineer is not the only one who fails in this respect. There is but a small minority of technically educated engineers who possess the ability to write good English. From his freshman days, when he rather bragged of his "flunk" in English composition, the technical man has disliked, even as has the practical man, to put his thoughts on paper. The result is that when a survey of a plant is required, both types are ignored and an outside engineer who can express his ideas, even though they may not be as good as those of the engineer who has been thrust aside, is called in.

The ambitious engineer will ask how this condition can be remedied. Surely he cannot be expected to attend school again. This is not necessary. All that is required is practice in the expression of his thoughts. If the engineer who has made an improvement or has overcome some operating trouble will attempt to write a concise account of this work, he will be surprised how much easier such reports become after two or three trials. Not only will he find that practice makes him write more concisely, but he will also find himself thinking more logically. Probably the best training an engineer can secure in writing intelligently is in the preparing of short articles for his favorite engineering magazine. Too many engineers think their ideas not worth pencil and paper. It is the universal experience that one mediocre idea well expressed is worth a thousand good ones if they be hidden away under one's own hat.

Bituminous Coal Bulletins Suspended

THE Federal Trade Commission, in its report on the bituminous-coal situation for May, gave warning that unless a sufficient number of operators should voluntarily furnish reports, the bulletin service would have to be discontinued. Now, after waiting a reasonable time, the commission reports that only 555 operators, representing but eighteen per cent of the estimated total bituminous coal mined in the seventy-four mining districts of the United States in June, have turned in their reports for that month. The June bulletin, just released, contains an announcement to the effect that its publication is to be suspended until the courts render final decision on the constitutional power of Congress to authorize the commission to require reports on the cost of production.

It is to be hoped that the courts will uphold the commission; but in the meantime, how does this secrecy on the part of the operators jibe with their very recent utterances at Cleveland as reported in last week's *Power*, indicating their desire, even anxiety, to co-operate with the Government in reducing coal prices?

CORRESPONDENCE

Diesel Engine Efficiency

The editorial on the maximum efficiency of Diesel engines in the Sept. 14 issue of *Power* should interest promoters and operators of this type of engine.

After three years of operation of the Diesel engine in electric power plants and also over a year of work on the development of the same class of engines as applied to submarine installations, it is the opinion of the writer that it lies largely with the operators whether the engine shall be a success or not. Perhaps this is a platitude that is common to any prime mover, but in dealing with internal-combustion engines the interest of the operator in his machine must be far more intimate than is the case with many steam installations.

As a comparison, take first the source of power in the steam plant, which is the boiler, which may provide a constant stream of steam at high pressure so that the engine, even if badly adjusted, may develop considerable power and in many plants be satisfactory to the owners.

In the oil engine there is no outside source of energy, all of the power being developed after the fuel has entered the cylinder. Since this action often occurs in a period of less than one second, it is plain that events must be timed correctly and the parts such as valves and pistons must be tight. Because of the lack of a reservoir of force similar to the steam boiler, the overload capacity is low, often not exceeding 10 per cent.

Right here, speaking of overloads, the attention of the operators of gasoline or oil engines that are not run at constant speeds, whether in marine or automobile work, must be drawn to the fact that in stationary service the prime mover must develop its rated power with a very slight change of speed from no load to full load. We can see where the auto engine on being speeded up can carry the car up heavy grades with comparative ease since the increase of speed means an increase in the power developed. The same is true in marine work, for the speed of the vessel depends on the speed of the propeller. An engine turning an alternator which must maintain a certain frequency has not this advantage.

The comment on the Greeley, Kan., fire is absolutely correct so far as the oil engines not being the cause of it is concerned. It is very apparent that pumps carrying oil at a pressure almost as high as that in the fuel lines to the engine cylinders, should be protected so that the engine room could not be sprayed with oil in case of a fracture of any part of them.

Regarding the efficiency of operation, in the case of the four-stroke-cycle engines running up to 200 r.p.m., the engineer can do much toward attaining good results even if he does not have the use of an indicator or pyrometer. The diagrams from a Diesel engine are, at most, very unsatisfactory for the diagram is not, even at excessive loads, of large area with the events prominently indicated as in the case of steam engines. A valve could be much out of adjustment before it would affect the diagram seriously. For testing the compression pressure, the indicator is very useful in the engines that are built today. In the early Diesel engines, with the pistons and valves tight, a certain predetermined linear clearance would give the correct compression. With these engines, when the valves and pistons were tight, excellent results were obtained even if an indicator were not applied for long periods. The oil was carefully measured of course, and by means of the electrical readings the power and fuel consumption were computed.

With the four-cycle engine the valve that requires setting the most frequently is the one controlling the fuel, and it is a simple matter to keep this in adjustment, and the writer has never seen it done with the use of the indicator. These valves should be tested once each month.

The exhaust and air admission valves are usually operated by large cams with a considerable throw. Since the cams are keyed to the camshaft and it is geared to the crankshaft, there is not much danger of the valve timing being changed unless it is necessary to take the gears off the shaft, in which case, if they are carefully marked, there should be no difficulty in replacing them correctly, or in event of excessive gear-tooth wear.

The space between the tappets should be adjusted from time to time. It is well to remember that in the four-stroke-cycle engine the events are comparatively far apart so that there is plenty of time for the different operations, such as admission of fuel, admission of air, period of compression and period of release, to take place.

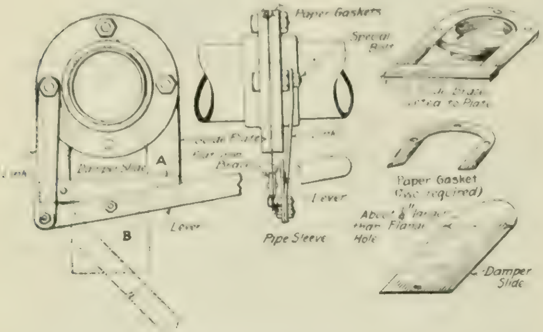
As to the need of a pyrometer, this would tell which cylinder is doing the most work by showing the temperature of the exhaust gases from the different cylinders and would prove interesting to the operators.

The necessary thing to attain is an engineer with common sense. If he is an ex-steam engineer let him make up his mind that he has a machine with many more parts than a steam engine, many more bearings to keep lubricated, low overload capacity, with piston rings apt to stick and allow gases to escape unless frequently examined; and if he remembers to keep the valves tight and the cooling water system in good order, barring accidents good results should be obtained.

East Dedham, Mass. G. H. KIMBALL.

Home-Made Flange Damper

The sketches show the construction of a damper for a low-pressure pipe line, as for instance a blower intake or outlet or an air inlet to a furnace, such a damper being frequently necessary to regulate the amount of air passing through the line. The construction is simple but effective, being a U-shaped piece *A* of heavy sheet iron, either black or galvanized, clamped between two pipe flanges in the line. A slide *B* cut from the same material fits into this U, and its width is made about a quarter of an inch larger than the diameter of the flange opening. A gasket of heavy paper set in shellac, paint or other adhesive is clamped between each flange and the outer plate; this gives clearance to the slide. Usually it will be necessary to leave out one of the flange bolts to allow room for the damper slide to enter.



DETAILS OF LOW-PRESSURE PIPE-LINE DAMPER

The arms of the U-piece *A*, or guide plate, extend out and serve as guides, two flat iron trips being riveted across the outer ends as shown. The operation of the damper will be greatly facilitated if a lever and link are connected as shown in the sketch, the link being pivoted on one of the flange bolts, which is made longer for the purpose. By using the lever, the slide can be made to work tightly enough to allow of its staying wherever placed as well as to almost entirely prevent the leakage of air. H. H. PARKER.

Oakland, Cal.

Does It Pay to Make Your Own Repairs?

The question of making your own power-plant repairs should be of interest to every progressive engineer, but whether it is cheaper to do so than to have the work done by outside forces is a question. To be sure, a goodly number of articles have been published in *Power*, illustrating and describing how engineers have repaired breakdowns, but most of them were of simple character and could easily have been fixed by anyone having a little mechanical ingenuity. It is seldom, however, that we find an account published of repair jobs that require very much time or labor or where the cost would amount to very much if done by the men in the plant.

Labor costs are about the same whether the work is performed by men in the plant or by an outside shop, and naturally, the labor supplied by the outside shop is more skilled in making repairs than the men employed by the power plant would be, owing to the fact that they are constantly employed in doing such work, whereas the power-plant man has it only occasionally and does not always know the quickest and best way of doing the work.

For instance, not long ago the armature of a generator burned out and the rewinding was done by men employed about the plant. So far as known, no account was kept of the amount of labor put in on the job, and there is a question if the work was done as well or as cheaply as it could have been done by a company engaged in such work. This same thing would apply to boiler and engine repairs.

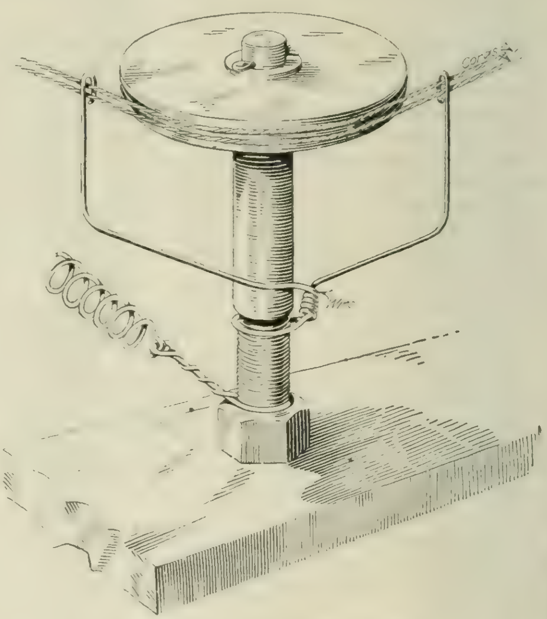
Perhaps some of the readers of *Power* have had repair jobs of some magnitude and have the facts and figures to show that money was saved over what would have been paid to an outside repair company. If there are such instances, accounts of them would be interesting and helpful to other engineers. M. G. GROOM.

Baltimore, Md.

Simple Indicator-Cord Holder

While running a continuous test on a Diesel engine recently, I found that each time I wished to take indicator diagrams, it was necessary to guide the cord through the groove in the pulleys before I could engage the hook in the traveling eye.

To keep the cords in place I used a short piece of wire bent as shown in the sketch. The ends that guide the cord are so bent that, when there is tension on the cord and the indicator drum is revolving, there is enough clearance to prevent interference with the free travel of the cord. Then, when the hook is disengaged, the cord rests against the wire supports and remains in the pulley groove.



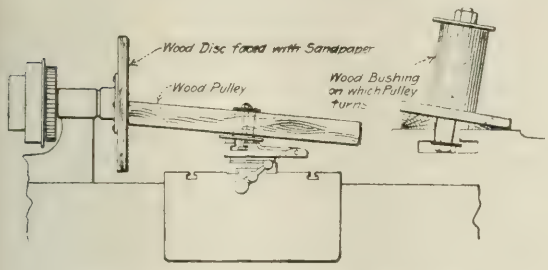
GUARD FOR INDICATOR CORDS

As I was obliged to take diagrams very often, I found this simple device a great help. W. E. GREENE.

Buffalo, N. Y.

Crowning a Large Wood Pulley in Lathe

The sketch shows a method for truing up or crowning a wood pulley that is too large to swing in a lathe. A large hardwood or steel disc is bolted to a faceplate and a sandpaper disc glued to its face; this disc should be run at high speed. The pulley is mounted on the tool slide; if to be trued, with its face horizontal, but if to be crowned, wedges will have to be set as shown in order to tilt it up to the angle necessary to give the amount of crown desired.


Wood Disc faced with Sandpaper
Wood Pulley
Wood Bushing on which Pulley turns

WOOD PULLEY PLACED FOR CROWNING

A hardwood bushing is turned up to fit the pulley bore; this is drilled for the clamping bolt. A metal plate is placed between the bushing and the tool block, and the wedges are driven under one edge of the plate. After placing the pulley over the bushing a large washer is put over the bolt to prevent the pulley, which should rotate freely but without play, from working up.

Then the disc grinder is set in motion and the pulley fed carefully up to it by means of the carriage handwheel. It is rotated slowly by hand until half its surface is finished, then reversed and the other half crowned. If a straight face is to be ground, reversing will not be necessary. In the case of a very large pulley or one with a wide face, the disc might have to be refaced with sandpaper before the operation is completed. H. H. PARKER.

Oakland, Cal.

Ammonia Stores in Coils

In the Sept. 14 issue R. G. Summers tells of trouble with a refrigerating system operating on freezers. The statement is made that the back pressure carried on the machine was fifteen pounds. It is my belief that the trouble is caused by the back pressure being carried too high for freezer work. As the temperature of ammonia due to fifteen pounds pressure is approximately zero, the temperature difference between the ammonia in the coils and the room itself is so small that the ammonia stores in the coils, as indicated by a shortage of ammonia in the receiver. When the expansion valves are opened even slightly this stored liquid is carried to the compressor in the form of a highly saturated gas, thus freezing up the compressor.

In operating freezers the main trouble encountered is the storage of liquid ammonia in the refrigerating coils if the expansion valves are left open for any length of time. The remedy is to determine by trial the length of time the liquid can be fed to a freezer coil or a system of coils without the excessive storing of liquid or the "freezing up" of the compressor. The method of operation will then be to leave the liquid valve open for the determined length of time, then close it and pump down until the compressor discharge begins to warm up well, when the liquid valve is again opened. The liquid is best controlled through a master valve in the engine room to obviate the necessity of setting a number of expansion valves.

If Mr. Summers will try this plan and reduce the back pressure on the machine handling the low-temperature work to five pounds or less, he will have no trouble, assuming that his machine is large enough to handle the load at the reduced back pressure.

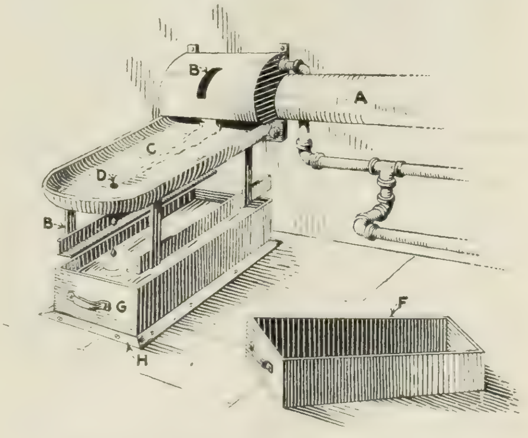
Tuckahoe, N. Y. F. G. SCHOENFELD.

Oil-Pan Arrangement for Ascertaining Fuel Leakage

During a recent economy test on an oil engine I found it necessary to know the amount of fuel oil that was leaking by the fuel-pump plunger. This pump was located over the camshaft *A*, and the plunger was driven by cam *B*. The pan *C* was placed directly under the pump (not shown) and had been draining all the leaking oil through the hole *D* into a pail.

In order to ascertain the exact amount of oil leaking between definite intervals of time, I arranged the apparatus shown in the sketch. The strips *B* were bent and fastened to the under side of the pan *C* by machine screws. Two light pieces of angle-iron were riveted so that the pan *F* would just slide into the pocket formed by these irons, which were made so that the pan fitted snugly enough to prevent sliding out due to vibration. Then the pan *G* was arranged underneath on the floor and held in place by wooden strips *H*.

With this arrangement the oil was allowed to leak into pan *G* until the start of the test. Then the pan *F* was slid into place and kept there for the duration of the test. For convenience the pan *F* was made to weigh an exact number of pounds.



OIL-PAN ARRANGEMENT FOR ASCERTAINING FUEL LEAKAGE

I found this very convenient in determining the number of pounds of oil that should be subtracted from that drawn from the supply tank by the pump. In calculating the economy of the engine, this fuel leaking past the pump plunger is an important consideration.

Buffalo, N. Y. W. E. GREENE.

Trouble in Burning Hog Fuel

In the Oct. 12 issue, page 592, C. W. Fields mentions having some difficulty in burning hogged fuel under boilers and gives a sketch of the oven in which this fuel is being burned. Unfortunately, the elevation of the drawing is not dimensioned and it is difficult to determine just exactly the shape of this furnace. If the furnace is shaped as shown according to scale, a great deal of the trouble is unquestionably due to the restricted throat, as an open throat is essential for burning wood, whether hogged or otherwise.

In order to burn wood successfully, the burning must be done on the outside and the air must come from the front of the furnace over the fire for the greater part; little, if any air comes through the grates, only sufficient, in fact, to prevent the grates from becoming overheated.

The fuel should be fed through the top chute by gravity, not under air pressure. It would help if the fuel were allowed to pile up in a cone, which would leave all four corners of the grate bare, to allow air to enter at these four points. In addition air should be allowed to enter above the grate through the firedoor or, preferably, rather higher up, and if possible this air should be heated. This can be accomplished by making a double arch allowing the air to enter through the side walls of the furnace between the two arches, then pass downward through openings in the front walls into the firebox. With this arrangement sufficiently heated air in a proper amount can be supplied to the fire to consume the fuel.

If air is forced into the furnace, the blast will carry over the chips and dust unconsumed into the tubes, where the fire in them will be quenched, and the ashes will be blown up into the stack. Sufficient air and fuel should be supplied in the proper proportions so that combustion is completed before the burning particles reach the rear end of the boilers. For this purpose the passage of the gases should not be accelerated by a blast, but should be retarded as much as possible. A wide throat will facilitate this result, and if the setting is properly built the losses in radiation will not be large. As a general proposition the character of the grate has very little to do with the burning of wood. All that is necessary is that sufficient air passes through the grates to prevent their overheating and providing a sufficient amount of heated air over the top of the fire.

We have two boilers operating on hog fuel using only half dutch ovens, owing to the restricted floor space in our boiler room, and we are burning this fuel practically without smoke and developing good efficiency; at least we so judge from the output of the boiler, as we have as yet made no evaporation test. The boiler is rated at 255 hp., and we have taken out over 430 hp. continuously for many days at a time, with little or no trouble as regards clinkers or ash.

Soot blowers are used frequently; that is to say, the tubes are blown out three or four times a day so as to keep them as clean as possible. The combustion chamber does not fill up with cinders; the ashpit is clear and free, even more so than with coal; no trouble is experienced with the grate, and none in keeping the pressure up.

The only difficulties that have been shown so far have been in maintaining the arch and the side walls, for the fire is exceedingly hot and quite variable owing to the difficulty in maintaining a constant feed of the fuel. This latter trouble we are in process of eliminating at the present time, and hope soon to arrange to be able to feed the fuel as the load demands. The question of controlling the air is comparatively easy, as it is done by opening or closing two 4 x 10-in. doors which are located almost directly over the firedoors.

Boston, Mass. HENRY D. JACKSON.

Engineers' License Laws

Referring to the article "Engineers' License Laws" on page 632 of the Oct. 19, 1920, issue of *Power* by W. F. Lockwood, I would say that he reasons only on one side of the question. As I am an engineer, also a member of a board of examiners for engineers, and an employer of eight to ten engineers for the company of which I am the chief engineer, it is my duty to know at least as much as the men I employ, about the engines and boilers in the plant; otherwise, I could not intelligently direct them in the course of their work, especially during the critical periods that sometimes arise in every power plant that is operating.

Mr. Lockwood says that the public is not concerned and that there would be no menace to the public if the valves were faultily set, etc. He does not consider that we are wasting those necessaries of life and health and raising the price of these materials to the public as well as the owner.

Mr. Lockwood says it would make no difference, to the public, if the engine were to run loose in all of its bearings and its thumping could be heard a mile away. I hope that I will never be compelled to live within a mile of his plant, or have to go to a hospital if he should ever be lucky enough to get a position as engineer in the same hospital, or have to send my children to school within a mile of his plant.

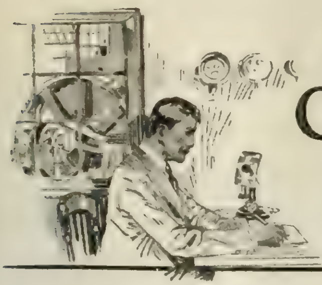
For the safety part I want to ask Mr. Lockwood if he ever knew of any accident caused by loose bearings and this thumping that he speaks about. Let him try to calculate the force of the blow against the metal in a thumping engine, and see how much more strain he puts on the engine frame, and then figure how much danger there is to the men and women working in a manufacturing plant where he is employed as an engineer. If he is not able to do this, let him go to some of the examiners in the State House at Boston and get them to do it for him. I know quite a number of them, and I know they can do it. GEORGE T. BROMLEY.

Wilmington, Del.

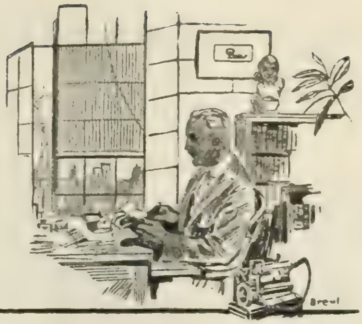
Referring to Mr. Lockwood's article, I do not wish to suggest that he has not said much truth, but it was conceded that Massachusetts plants during the recent war were far more efficiently operated than plants in no-license states. A flywheel explosion sometimes is quite a serious affair, and the learned engineer tries, by properly adjusted valve gear and governor, to protect his plant from such a catastrophe, although explosions have occurred in plants, as Mr. Lockwood says, where licenses obtained.

Our best surgeons and physicians fail to save every patient. Do the majority of engineers and firemen in license states wish to go back to the days before licenses? I think not. Does the progressive citizen wish the law licensing engineers and firemen abolished? I think not. Does Mr. Lockwood wish to embark on a vessel under a licensed captain and chief engineer or otherwise?

New York City. C. W. PETERS.



INQUIRIES OF GENERAL INTEREST



Carbon in Lubricating Oil—After refiltering the lubricating oil in a Diesel engine, I find a lot of carbon particles still in the oil. Can this be remedied? R. G. N.

It is practically impossible to remove all the free carbon from the oil. A small amount will do no damage.

Diesel Hard to Start—In starting a Diesel engine using 26-deg. oil, the cylinders do not fire until the flywheel has turned over a dozen or more times. How can this be improved? D. B.

Evidently the cylinders are worn, losing compression until warmed up by making several strokes. As an emergency, use kerosene to start, since it fires at a lower temperature.

Clattering of Balanced Valve With Circular Back—Our shaft governor engine is provided with a balanced valve that, judging from the large amount of steam used, probably leaks badly, and when the engine is running the valve makes a clattering noise such as made by most engines when started up or stopped. A short time after the valve and circular top-plate were planed and supplied with new packing rings, the noise became as bad as before. How can the trouble be remedied? E. W.

The trouble complained of is common with the type of valve described, especially when the engine is operated with a heavier load than the load for which wear has caused shoulders to be formed on the steam-chest cover. For the greater valve travel with heavier loads, the circular edge of the top plate strikes these shoulders or travels over them with a chattering of the valve. The only remedy is to make frequent inspections of the surfaces and keep them true and parallel, and keep in order the springs that hold the valve-back against the steam-chest cover.

Chatter and Blow-down of Safety Valve—Why does a safety valve continue to blow off after the boiler pressure has dropped below the pressure for which the valve is set? What would cause a safety valve to chatter or rumble when blowing off? C. T. C.

Blowing off continues after the boiler pressure is reduced below the "pop" pressure because the discharge passages guide the escaping steam in such a manner that it helps the boiler pressure to hold the valve away from its seat. The greater this assistance while the valve is open the lower the boiler pressure will be reduced below the "pop" pressure before the valve will be closed. The reduction in boiler pressure below the "pop" pressure is called the "blow-down" and most direct spring loaded safety valves are provided with an adjustable "blow-down ring" or other means for varying the amount of blow down. When the valve is raised from its seat the pressure exerted by the spring is greater than when the valve is closed. Hence when the valve opens, unless the escaping stem exerts enough force to overcome the greater spring resistance, for continuance of a little more than pop pressure in the boiler there are rapid alternations of partial openings and closings, due to the ricochetting of the spring and small sudden changes of boiler pressure that give rise to chattering of the valve with intermittances of discharge, causing vibrations of the atmosphere that produce a humming or rumbling sound.

Anchorage for Base Elbow of Turbine Exhaust—A steam turbine running under 28 in. vacuum has a 30-in. diameter exhaust opening to which a copper expansion joint is bolted, and there is a base elbow bolted to the expansion joint, which is anchored to a concrete pier. What should be the weight of the pier? R. J. D.

A vacuum of 28 in. $= 28 \times 0.491 = 13.75$ lb. pressure per square inch less than the pressure of the atmosphere. The area of opening of the elbow is $30 \times 30 \times 0.7854 = 706.86$ sq.in. Assuming perfect flexibility of the expansion joint and elbow connections and neglecting the weight of the elbow, the excess external pressure tending to lift the elbow and weight of concrete required for its anchorage would be $13.75 \times 706.86 = 9{,}719$ lb. The actual weight of concrete required would be reduced by the weight of the elbow and any upward thrust exerted by the expansion joint.

Reconnecting Induction Motor—We have a 60-cycle 440-volt 150-hp. 720 r.p.m. motor. This machine when it came from the factory was connected five-parallel for two-phase. Without removing any of the coils somebody connected it five-parallel-star for three-phase. In the two-phase winding the coils were arranged in groups of four. In the three-phase winding one coil has been left dead in each group, and this motor is operating satisfactorily. In other words, there are now only three active coils in each pole-phase group. What effect has the change on the horsepower rating and speed of the motor? W. H. K.

A two-phase motor connected star for three-phase operation, using the same grouping of coils as for the two-phase machine, will be correct to operate on 125 per cent of the two-phase machine's volts. With the motor in question, the winding was grouped in five parellels for two-phase and was correct to operate on 440 volts. If this same winding was grouped five-parallel-star for three-phase it would be good for 125 per cent of 440 volts or 550. However, 25 per cent of the coils have been left inactive in the winding, consequently the motor is now only good for operation on 75 per cent of 550 or 412.5 volts, and will act the same as though it was on a circuit of 106 per cent normal volts. No doubt the motor is conservatively enough designed so that it will operate satisfactorily under the new condition. Since the copper has been reduced by 25 per cent, the output will be normally reduced by 25 per cent and the rating will be 75 per cent of 150 or 112.5 horsepower. Since the motor is operating satisfactorily under conditions equivalent to 6 per cent increased voltage, it is probably good for about 80 per cent of its normal rating, or 120 horsepower. The starting torque and pull-out torque will be only about 80 per cent of that developed by the two-phase winding, but the speed will be practically the same for either two- or three-phase. To materially affect the speed the frequency on the number of poles would have to be changed.

[Correspondents sending us inquiries should sign thei communications with full names and post office addresses This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor]

Automatically Controlled Substations for Industrial Service*

R. J. WENSLEY
Switchboard Engineer, Westinghouse Electric and Manufacturing Company

WHILE the automatic substation has been principally exploited for use by the electric railways, the past year has witnessed a decided awakening on the part of industrial power systems and central stations having Edison systems to the desirability of eliminating the human element from the operation of rotary transforming and converting equipment. In many instances in the industrial field the direct-current system is the outgrowth of small isolated plants with one or more generators driven by reciprocating engines. As the industry grows this plant is extended until a large investment is tied up in direct-current motors. When the plant area grows to more than one or two acres the problem of transmitting power at 125 or 250 volts becomes quite serious and very expensive. The investment in copper feeders is a large factor as well as the actual I^2R losses in the feeders. In most cases these losses are not as serious as the decrease in production due to the slowing down of machines which, of course, follows the drop in voltage. This cannot be avoided without the expenditure of unreasonably large sums for copper. It is undoubtedly true that many of the industries in this class would be better served by the exclusive use of alternating-current distribution, but in many cases the cost of changing over the equipment is absolutely prohibitive. Notable examples of this class of industry are the Detroit plants of the Packard and Ford motor companies. Both of these companies are turning to the automatically controlled substation as a way to solve the direct-current distribution problem.

There are other classes of industry that require large amounts of direct-current energy—for instance, the steel mills. Without going into the merits of alternating-current versus direct-current drive, in this instance the fact remains that numerous extensive and high-capacity direct-current systems are maintained by the larger mills and are constantly being extended. The use of automatic or semi-automatic control for the converting machinery offers a convenient and economical method by which good regulation can be obtained for the least initial investment.

USE OF SUBSTATIONS IN MINES

Large mining industries are compelled to use direct current at a potential not exceeding 275 volts for the locomotives that haul the dump-cars from the mines. The tracks of these miniature railway systems quite often spread over an appreciable area and thus require that current be fed to the system at more than one point. The least expensive method of accomplishing this is by the use of automatically controlled converting equipment installed underground at points as close to the load centers as convenient. The first use of this means of distribution to come to the writer's attention is by the Lincoln Coal Co. operating near Johnstown, Cambria County, Pensylvania.

In the past year or so there has been a marked tendency on the part of users of electric power to eliminate the human element in the starting of motors driving various sorts of machinery, so as to avoid both the abuse of the motor and the necessity for educating the machine operator in the exceedingly simple starting operation. As the use of such automatic starters is now so universal and as many of the operating principles of the automatic substation are similar, factory electricians are well prepared to undertake the maintenance of the latter.

Labor of the sort available for operating manually controlled converting apparatus has become, in the last few years, both expensive and inefficient. Few of the operators are able to do more than call for help if any operating difficulties present themselves. If they attempt to go ahead on their own initiative they are likely to make expensive errors in judgment that will result in even more extensive trouble than the first encountered.

On the other hand, the designers of electrical machinery have been improving methods and materials until it is now possible to construct apparatus that can be reasonably expected to give long service with a minimum of lost time for repairs. Experience gained in the railway field has shown that automatic control can be made so nearly perfect that with any sort of reasonably good maintenance the service should be equally as good as the best manual operation, or very possibly much better, especially as regards speed of service restoration after a failure of the primary power supply.

AUTOMATIC CONTROL RELIABLE

An instance of the performance obtained is that of the automatic railway station installed on the Lima-Toledo division of the Ohio Electric Railways. After about two years of operation there was a strike in which the maintenance crew joined. This station operated for some six or eight weeks with no inspection or maintenance service of any sort. Unfortunately, the use of this incident as a shining example is spoiled by the fact that a severe electrical storm burned out the direct-current reverse-current relay at the end of this period, and the man responsible for operation was unwilling to take a chance on allowing the equipment to function without this protective feature. This shows, however, that the automatic control does not have to be petted and nursed along daily to keep it operating.

Criticism of the complexity of the wiring connections in the automatic control for converting machinery has died out to a considerable extent, due both to the effort on the part of the designers to simplify the connections and to comparison with such equipment as the controls of paper-mill machinery or large reversing rolling mills. Beside the diagrams of such equipments the automatic substation seems almost elementarily simple.

The tendency is for the use of synchronous-motor generator sets in industrial plants. In fact, all the equipments actually sold for use in industrial automatic substations, so far as the writer knows, are of this class. The largest and most interesting of these are the two being installed by the Packard Motor Car Co. at its Detroit plant. Each of these will have one 1500-kw. synchronous-motor generator set with a 4600-volt three-phase 60-cycle motor and 250-volt direct-current generator, the latter equipped with compound, interpole and distributed compensating-field windings. For full automatic operation the compound winding will be short-circuited, the regulation being obtained from a special form of regulator.

PACKARD PLANT INSTALLATION

The Packard plant is laid out on a long narrow strip of ground directly adjoining a railroad on one side. The existing direct-current power plant is near the center. Power is transmitted in either direction through cables laid in a tunnel. All the cables of each polarity are paralleled so as to form one heavy bus. As the load is growing toward the ends of this bus tunnel it has been decided to put in two automatic substations near the heaviest load centers located farthest from the generating plant. Power for these stations will be purchased from the Detroit Edison Co.

The control equipment has been built for full automatic operation, this meaning that the stations will start up when the bus voltage is reduced below a certain point and will be shut down when the load remains less than a predetermined value for a given length of time. It may prove more satisfactory, however, to control the starting and stopping of these stations by means of pilot wires from a central point, as the load grows with such extreme rapidity in the morning and immediately after the noon hour.

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*Abstract from a paper presented before the Providence Section of the American Institute of Electrical Engineers, Oct. 8, 1920.

Automatic converting stations are, in general, applicable to any sort of industrial requirement where operating labor can be saved by their use. Proposals have been made for their use in all sorts of mills and factories, motion-picture studios, electrolytic industries, mines and many other applications. In some instances the prospective purchasers have been more eager to eliminate the troublesome operator than to save the cost of operating labor. The problem of keeping maintenance men seems much easier. The automatic substation will continue to operate for quite some time without a maintenance man, but the manually operated equipment will not run without its operator.

Modern Development in the Use of Pulverized Fuel

In the United States 85 per cent of the power and heating plants do not run over 1,000 hp., and the expense of a complete pulverizing plant has been prohibitive. This problem is now being solved by a centralized pulverizing plant, delivering the pulverized fuel to the consumer in tank wagons, according to a paper by C. L. Bohannan, combustion engineer of the Bonnot Co., before the Minneapolis Section of the National Association of Stationary Engineers.

The Hennepin Atomized Fuel Co. is now erecting a pulverized-fuel plant in Minneapolis to supply pulverized fuel for boiler plants and for power and heating plants. As soon as the installation at this point is completed, the company will begin erecting plants in St. Paul and Duluth, and eventually will have a network of them in the State of Minnesota. The plant is being built by the Bonnot Co., of Canton, Ohio, which will also furnish the burning equipment for the various installations.

The peat operations of the Hennepin company have now passed the experimental stage, and it is expected that a considerable amount of this fuel will be on the market by the fall of 1921. The work of excavating and air-drying the peat has been done on a 60-acre tract, situated three miles from the city limits of Minneapolis on Superior Boulevard. The peat on this bog averages about seven feet in depth and is not as high a grade of fuel peat as that found in the northern part of the state, where the depth is from twelve to twenty-five feet. This peat is much more compact and of an older formation. It is excavated by the Garnett peat machine, which digs, macerates, spreads and cuts into briquets at one operation. This machine requires only one man to operate and has a capacity of 100 tons of air-dry peat per day. After the peat is spread, the crop is allowed to lie for about two weeks, exposed to the wind and sun, when it is piled into windrows by the use of an ordinary road scraper for further air drying, and put into stockpiles to await transportation to the pulverizing plant.

The dry pulverized peat contains about 3 per cent moisture, 10 per cent ash, 0.32 per cent sulphur and from 9,000 to 10,000 B.t.u. per lb.

The experimental work of burning pulverized peat was conducted at the Phœnix Building, Minneapolis, with very satisfactory results. The actual comparison obtained by a weighed water test showed that about 10 per cent more peat was required to carry the same load than when burning pulverized coal.

Pulverized peat burns with a longer flame than pulverized coal, due to its high volatile content and weight. A cubic foot of pulverized coal weighs 36 lb., while a cubic foot of pulverized peat weighs 31 lb. From the nature of the fuel, with its high oxygen content, the quantity of air for combustion can be greatly reduced from that required for coal. A slight variation in the air supply will affect the furnace conditions with peat burning more than the same variation where coal is used. The ash is very light and does not stick to the tubes.

The Bureau of Mines, University of Minnesota, estimates that there are, in that state alone, seven billion tons of peat, the greater portion of which is available for fuel. The burning of pulverized peat, while a new departure in this country, has been in successful operation in Sweden for several years. Results of tests by the Swedish government are summarized by Captain Ernst Wallagren, Chief Peat Engineer of that government, who says: "The peat powder, when burned by the method used at Bäck, was equal in fuel value to the best English coal ton for ton. This discovery makes Sweden independent of other countries for fuel supplies for industrial uses."

In summing up, Mr. Bohannan declared it to be an absolute fact that the use of pulverized fuel produces a great saving in both fuel and labor costs. Owing to the scarcity of skilled operators, it is more difficult than ever to produce high efficiencies in hand or stoker firing. For these conditions pulverized fuel gives an ease of control equivalent to that of a gas or oil fire.

Increased Operating Costs

In a paper, "Operating Costs—Power Expenses," presented before the Municipal Tramways Association, Cardiff, Wales, A. L. C. Fells said in part:

Before the war it was possible to issue a fairly close specification for coal, and payment was made for value received. Since 1914, however, anything available has had to be taken, and absolute rubbish has been supplied in innumerable instances, notwithstanding all the complaints made to the authorities concerned.

To-day the situation is still unsatisfactory. The following particulars with regard to the coal supply to the London County Council's Greenwich Power Station may be of interest:

	1913-14	1919-20
Tons of fuel burned	166,040	176,400
Total cost of fuel burned	£139,577	£348,395
Average price paid per ton for coal	16s. 9¾d.	41s. 11$\frac{3}{10}$d.
Average calorific value British thermal units	13,350	10,780
Average percentage of ash	6.79	14.59

It will be seen that the fuel supplied in 1919-20 contained 7.8 per cent. more ash than that supplied during 1913-14, or a total increase in the waste material supplied to the station of 13,759 tons. This waste material, paid for at 41s. 11.3d. per ton, represents a dead loss of £28,854 during the year. In addition, the extra cost of barging away the ashes at 3s. 8d. per cubic yard amounted to £6,306, and owing to the increasing cost of labor this figure will become more serious as time goes on. The present cost of barging amounts to 4s. 9d. per cubic yard, or a total cost of barging the above quantity of ash would amount to approximately £8,170. In addition to this, it has been necessary to incur very heavy expenditure at the station for labor in connection with the removal of ashes. The figures quoted would have been considerably higher, as a larger amount of fuel would have been consumed in 1919-20, if it had not been possible to bring into commission more economical generating plant.

Dr. Steinmetz Speaks on Lightning

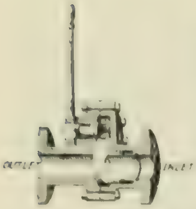
On the evening of Oct. 20 Dr. Charles P. Steinmetz addressed a Chicago audience that taxed the capacity of Fullerton Hall. The occasion was a joint meeting of the Chicago Section of the American Institute of Electrical Engineers, the Electrical Section of the Western Society of Engineers and the Chicago Chemists' Club. The topic of the evening was the "Origin and Energy of the Lightning Flash." According to the speaker's conception the lightning flash is not a destructive charge like that from a condenser, but is more in the nature of an equalization of unequal electrostatic charges. The tremendous power required for a destructive spark is not present. The origin of the tremendous voltages may be in a combination of highly charged moisture particles into raindrops, the charge carried by the small particles being due to their position in the electrostatic field surrounding the earth.

There was 35 per cent less coal produced in the mines of Upper Silesia in 1919 than in the previous year; 21,204,043 tons of coal was shipped from these mines in 1919, as against 36,113,360 tons in 1918 and 40,337,215 tons in 1913.

Condensed-Clipping Index of Equipment

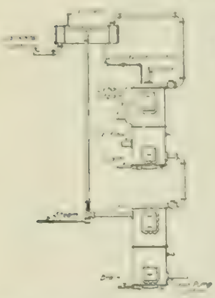
Clip, paste on 3 x 5-in. cards and file as desired

Yarway Double-Tightening Valve
Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.
"Power," 1920



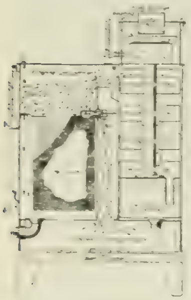
This valve is of the lever operated water-gate type having a seating bushing on the inlet side of the disc so that it is double tightening on both sides. A guard on the tailpiece of the seating bushing protects the spring and prevents scale-forming matter from getting behind the seating bushing and interfering with the spring action, which keeps the seating bushing against the disc when no pressure is on the valve. When pressure is applied, the seating bushing is forced against the machined surface of the gate disc and is ground in as is the opposite face of the gate as it passes across the seat.

Air Separating Process
The Elliott Co., Pittsburgh, Pa.
"Power," Sept. 21, 1920



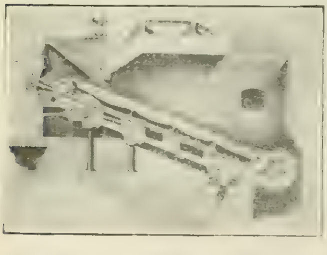
The purpose of this air separation is to remove the dissolved gases and also one class of dissolved solids which are found in natural water as it is fed to boilers. Fundamentally, the process consists of heating the water to its approximate boiling point and then injecting it into a chamber under vacuum. The vacuum is maintained with an air pump with a condenser or heat exchanger in series so that all the heat from the vapor exhausted from the region of vacuum is returned to the feed-water heater through the heat exchanger. The process operates at 100 per cent efficiency thermally, but thermodynamically, the energy loss due to pumping from the region of vacuum slightly lowers the over-all efficiency.

Filter, "Type A" Power Plant Oil
The Richardson-Phenix Company, Milwaukee, Wis.
"Power," Aug. 31, 1920



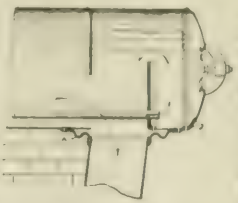
This filter operates on the so-called dry principle of filtration, in which the oil is not passed through water. It accomplishes purification, both by precipitation and by filtration through closely woven cloth. In the former process, the oil is brought practically to a rest and entrained water and heavy particles of foreign matter are allowed to settle out. The incoming dirty water is heated. The oil takes a long path flowing at low velocity over shallow trays, where precipitation takes place. It then flows through the filtering medium. When necessary, the oil is passed over cooling coils after it has been filtered. The clean oil occupies all the space in the bottom of the filter under the precipitation and filtration compartment and also the space alongside the filtering compartment, which is about one-half the width of the filter.

Stoker, Stowe Forced-Draft
Laclede-Christy Clay Products Co., St. Louis.
"Power," Oct. 19, 1920



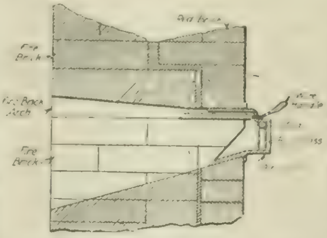
This forced-draft stoker consists of traveling chain-grate elements alternating with stationary tuyeres. The grate is inclined at an angle of 20 deg.; both moving and stationary grates are provided with relatively small area air space through which air is forced at a uniform draft pressure not exceeding 2 in. of water. The chains are made up of four rows of links and are adjusted by eccentric pins. The tuyeres terminate in sharp vibrating bars that slowly rise above and then drop below the chains. In the upper position they start the movement of the fuel and in the lower position permit the chain to carry the refuse to the ashpit. The tuyere rockers are actuated by eccentrics.

Flange, Purifier and Corrugated Boiler
Union Iron Works, Erie, Pa.
"Power," Sept. 28, 1920



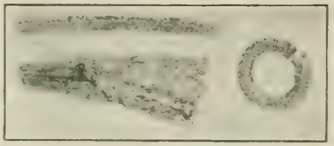
A corrugated flange connection is made between the header and the steam drum in order to take care of expansion and contraction. The flange provides an opening of large area for unrestricted water circulation, and requires no throat bracing. Flange connections are made riveted. The purifier consists of a settling chamber, into which the feed water discharges, and where the precipitates and solids are removed from the water before it passes into the drum. Each settling chamber is equipped with a blowoff. Baffles isolate the purifier and conducting water from the rest of the boiler, without obstructing the circulation from the front to the rear of the drum.

Furnace Door, The C-E-Z.
Curry & Barnum, Box 706, New Haven, Conn.
"Power," 1920



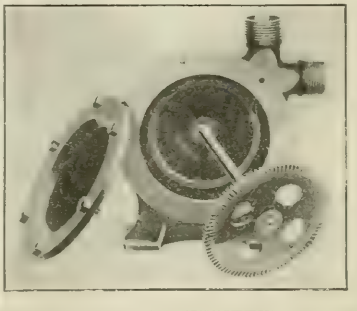
This door is composed of a cast-iron frame, with an opening approximately 2 x 6 in. When not in use the cast-iron flap, about ⅝ in. thick, is closed and in such position protects the door and slab. When the condition of the fire is to be determined, it is merely necessary to pull the handle down and observe the fire. In this 2 x 6 in. opening there is a piece of blue glass which in turn is protected when the flap is up by a piece of mica placed in front of the glass. Between the mica and blue glass there is always a circulation of air. The use of this door obviates the necessity of opening the firedoor for observation. Furthermore, the observer is protected from the intense heat of the furnace when observing the fire.

Packing "Metalpac" Flexible Metallic
Goodsell Packing Co., Maywood, Ill.
"Power," Oct. 19, 1920



This packing is composed of continuous metallic sheets that are passed through a bath of lubricant and crinkled so that the material on the inside of the braided copper-wire covering with which it is wound is as pliable and compressible as the outer surface. The copper braiding prevents flaking of the inner material and also permits of making the packing in continuous lengths. It has the flexibility of fiber packing and is made to withstand the highest pressure for steam, air, vapor, hydraulic pressure and all liquids. It is supplied on reels, in gasket shape, rings and spiral coils.

Pump, Westco
Western Pump Co., Davenport, Iowa.
"Power," 1920



The Westco pump has but one moving part, which is a disc impeller fastened to the shaft, and has a certain determined number of blades on each side of the outer rim. The impeller, rotating at high velocity in the water channel, causes the water to be drawn from the source of supply and discharged under pressure at the outlet. The water is taken in at the periphery and discharged at the periphery. It is used to handle small and large quantities of water under all pressures.

Patented Aug. 20, 1918

Work of the Engineering Standards Committee

Considerable progress has been made on the comprehensive program of safety codes being undertaken by a large number of organizations under the auspices and rules of procedure of the American Engineering Standards Committee. Following this regular procedure, each code is being formulated by a sectional committee, broadly representative of the interests concerned and composed primarily of representatives designated by the various bodies interested in the particular code. The sectional committee is organized by one or more bodies designated for the purpose by the American Engineering Standards Committee and known as sponsors.

Sponsorships for the following safety codes have been arranged for: Construction Work, Electrical Fire Code, Electrical Safety Code, Floor Openings, Railways and Toe Boards, Lighting Code, Lightning Protection, Machine Tools, Mechanical Transmission of Power, Industrial Sanitation Code, Stairways, Fire Escapes and other Exits, Textiles, Abrasive Wheels, Foundries, Gas Safety Code, Head and Eye Protection, Paper and Pulp Mills, Power Presses, Pressure Vessels (Non-fired), Refrigeration (Mechanical), Woodworking Machinery.

The Head and Eye Protection Code has been completed, and the sponsor, the Bureau of Standards, has submitted the code to the main committee for approval.

Specifications and tests for portland cement, and specifications for fire tests of material and construction have been approved by the committee as Tentative Standards. The committee has under consideration several other standards covering specifications for materials.

A specification for standard pipe threads has been approved as an American standard. The American Society of Mechanical Engineers and American Gas Association are sponsors and are representing America on the subject at an international conference in Paris.

A sectional committee on steel sections is actively at work, the Association of American Steel Manufacturers, the American Society of Civil Engineers and the Society of Naval Architects and Marine Engineers having accepted sponsorship. The American Bureau of Shipping and the United States Navy have representatives on this sectional committee. Real progress has been made and steps taken toward agreement with the British Engineering Standards Association.

The Swiss have requested co-operation on standards for ball bearings. The American Society of Mechanical Engineers and Society of Automotive Engineers have accepted the sponsorship, and a sectional committee is now being formed.

The British have asked for co-operation on standards for gears. The American Society of Mechanical Engineers has accepted sponsorship and has invited the American Gear Manufacturers Association to act jointly with them.

Plans are under way for sectional committees on screw threads and on cylindrical limit gages for co-operation with the British association. The main committee has a satisfactory understanding on screw threads with the National Thread Commission.

At a safety-code conference in Washington, Dec. 8, 1919, a resolution was passed expressing the opinion that safety codes for general use should be prepared according to the procedure of the American Engineering Standards Committee. A second resolution requested the American Engineering Standards Committee to ask the International Association of Industrial Accident Boards and Commissions, National Safety Council, and Bureau of Standards, to form a safety code committee, which should suggest a list of safety codes and recommend sponsors. The American Engineering Standards Committee acted favorably upon this request. The committee appointed has made a progress report, suggesting 37 codes.

The American Engineering Standards Committee is in communication with similar organizations in Belgium, Canada, France, Great Britain, Holland, Sweden and Switzerland.

The committee will be of great help in co-ordinating and furthering standardization work, thus helping to place industries at large in a position to increase production. The economic advantage to the whole country of any movement that would tend to increase production is obvious.

Upon request of the American Institute of Architects and the Elevator Manufacturers' Association of the United States, a conference of the various bodies interested in the question of the standardization of elevators was called by the committee to decide whether such standardization work should be undertaken, and if so, what the scope of the work should be. The conference was held in New York on Sept. 21, and was attended by representatives of thirteen different organizations. After a full discussion, the following resolution was unanimously voted:

Resolved: that this conference fully recognizes the need and the desirability of standardizing such features of both passenger and material-handling elevators as capacities, platform sizes and methods of test.

Acting upon a request from the Secretary of the International Aircraft Standards Commission, that arrangements be made, if possible, for American participation in the next meeting of the commission, the American Engineering Standards Committee invited the various government and industrial organizations interested in aircraft standardization to send representatives to a conference to discuss the question. It was the uanimous view of this conference, which was held in Washington Aug. 11, that there should be American participation. A committee was appointed to present the matter to the President through the chairman of the Council of National Defense. As a result, the President addressed a letter to the National Advisory Committee for Aëronautics, requesting it to arrange for the presence of American representatives at the conference. The National Advisory Committee for Aëronautics is taking steps to provide such representation.

There has been formed in Austria a national engineering standardizing body. It is the tenth to be formed, the others being in Belgium, Canada, France, Germany, Great Britain, Holland, Sweden, Switzerland and the United States.

Coal Still Scarce In Spite of Lifting of Lake Priority Order

The lifting of the Lake priority order has had the effect of releasing one-half of the 4,000 cars that have been dumped daily at lower Lake ports. During the latter part of the time that the Lake order was in effect, the refusal of the Northwest to buy resulted in a large number of cars being held under load. With the lifting of the order this accumulation of coal on cars was hurried into distribution with the result that very substantial relief was felt in the Middle West during the week following the cancellation of the Lake order. This gave rise to the hope that the movement would continue at that rate, and some disappointment is resulting because deliveries have slowed down.

The public utilities continue to be very uneasy about their car supply, and the Interstate Commerce Commission was asked formally on Nov. 1 to invoke service order No. 21 so that the use of assigned cars could be permitted. The commission declined to take that action on the plea that general conditions throughout the counry, among the public utilities, do not warrant a return to assigned cars.

Registration of Engineers in Canada

The Engineering Institute of Canada some time ago proposed a plan for the registration of engineers. Since that time the Canadian government has framed a law along the same general lines, providing for associations of engineers in each province. General rules of procedure were laid down by the government, by which these associations might register engineers as members. Such registration has the same effect in Canada as the licensing of an engineer has in some states in this country. There is this difference, however: In the United States the licensing of engineers is in the hands of a board appointed by the government of the state, while in Canada the situation is almost entirely in the hands of the engineers themselves.

Progress of Federated American Engineering Societies

The American Institute of Electrical Engineers at a meeting of its board of directors on Oct. 8 appointed the following representatives of the institute on the American Engineering Council, the governing body of the Federated American Engineering Societies: Comfort A. Adams, Cambridge, Mass.; A. W. Berresford, Milwaukee, Wis.; H. W. Buck, New York City; F. L. Hutchinson, New York City; W. A. Layman, St. Louis, Mo.; William McClellan, Philadelphia, Pa.; L. F. Morehouse, New York City; L. T. Robinson, Schenectady, N. Y.; Charles S. Ruffner, New York City; L. B. Stillwell, New York City; Calvert Townley, New York City.

The Florida Engineering Society has appointed L. R. McLain to represent it at the first meeting of American Engineering Council, Nov. 18 and 19, 1920.

The Federated American Engineering Societies now consist of the following organizations: Alabama Technical Association, Birmingham, Ala.; American Institute of Chemical Engineers, Brooklyn, N. Y.; American Institute of Electrical Engineers, New York City; American Institute of Mining and Metallurgical Engineers, New York City; American Society of Agricultural Engineers, Ames, Iowa; American Society of Mechanical Engineers, New York City; Detroit Engineering Society, Detroit, Mich.; Engineering Association of Nashville, Nashville, Tenn.; Engineering Society of Buffalo, Buffalo, N. Y.; Florida Engineering Society, Gainesville, Fla.; Kansas Engineering Society, Topeka, Kan.; Technical Club of Dallas, Dallas, Tex.; The Cleveland Engineering Society, Cleveland, Ohio; The Society of Industrial Engineers, Baltimore, Md.

Twenty-seven additional societies have been invited to become charter members and are now considering the question of acceptance.

New A. S. M. E. Officers Chosen

The American Society of Mechanical Engineers has completed its letter ballot for new officers. The successful candidates will take office after the annual convention of the society early in December. Edwin S. Carman, a Cleveland manufacturer, was selected as the president for a term of one year. The new vice presidents, who will serve for two years, are: John L. Harrington, a consulting engineer of Kansas City; Leon P. Alford, a New York editor, and Robert B. Wolf, president of the R. B. Wolf Co., of New York. The three managers, who are to serve for three years, are Henry M. Norris, of Cincinnati, Ohio; Carl C. Thomas, of Los Angeles, Cal., and Louis C. Nordmyer, of St. Louis, Mo. Major William H. Wiley, a New York publisher, was re-elected treasurer. The society's council will choose the secretary in December.

Prominent Engineer Dead

Percy B. Taylor, Newark, N. J., a prominent consulting engineer, died at his home in that city on Oct. 21, after many months of illness due to heart trouble. Mr. Taylor was born at Manchester, England, May 26, 1865, and came to this country when eight years of age. He started as a young man at the plant of Cyrus Currier & Sons, manufacturers of machinery, Newark, and for many years was associated with this organization, becoming head of the engineering department. He later formed the Taylor-Martin Co., and with a plant on New Jersey Railroad Avenue this company engaged in the manufacture of special machinery and equipment. In 1897 Mr. Taylor dissolved this organization to engage independently as a consulting engineer in mechanical and electrical work, making a specialty of power-plant installations.

For a number of years he was employed as consulting expert by the Board of Education for the installation of heating and ventilating equipment in the local public schools. In his later years he undertook complete plant construction, including power and electrical installations and machinery. He designed a successful internal-combustion engine of special type, automobile transmission and other mechanisms.

Mr. Taylor is survived by a widow, a daughter, a son and two brothers. The son, Kenneth H., will continue his father's business with Robert Bolton, who was associated with Mr. Taylor for fourteen years. Mr. Taylor was a member of the American Society of Mechanical Engineers.

A. S. M. E. Organizes Special Sections

The American Society of Mechanical Engineers has organized in the past seven months seven professional sections and is planning to organize four more. The seven sections already in existence, with the number of members so far registered in each, are as follows: "Aëronautic, 201; Fuels, 498; Machine-Shop Practice, 557; Management, 921; Materials Handling, 605; Power, 920; Railroads, 396. Those not yet organized are: Cement, 92; Gas Power, 322; Ordnance, 172; Textiles, 258.

The object of these professional sections is to provide organizations of members who are particularly interested, and others who may affiliate with them, with means for promoting the arts and sciences of the several branches of engineering included in the scope of the society's activities. The affairs of the sections will be in the hands of a standing committee, which will consist of the chairman selected by each of the various professional sections. The chairman of the standing committee so formed will have a seat in the Council of the society.

Plan to Increase Endowment of Engineering Foundation

The Council of the American Society of Mechanical Engineers has passed a resolution to the effect that the officers of the society be authorized and requested to co-operate with the officers of Engineering Foundation and the officers of the Societies of Civil, Mining and Electrical Engineers in promulgating a plan for increasing the endowment of Engineering Foundation and that when the plan is adopted the officers of this society are authorized to circularize the membership of this society with reference thereto.

The Board of Directors of the American Institute of Mining and Metallurgical Engineers has passed a similar resolution providing that the officers of this institute are authorized to co-operate with the officers of Engineering Foundation and with the officers of the other Founder Societies in formulating and assisting in carrying out a plan for increasing the endowment of Engineerig Foundation. The officers are also authorized to circularize the membership in furtherance of this plan.

Under average conditions an automobile discharges exhaust gases containing about 6.4 per cent of carbon monoxide and about half this percentage of hydrogen according to the tests of the Bureau of Mines. This investigation was reported by A. C. Fieldner, supervising chemist of the Pittsburgh station of the Bureau, in an address before the Chemical Society of Washington on Oct. 28. The work was done by the Bureau of Mines for the New York-New Jersey Tunnel Commission, in order to determine the extent to which ventilation of the tunnel would be essential for proper reduction of the carbon-monoxide content of the atmosphere of the tunnel. With the tunnel operating at full capacity a discharge of approximately 400 feet of carbon monoxide per minute would be expected from these results. This means that the proper elimination of these exhaust gases requires the supplying of approximately one million cubic feet of fresh air per minute.

The French Commission reports that the development of water power in France under plans now being carried out will make that country third among the nations who lead in this respect. The water power resources of France are reckoned to be about 9,000,000 hp. Of this amount 1,165,000 hp. is in use, and about 500,000 hp. additional is being developed. In about fifteen years 6,000,000 hp. more should be realized.

Obituary

Professor E. M. Shealy, who for a number of years was associate professor of Steam Engineering in the University of Wisconsin, died recently at his home in Madison, Wisconsin. Professor Shealy's health had been impaired for some time prior to his death. Outside of the University of Wisconsin, he was probably best known in the field of practical power-plant operation for his excellent works entitled "Steam Boilers," "Heat" and "Steam Engines," prepared by him in the Extension Division of the University. In these books, Professor Shealy demonstrated his thorough knowledge of power-plant operation and his ability to describe it and explain it in language understandable to the practical steam plant operator.

George Tangye, an English engineer of the old school, died recently at his home, Heathfield Hall, Hansworth, England. He was born in 1835, and after completing his schooling at the age of 18, he joined his brother Richard as a clerk in a railway-supply factory at Birmingham. They were soon joined by James and Joseph, but they did not remain long in this place, for Richard soon started in business for himself and it was not long before all the brothers had left. In 1858 they pooled their experience and their ability and established themselves in business as machinists. The Tangye brothers were all mechanically inclined and were brilliantly gifted, so it was only natural that their efforts should meet with singular success. Probably their first notable achievement was their hydraulic jack, which was used to move the "Great Eastern" when she stuck on the launching ways, and which has not been materially improved upon to this day. In 1862, it is said that George conceived the idea of a steam engine that could be built in numbers with the various parts interchangeable, and that his brother James carried the plan into execution, producing what has been known as the Tangye engine. Heathfield Hall, where Mr Tangye was born and where he lived for some years and finally died, was formerly the home of James Watt. Mr Tangye carefully preserved the garret in which the great inventor had worked, as well as a fine collection of relics of Boulton & Watt.

Personals

E. F. Troop is now chief engineer for the P. H. Glatfelter Co., Spring Grove, Pa.

R. J. S. Pigott, formerly industrial engineer for the Bridgeport Chamber of Commerce, is now with the Crosby Steam Gauge & Valve Co, Boston, Mass.

E. H. Aldworth, formerly assistant chief engineer with R. Martens & Co., Inc., New York City, is now chief engineer with Livermore, Rojas & Co., Inc., New York City.

Society Affairs

The Engineering Society of Buffalo will meet on Nov. 9 to discuss "The Einstein Theory."

The Engineering Council has compiled figures, showing that out of the 170 Public Service Commissioners throughout the United States, only 6, or 3½%, are members of engineering societies.

The Columbus (Ohio) Section, A. S. M. E., is to hear an address on Nov. 12 by Howard J. Webster, of the Uniflow Boiler Co., Philadelphia, Pa. Mr. Webster will speak on the desgn and construction of the uniflow boiler.

The American Association of Engineers is to sponsor a conference on employment and professional education at the Congress Hotel, Chicago, on Nov. 12. The conference will last throughout the day and will deal with the subject's different phases very thoroughly.

The New England Water Works Association will hold its November meeting at the Copley Square Hotel, Boston, on Nov 10. Four papers will be presented by John S. Caldwell, Engineer New England Insurance Exchange; W. R. Brann, Superintendent Water Works, Hallowell, Me., and Charles W. Sherman, of Metcalf & Eddy, consulting engineers, Boston, Mass.; Frank A. McInnes, Division Engineer, Boston, Mass.; and J. W. Ledoux, Consulting Engineer, Philadelphia, Pa.

The Society of Naval Architects and Marine Engineers is to hold its Twenty-eighth General Meeting in the Engineering Societies Bldg., New York, N. Y., on Nov. 11 and 12. Professional sessions will begin at 10 a.m. each day, and a number of excellent papers are to be presented. Among these are "Surface Condensers," by Luther D. Lovekin, and "Recent Advance in Oil Burning," by Ernest H. Peabody. These two papers will be presented on the 12th.

The Engineering Society of Western Massachusetts will make an inspection trip at 2 p.m., Nov. 11, through the plant of the H. B. Smith Co., Westfield, Mass., manufacturer of cast-iron steam-heating boilers and radiators. After the trip dinner will be served at the Hotel Bismarck. Following the dinner the regular October meeting of the society will be called to order, and Professor Breckenridge, of Yale, will speak on "The Evolution of the Cast-Iron Heating Boiler as Related to the Problem of Power and Fuel"

The Society of Liquid Fuel Engineers was organized Oct. 21, at the Engineering Societies Building, New York City. Dr. W. N. Best, F. R. S. A., was selected as the president. Among the Vice-Presidents were Earnest H. Peabody and Jarvis C Buxton; the treasurer was Roscoe C. Bulger, and the secretary was Charles F. Reuter. The list of incorporators included, besides the officers, the following: Albert A. Cary, Dr John H. Banks, John C. Wait, Gano Dunn, Hart H. Fleming, Walter S. Rockwell, William Schwanhausser, and Edgar J. Kates. The society plans to secure quarters in the Engineering Societies Building in New York, very shortly.

Business Items

Charles L. Pillsbury Co., Engineers, announce that after Nov. 1 their Minneapolis office address will be 1200 Second Avenue South.

The Conveyors Corporation of America, formerly the American Steel Conveyor Corporation, 110 West 40th St., New York, has placed Clarence C. Brinley in charge of a new branch of their business to handle eastern and Canadian affairs

The S. Obermayer Co., manufacturer of foundry equipment, and Hott-Patch furnace cement, has opened an office and warehouse at Blanchard and Ferry Sts., Newark, N. J., for the purpose of taking care of their export business. This warehouse will carry a very complete line and will be in charge of Mr. Beckman, formerly of Chicago.

Trade Catalogs

The Ajax Metal Co., Philadelphia, Pa., have published a new catalog in two editions, one in English, and one in Spanish. This was made necesary by the company's grawing export trade. The two editions are identical in text and illustrations, and cover all Ajax products from babbitt metals to car basses and castings, and ingot metal.

The Worthington Pump and Machinery Corporation, New York City, has ready for distribution a new catalog of marine pumps and other auxiliary equipment. This catalog is exceptionally thorough and complete. Its 125 pages describe in detail a very extensive line of pumping machinery and other auxiliary apparatus for steam-operated vessels. Engines and equipment for oil and other motor-driven ships will be covered in a separate publication.

Valves, Fittings and Tools is the title of a new 400-page catalog issued by the Walworth Manufacturing Co., of Boston. This book, which is intended for circulation only in foreign countries in which the British standard thread is used, is probably the most complete catalog printed in foreign languages covering pipe fittings, valves and tools that has yet appeared. A special bulletin has been prepared for use in the United States. The book is printed in four languages—English, Spanish, Portuguese and French. The arrangement is such that these appear in the same sequence on each page so that a man who can read only one language will have no difficulty in getting just the information which he desires. The catalog is profusely illustrated with engravings.

New Construction

PROPOSED WORK

Mass., East Lee—Carl Wurtzbach, High St., Lee, is interested in a proposed electric power plant to be built on the Housatonic River, here. Owner's name withheld.

Conn., New Britain—The City plans to develop a waterworks project including a pumping plant. Over $3,000,000. Jos D. Williams, City Hall, Engr., Hazen, Whipple & Fuller, 30 East 42nd St., New York City, Consult. Engrs.

N. Y., Buffalo—Geo. B. Post, Archt., 101 Park Ave., New York City, will receive bids until Nov. 22 for a 17 story hotel and theater building here including a steam heating system, for the Hotel Statler Co., Washington St. About $5,500,000. Noted May 3.

N. Y, Ossining—Chas. S. Ratigan, Supt. of Prisons, will receive bids until Nov. 23 for a 1 and 2 story building, two wings, 40 x 40 ft. and 28 x 120 ft., including a steam heating system, for additional accommodations at Sing Sing Prison. About $400,000.

Md., Baltimore—The Church Home & Infirmary, Bway. and Fairmont Ave., has engaged architects to prepare plans for a 6 story addition to hospital. An addition to the steam heating system will be installed in same. About $600,000. Wyatt & Nolting, 1012 Keyser Bldg., Archts

Md., Baltimore—The Horn Ice Cream Co., 446 Aisquith St., plans to build an ice and ice cream manufacturing plants, at Low and Aisquth Sts. About $300,000. Archt. not yet selected.

Va., Richmond—The Heisler Auto Repair Co., 309 North Laurel St., is in the market for a 3 hp. motor.

O., Cleveland—The Euclid Ave. Baptist Church, c/o Rev. W. W. Bustard, Euclid Ave. and East 18th St., plans to build a church including a steam heating system. About $300,000. Archt. not yet selected.

O., East Cleveland (Cleveland P. O)—The City, c/o A. Carran, City Hall, plans to build a light plant. About $90,000.

Ind., South Bend—The Tavern Hotel Co is having plans prepared for a 10 story, 85 x 165 ft. hotel including a steam heating system. About $750,000 R. T France, 155 North Clark St., Chicago, Archt.

Mich., Detroit—The Bd. Educ., 59 Bway Ave., received bids for an addition to the school on Abbott St., including a plenum steam heating system, mechanical ventilating device, etc., from A. W Kutche, 623 Ford Bldg., $217,213; Bryant & Detwiler, 2336 Dime Bank Bldg., $232,680; M. A. Mahoney, 400 Penobscot Bldg., $233,606.

Ill., Chicago—Marshall & Fox, Archts., 721 North Michigan Ave., will soon award the contract for a 3 story, 296 x 310 ft power plant to generate 200,000 kw., at 100th St. and Commercial Ave. for the Commonwealth Edison Co., 72 West Adams St. About $5,000,000. Sargent & Lundy, 72 West Adams St., Electrical Engrs. Noted Feb. 2.

Ill., Rock Island—The State Utilities Comn. has authorized the receivers of the Rock Island Southern Railway Co. to abandon its electric line and install steam and gasoline motor cars.

Wis., Janesville—Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, Ill., are preparing a report for furnishing additional water supply for the city.

Wis., Albany — W. G. Kirchoffer, Engr., 31 Vroman Block, Madison, will receive bids until Nov. 12 for one centrifugal pump, motor and controlling apparatus for waterworks plant here; pump to be of 160 gal. per minute capacity against a total head of 165 ft.

Wis., Kenosha—C. Mantkus, 216 Sheridan Rd., had preliminary plans prepared for a 2 story, 140 x 150 ft theater and commercial building. About $400,000. C. Augustine, Archt. and Engr.

Wis., Port Wing—The Northern Wisconsin River Electric Power Co., promoted by E. N. Christenson, has been granted permission to build a hydro-electric plant and dam on the Iron River. J. C. Jacobson, 333 Metropolitan Bank Bldg., Minneapolis, Minn., Engr.

Wis., Prairie du Chien—The City has appointed Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, Ill., to prepare report for furnishing additional water supply and a new pumping station.

Wis., Racine—Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, Ill., have presented report recommending abandonment of the present municipal water station and instead to install new pumps and filtration plants. Total estimated cost about $[illegible].

Wis., Racine—The New York Market Co., 709 Washington Blvd., is receiving bids for a 2 story 94 x 117 ft. sausage factory including electric motors, etc. Parker's Engineering Co., 431 South Dearborn St., Chicago, Ill., Engr.

Wis., Sheboygan—The City had preliminary plans prepared for a new pumphouse. About $25,000. C. N. Boley, City Hall, Engr.

Wis., Union Grove—The State Bd. of Control, M. J. Tappins, Secy., Madison, is having plans prepared for a power plant at the Southern Wisconsin Home for the Feeble Minded, here. John C. White, Madison, Engr.

Ia., Pocahontas—C. Gilchrist, Co. Aud., will receive bids until Nov. 12 for a 2 story, 80 x 125 ft. court house including a steam heating system. About $400,000. Proudfoot, Bird & Rawson, 810 Hubbell Bldg., Des Moines, Archts.

Minn., Aitkin—Aitkin County is having plans prepared for a court house including a steam heating system. About $400,000. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Archts.

Minn., Minneapolis—The State Bd. of Control, D. E. Mullen, Secy., Capitol, St. Paul, will soon award the contract for a 4 story administration building including a steam heating and ventilating system to connect with the present central system, on the State University campus, here. About $500,000. O. H. Johnson, 715 Capital Bank Bldg., St. Paul, Archt. Noted July 27.

Kan., Peabody—The City had plans prepared for a small pumphouse and 9 miles of main. About $180,000. Black & Veatch, Mutual Bldg., Kansas City, Mo., Engrs.

Kan., Pittsburg—A. L. Lamar, 1029 East 8th St., will receive bids until Nov. 15 for a machine shop and factory including a steam heating system, etc. About $12,000.

Kan., Stockton—Rooks County will soon receive bids for a 3 story, 80 x 100 ft. court house including a steam heating system. About $250,000. Frank C. Squires, 630 Kansas Ave., Topeka, Archt.

Mo., St. Louis—John F. Queeny, Pres. Monsanto Chem. Wks., 2nd and Lafayette Sts., plans to remodel the Old Southern Hotel, Broadway and Walnut Sts., into a 6 story, 150 x 300 ft. office building. About $500,000. Archt. not yet selected.

Tex., Austin—The Home Ice & Cold Storage Co., 3d St., plans improvements to its plant including new buildings and machinery. About $200,000. A. M. Fitzpatrick, Pres. and Gen. Mgr.

Tex., Dallas—The Mack Mfg. Co., Houston, is having plans prepared for a factory, here, including machinery for the manufacture of rotary drilling outfits and oil field supplies. About $1,000,000.

Tex., Ft. Worth—Thos. Holiday, Longview, is having plans prepared for a modern electrically driven hardwood lumber mill at 800 North Houston St., here. About $250,000.

Tex., San Antonio—The Bd. of Directors of the Southern Ice & Cold Storage Co. has voted for the erection of the first unit of a 20,000-ton ice storage warehouse. About $250,000. Mark Postlewaite, Mgr.

Okla., Tulsa—The Bd. Educ. will soon award the contract for a 4 story high school. About $800,000. Geo. Winkler, 414 Palace Pl., Archt.

Cal., San Diego—The San Diego Consolidated Gas & Electric Co. has applied for permission to appropriate 10 cubic ft. of water per second from the Pauma Creek to develop 560 hp. Diversion works consist of main ditch and a 25 x 125 x 900 ft. dam. About $225,000.

Que., Montreal—The Montreal Water Bd. will soon receive bids for two 12,000,000 gal. pumps and one 6,000,000 gal. pump.

Que., Montreal—The Riordon Pulp & Paper Co., here, plans to develop 250,000 hp. at Three Rivers.

Ont., Tillsonburg—The Canadian Cereal Mills Co., Stratford, plans to build an electrically driven flour mill, here. About $500,000.

Alta., Edmonton—The San Francisco & McMillan Oil Refining Co., Ltd., plans to build a plant. Estimated cost of initial unit, $500,000.

Australia, Morwell—The Secretary, Electricity Comnrs., State of Victoria, 673 Bourke St., Melbourne, Australia, will receive bids until February 24, 1921, for a generating and transmission plant, here, to develop an initial capacity of 50,000 kw. and a maximum of 150,000 kw. Plans also include a 90-mile transmission line from here to Melbourne, consisting, in the first stage, of one line of towers with 2 three-phase circuits each, having a capacity of 25,000 kw. Installation equipment for Melbourne is listed as follows:

Specification No. 32—Three 25,000-kw. turbo-alternator sets complete with condensing plant, pumps and all necessary accessories. Generators to be wound for 11,000 volt, three-phase, 50-cycle, 1,500 r.p.m. As an alternative 12,500 kw. sets will be considered at 3,000 r.p.m. In the same specification one 600-kw., 400-volt, three-phase, 50-cycle, 3,000 r.p.m. turbo-alternator is called for.

Specification No. 33.—Transformers and switchgear for controlling the above generators and also two high-tension lines. The transformers are to be of the single-phase, water-cooled outdoor type, 9,260 kva., each stepping up the voltage from 11,000 to 132,000, connected delta-star neutral permanently earthed, all the switchgear to be of the outdoor type and the necessary control panels, conduits, control cable and galvanized steel work as called for in this specification.

Specification No 34.—Seven hundred miles of 37/14 S. W. G. wire (area 0.182 sq.in.); or Specification No. 37.—Seven hundred miles of aluminum steel reinforced cable. (Alternative.)

Specification No. 35.—Eight hundred and fifty suspension and one hundred strain towers, normal span, 700 ft.; or Specification No. 38.—Five hundred and fifty suspension and seventy-five strain towers, normal span 1,056 ft. (Alternative.)

Specification No. 36.—Fifty thousand suspension units to be made up into strings of seven and eight, suitable for 132,000 volts (for copper cable line); or Specification No 39.—Forty-five thousand suspension units to be made up into strings of seven and eight (for aluminum cable.) (Alternative.)

Specification No. 40.—One hundred and twenty-five miles ½-in. double galvanized steel cable.

Specification No. 41.—Complete installation of terminal station in which is included: Two 16,000-kva. synchronous condensers, two banks of 30,000-kva. water-cooled transformers, 120,000 to 22,000 volts, connected delta-star neutral point earthed through a resistance, one 12,000-kw. frequency changer, 22,000 volts, 50 cycle, 20,000 volts, 50 cycle, two banks of 6,000-kva. water-cooled transformers, 22,000 volts to 6,600 volts. Necessary 120,000-volt to 22,000-volt, 6,600-volt outdoor type switchgear, also control panels, cables, conduits, control wiring and all steel work.

Specification No. 42.—Complete installation of three substations in which are included banks of 3,000-kva. and 6,000-kva. transformers outgoing and incoming overhead and underground feeders. All this equipment will be of the indoor type.

Specification No. 43.—Two thousand steel telephone poles approximately 35 ft. high to carry two telephone lines and one 22,000-volt feeder line between Morwell and Melbourne.

Specification No. 44.—Complete installation of telephone apparatus at the power house, terminal station and along the route of the transmission line. At the power station and the terminal station there will be in each a C. B. board suitable for 30 lines, to be extended at a later date to 100 lines; also all necessary high-tension telephone apparatus suitable for a telephone line operating in the vicinity of the 132,000-volt transmission.

The total cost of this project is estimated at $15,000,000. A number of bid forms and specifications have been forwarded to the Commercial Intelligence Branch of the Department of Trade and Commerce, Ottawa, Ont. Copies of the specifications may also be seen at the offices of the Canadian Manufacturers' Association, 42 St. Sacrament, Montreal, and at Traders' Bank Building, Toronto.

CONTRACTS AWARDED

Mass., West Medford—The American Woolen Co., 245 State St., Boston, has awarded the contract for a woolen manufacturing plant including a steam heating system on Boston Ave., here, to the Turner Constr. Co., 178 Tremont St., Boston, at $250,000.

Mass., Willimansett—The Stevens-Duryea Co. has awarded the contract for a 1 story, 34 x 41 boiler house to P. J. Kennedy & Co., Inc. 464 Maple St., Holyoke, at $30,000.

Conn., New Britain—The Bd. Educ. has awarded the contract for a 2 story, 60 x 240 ft. school including a steam heating system on Tremont St. to the Eastern Engr. & Constr. Co., 886 Main St., Bridgeport, at $330,000. Noted Sept. 28.

O., Canton—The Hoover Suction Sweeper Co. has awarded the contract for a 1 story, 50 x 60 ft. addition to its boiler house to L. W. Kilgore, Builders' Exchange, at $25,000.

O., Canton—The City has awarded the contract for a 2 story, 60 x 80 ft. addition to the Lehman High School to R. H. Evans Co., Schaffer Block, at $497,885. Contract for heating and ventilating system will be sublet.

O., Canton—The Bd. Educ. has awarded the contracts for the installation of a steam heating system in the Belden Ave and the Grace Ave. schools to the Witters Co., at $42,600 and $42,900, respectively. Noted Oct. 19 and 26.

Wis., Marshfield—The City has awarded the contract for boilers to the Erie City Iron Wks., Erie City, Pa., at $22,000.

Kan., Baxter Springs—The Iowa Mining Co., 4th and School Sts., has awarded the contract for removing mill from Joplin Mo., to here, and remodeling same, to Ber Hoskins, as $20,000. Gas engines will be installed in same.

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POWER

Volume 52 New York, November 16, 1920 Number 20

FIRELESS HELP

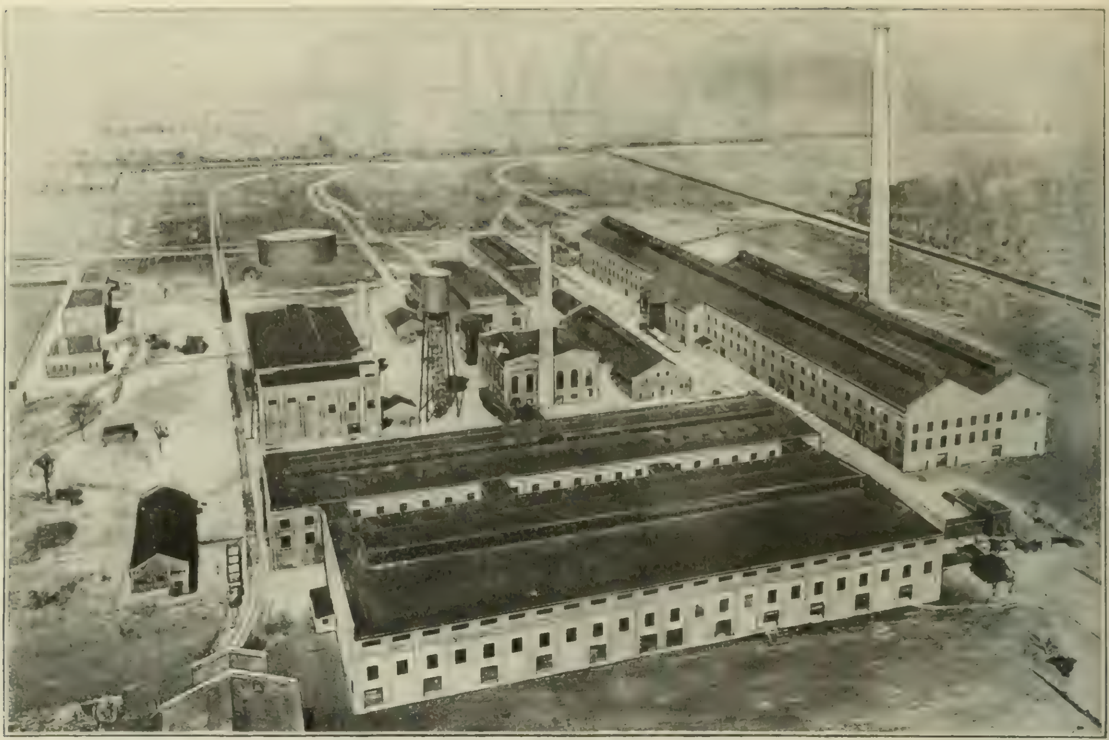
By Rufus T. Strohm

Harold Percy Cecil Peters
  (Ain't that moniker a crime?)
Tendin' boilers, pumps an' heaters,
  Gits his features smeared with grime.
Harold ain't no howlin' wonder
  As a helper, that we grant,
But we grin an' knuckle under,
  For his daddy owns the plant.

Dad has got the grand idea
  Firmly stuck between his ears
That his offspring oughta be a
  Future chief of engineers;
Now, the boy don't have the makin',
  But we never tell him so,
For we'd only burn our bacon,
  Since his pater runs the show.

Have we troubles? Lord 'a mercy,
  I should rather think we do!
Every day young Harold Percy
  Pulls a bonehead play or two;
An' although we're mad an' tired,
  We conceal the boob's disgrace,
For we know he can't be fired,
  Since his father owns the place.

Engineerin' life is pleasin'
  An' it's never dull or tame,
For you've got to hunt the reason
  When the plant goes runnin' lame;
But you'll find your power station
  Showin' new an' funny quirks
If the boss's near relation
  Gits a job around the works.



High-Speed Direct-Current Generator and Turbo-Blower Power Plant

Two 1,000-Kw. Direct-Current GeneratorOperating at 1,700 r.p.m., Two 1,000-Hp. Blowers Operating at 8,500 r.p.m. – Waste-Heat Boilers Used on Nickel-Refining Furnaces – Circulating Water from Rabble Arms in Calciner Furnaces Used for Boiler-Feed Water – Other Features in Power-Plant Construction of Particular Interest.

By H. W. SPOONER* and F. A. ANNETT†

LOCATED at Port Colborne, Ont., Canada, near the Lake Erie entrance of the Welland Canal, on a 330-acre tract of land, is the refinery of the International Nickel Company of Canada, Ltd. (see headpiece). Late in 1916 it was decided by the International Nickel Co. to construct a nickel-refining plant in Canada of sufficient capacity to meet the needs of the British Empire, which were very urgent at that time on account of the war. Nickel matte is received from the smelters at Sudbury, Ont., where the mines are also located, and is converted into refined nickel and nickel oxide at Port Colborne. A monthly production of 1,250,000 lb. of refined nickel and 500,000 lb. of copper represents the chief output. The plant consists of 31 buildings of steel and brick construction designed and built by The Foundation Co., New York City, and is situated about one-half mile from either the Welland Canal or Lake Erie. When the power supply for this plant was considered, there were two sources to choose from. The first was purchased power from either the Hydro-Electric Commission of Ontario or from the Dominion Power and Transmission Co., both of which have transmission lines running into Port Colborne. Under ordinary conditions these companies would have offered very attractive rates for this load, which would have been fairly constant and amounted to approximately 10,000,000 kw.-hr. per year. A second and only other source of power was the installation of an isolated plant at the works. After carefully investigating the various factors entering into the problem, the latter course was adopted. This decision was influenced largely by the fact that great quantities of live steam and hot water are required in the manufacturing processes and large amounts of waste heat are available from the refining furnaces. Furthermore, on account of the shortage of power existing on the Niagara Peninsula for the last four or five years, the two companies having transmission lines running into Port Colborne were not in a position to

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*Engineer, The Foundation Company.
†Associate Editor, *Power*.

guarantee a satisfactory power supply. This was substantiated during the war, when some of the industries were shut down or operated only on part time because of the power shortage.

A unique feature of the power plant, shown at *X* in the headpiece, is the high speed at which most of the machinery operates. The 1,000-kw. turbo direct-current generators have a speed of 1,700 r.p.m.; 1,000 hp. blowers, 8,500 r.p.m., and the turbines driving the condenser pumps run 5,700 r.p.m.; there are also a number of other high-speed turbine-driven pumps. Out in the plant there are three 90-hp. direct-current motors direct-connected to blowers that operate at from 2,300 to 3,600 r.p.m. These blowers have a normal capacity of 7,500 cu.ft. and a maximum capacity of 12,000 cu.ft. of free air per minute raised to 1.75 lb. pressure. The only reciprocating unit of importance in the plant is the 200-hp. air compressor shown in the foreground, Fig. 2.

The adoption of direct current was largely influenced by the heavy crane load, which makes up a considerable part of the current consumption in the entire plant. An additional factor in the advantage of direct current was the desirability of using series-wound motors for tilting the copper converters and adjustable-speed, field-control motors for driving the cupola blowers, in which a considerable variation in speed and pressure was necessary.

COAL HANDLING EQUIPMENT

Coal for the power plant is received by rail and either stored in the yard adjacent to the plant or dumped from bottom-dump cars into a track hopper, from which it passes down through a coal crusher into a pit. From the pit the coal is elevated vertically by a bucket conveyor to the top of the coal tower and delivered upon a belt which conveys it over the firing aisle into a 200-ton steel bunker lined with brick on edge. A traveling automatic tripper unloads the belt into the bunker at any desired point. The coal-handling equipment has a capacity of about 50 tons per hour. When coal is to be stored in the yard it is unloaded from the cars with a yard crane and clamshell buckets, and is recovered in the same way. About 100 tons of coal is required per day in the operation of the entire plant, 50 per cent of which is used for steam generation and 50 per cent in the refining processes. In addition to the power-house coal bunker there is one of reinforced-concrete construction in the calcining building, 380 ft. in length, having a capacity of 1,000 tons. Coal for this building is handled in practically the same way as for the power plant.

COAL-FIRED BOILERS

In the boiler plant there are four 400-hp. Babcock & Wilcox water-tube boilers equipped with chain-gate stokers. The boilers are set in batteries of two each, and space is provided for two additional units. All the boilers and stokers in the power plant were manufactured in Scotland. Although the coal used at this time is of no particular grade, being whatever may be purchased, it is possible to force the boilers up to 200 per cent of their normal rating. Each boiler has 196 tubes arranged 14 high by 14 wide, baffled for three passes (see Fig. 4). The front and rear headers are connected by two 42-in. steam and water drums. Each tube is 18 ft. long by 4 in. in diameter, giving the boilers each 4,390 sq.ft. of heating surface. The superheaters have

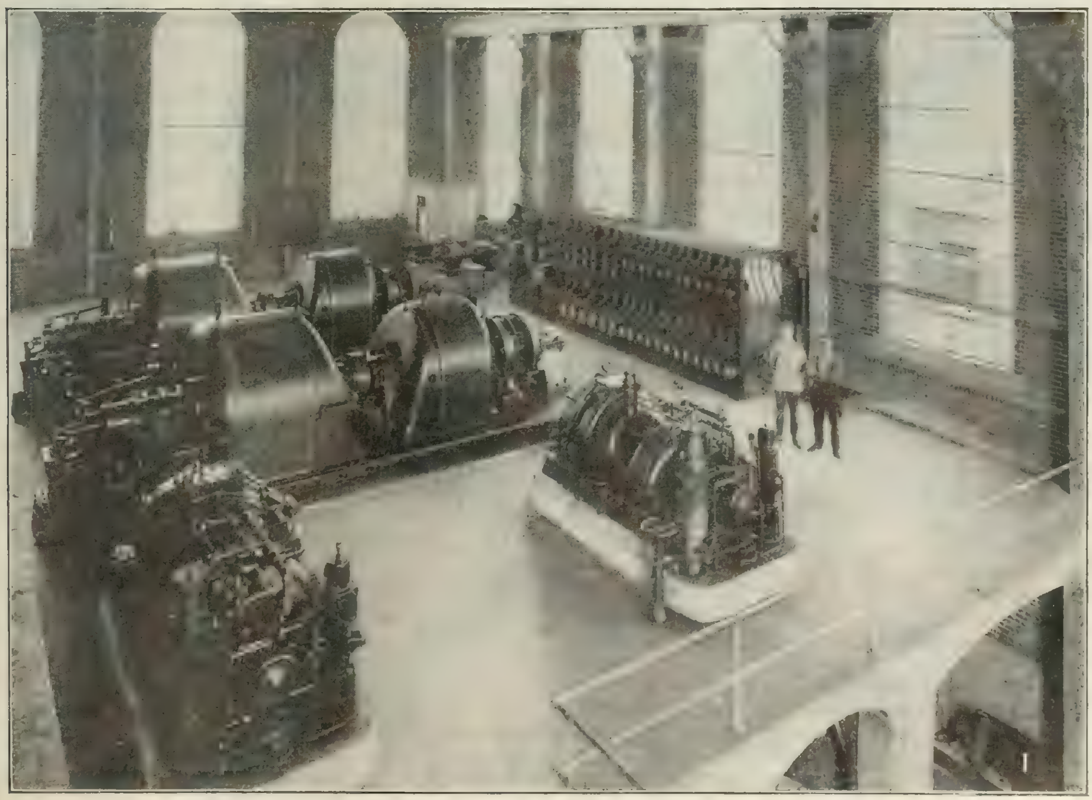


FIG. 1. VIEW OF MAIN GENERATOR ROOM, TURBO-BLOWERS IN FOREGROUND

770 sq.ft. of heating surface and are of particular interest since they differ in shape from those used in American practice, as is clearly indicated in the figure. A reinforced-concrete chimney 175 ft. high by 8 ft. inside diameter furnishes the draft for the boilers. The draft for each boiler is controlled through dampers in the downtake by automatic damper regulators.

Located under the boiler-room floor at the rear of the boilers is the concrete flue, lined with brick, connecting to the chimney, which is outside of the boiler room. The chimney is brick-lined for approximately one-third its height.

Coal from the bunkers is delivered through chutes to the hoppers on the front of the stokers, which are belt-driven from a lineshaft operated by an adjustable-speed motor, as shown in Figs. 5 and 6. The speed of the stokers can also be controlled by diffierential gears. The coal in passing into the furnace is carried under a coking arch 7 ft. long and 2 ft. high; by this means it is possible to obtain practically smokeless combustion at all loads. Although economizers are not used, the gases go to the chimney at a temperature of about 450 deg. Each stoker has an active grate area of 7 by 12 ft., or 84 sq.ft., giving a ratio of grate area to boiler-heating surface of 1 to 52.

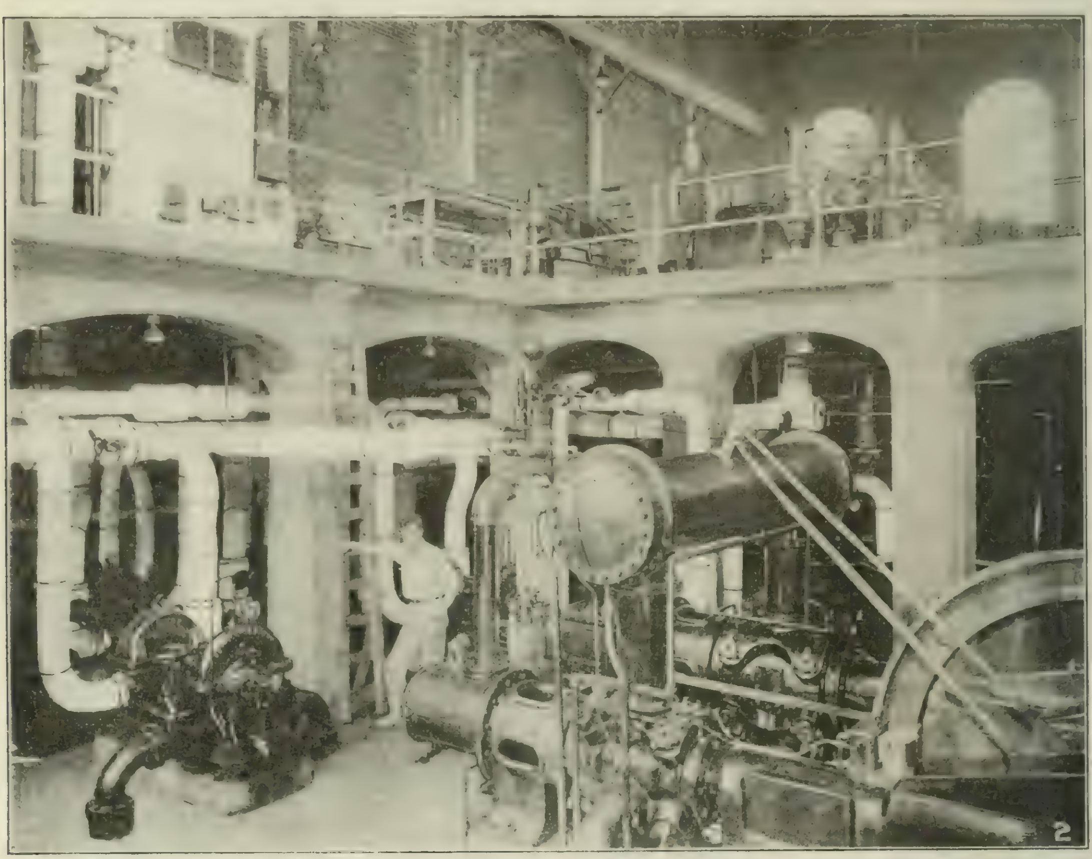


FIG. 2. VIEW OF PUMPROOM BELOW AND GENERATOR ROOM ABOVE

Ashes from the stokers fall into reinforced-concrete brick-lined hoppers from which they are dumped into a small side-dump car and are run through a tunnel to the coal tower and dumped into a pit from which they are elevated into a concrete bin in the tower. At given intervals the ashes are delivered to railway cars and are hauled away.

WASTE-HEAT BOILERS

In the nickel-refining plant, shown to the left of the water tower in the headpiece, are two 400-hp. American B. & W. waste-heat boilers, Fig. 3, each having 260 tubes 4 in. by 18 ft., arranged 10 wide and 26 high, baffled for three passes and equipped with superheaters. Gases from two refining furnaces pass through these boilers, one boiler on each furnace. One furnace is usually in service when the other is down for relining; thus only one boiler is in operation at a time. The waste-heat boiler allows the taking out of service of one unit in the power plant. Each boiler is served by a concrete chimney 100 ft. high. Additional draft, to overcome the frictional resistance through the boilers, is obtained by an induced-draft fan driven by a 35-hp. adjustable-speed motor. In this installation the gases go to the chimney at a temperature of around 650 to 680 deg. F. In addition to those which serve the boilers, there are two reinforced-concrete chimneys, each 350 ft. high by 12 ft. inside diameter at the top; these are used in connection with the cupolas and the reverberating and roasting furnaces in the process buildings. When the gases leave the nickel-refining furnaces, they pass through a series of chambers located in the underground flues between the furnaces and the boilers, where they drop a large percentage of the solid materials from them before they go to the boiler. In addition to this the boiler tubes are blown down every eight hours, and as a result no difficulty has been experienced from deposits on the outside of the tubes.

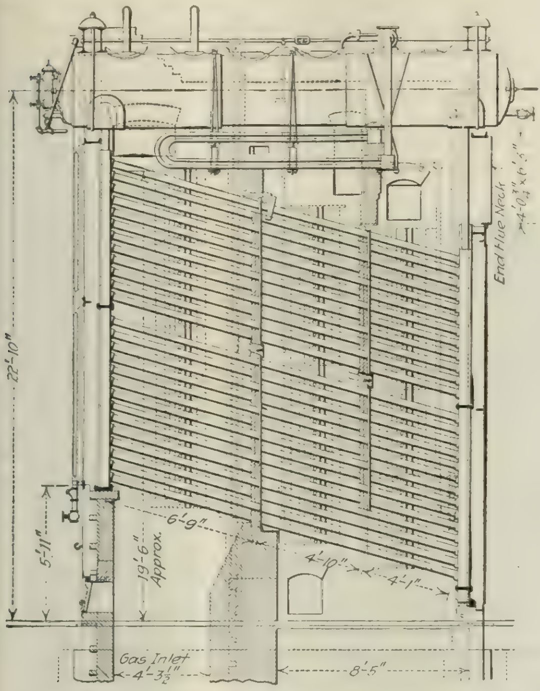


FIG. 3. SECTION THROUGH WASTE-HEAT BOILER

All boilers operate at 150 lb. gage pressure and are connected into two steam headers, one 3½ in. in diameter for saturated steam and the other 10 in. in diameter for superheated steam. Large quantities of saturated steam are reduced from boiler pressure down to from 50 to 10 lb. through reducing valves, for use in the refining processes. Steam at 10-lb. pressure is also used during the winter months in the heating system of all buildings requiring heat, such as offices, clubrooms, washrooms, etc.

Power-Plant Equipment

Adjacent to the boiler plant is the turbine room, on the main floor of which (Fig. 1) are two 1,000-kw. 250-volt, 4,000-ampere, Rateau-Battu-Smoot Co. direct-current generators directly connected to Ridgway-Rateau steam turbines operating at 1,700 r.p.m. Space has been provided for one additional unit. For their size these are two of the highest speed direct-current generators in operation. The field frame of one of these units is shown in Fig. 7, and the armature in Fig. 8. A more detailed description will be given in a future issue. On the main turbine-room floor there are also two 1,000-hp. turbo-blowers operating at 8,500 r.p.m., of the same make as the generators. In addition to these are the main switchboard of 13 panels, 2 balancer sets for the 250-125-volt three-wire system, 2 open feed-water heaters and meters, also gage boards on which are mounted instruments to give steam, air and oil pressure. Under the main floor of the turbine room, Fig. 2, are located all auxiliaries, including the boiler-feed pumps, consequently there is no equipment under the boiler room except the ash car. This arrangement isolates all moving machinery from the ash and coal dust of the boiler room, which greatly reduces the amount of work required to keep them clean and in good operating condition.

Steam enters the main turbines at 150 lb. pressure and 100 deg. F. superheat, or a total temperature of 466 deg; and is exhausted down to 28.25 in. vacuum through Westinghouse Le Blanc jet condensers. The condenser pumps are of the rotating type, mounted on the same shaft, and are driven by 31-hp. turbines operating at 5,700 r.p.m., geared down to the speed of the pump. Each condenser is capable of handling 17,500 lb. of exhaust steam per hour and maintaining a 29-in. vacuum with 40-deg. cooling water. Condensing water is taken from the cold well running under the center of the pumproom. The condenser water discharges into a hotwell or conduit, which discharges into the storm sewer and thence into Lake Erie, about one-half mile away.

In the foreground of Fig. 1 are shown the two 1,000-hp. 8,500-r.p.m. turbo-blowers used for supplying air to the furnaces converting matte into blister copper. Each of these units has a capacity of 15,000 cu.ft. of free air per minute raised to 15 lb. pressure. The turbines driving these blowers operate on steam at 150 lb. gage and 100 deg. F. superheat and also exhaust into Le Blanc jet condensers which are capable of condensing 11,000 lb. of steam per hour and maintaining a vacuum of 29.05 in. with condensing water at 40 deg. F. A 21-hp. geared turbine is used to drive the air and cooling-water

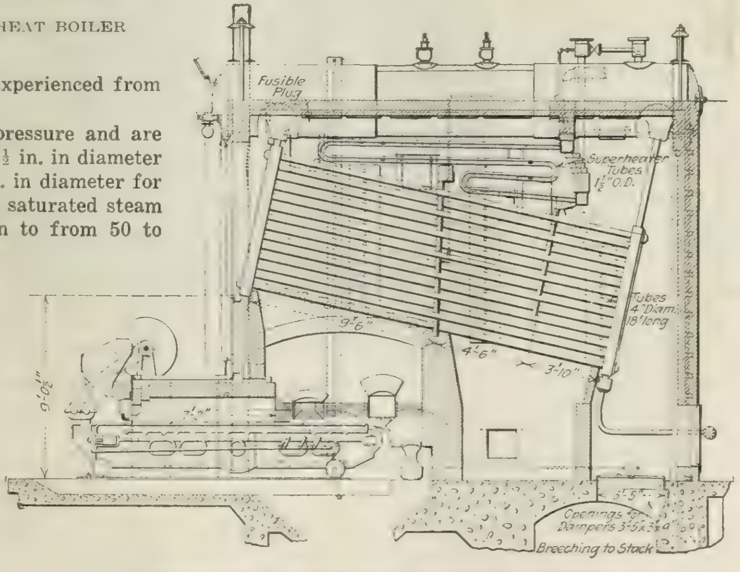


FIG. 4. SECTION THROUGH COAL-FIRED BOILER

pumps on these units. All main bearings of the blower units are force-lubricated and water-cooled. A comparison of the size of the blower unit with the men standing in Fig. 1 will give some conception of the economy in space realized by the use of blowers operating at such high speeds over those of the old reciprocating type of blowing engine operating at slow speeds. (For a more detailed description of these blowers see Mar. 23, 1920, issue of *Power*, page 450.)

Three other blowers of special interest are those used to supply air to the nickel and copper cupolas. Each of these blowers has a normal capacity of 7,500 cu.ft. of free air per minute raised to 28 oz. pressure and is directly connected to a 90-hp. motor operating at speeds from 2,300 to 3,600 r.p.m. These units are also of the Ridgway-Rateau make. The generators are of the two-wire type, but a three-wire lighting system was installed throughout the plant, with two motor-generator balancer sets for taking care of the unbalanced lighting load. The manual operation required to place one of the balancers on the line consists merely in closing a double-pole switch on the balancer panel in the main switchboard. This brings into action an automatic motor starter, and after the machine has come up to speed an automatic switch is closed in the neutral lead, placing the unit on the line. An inverse time-limit overload relay is connected to the automatic single-pole switch in the neutral lead, adjusted to trip in 20 sec. at 400 per cent load, for the protection not only of the balancer sets, but also of the lights about the plant.

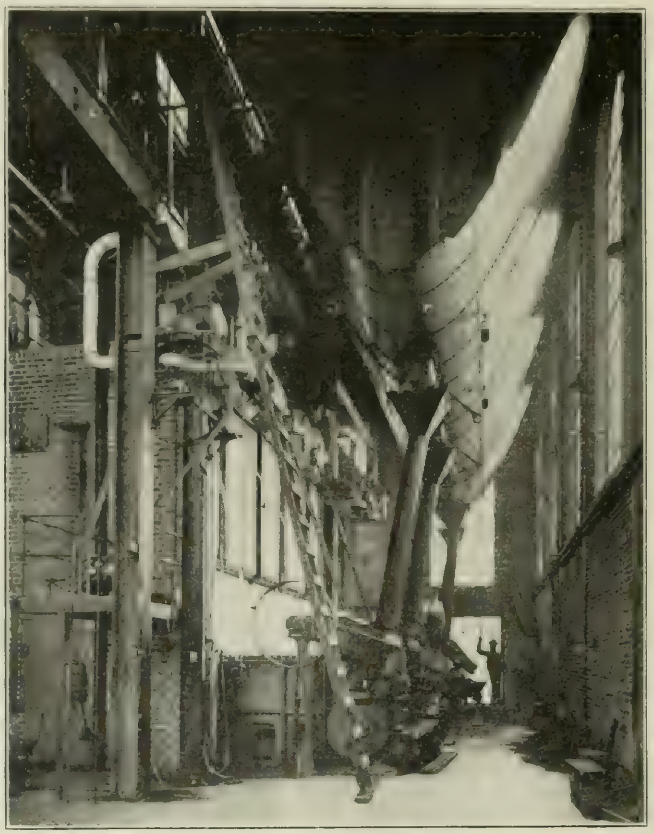


FIG. 5. FRONT OF BOILER ROOM, SHOWING COAL BUNKERS AND STOKERS

An emergency lighting system is provided for the power plant. The lamps in this system are neither as large nor as numerous as those in the regular 110-volt lighting system, but they are distributed at all necessary points in the turbine room, pumproom, and boiler room. The current for these emergency lights is obtained from a duplicate installation of 32-volt storage batteries. This system is automatic and in the event of failure for any reason of the regular lighting system in the power plant the closing of an automatic switch cuts in the emergency lights. The storage battery also serves other purposes about the power plant.

The thermodynamic problems involved in the design of this plant were of considerable interest and of great importance in regard to possible savings in fuel. A large quantity of circulating water is used in the calciner building for cooling the rabbles in the mechanical calcining furnaces, and large quantities of hot water are used in the vats in the leaching building. The problem was to raise the temperature of this circulating water to approximately boiling point with the use of a minimum quantity of steam and, of course, preferably by using exhaust steam. It was also necessary to soften the water, not only for the leaching processes, but also for boiler-feed purposes as well. The short length of the hand calciner furnaces as compared with the mechanical furnaces afforded ample room for the installation of the water-softening system in the calciner building. This system was built and installed by William B. Scaife & Sons Co., of Pittsburgh, Pa., and consists of three large treating tanks and one small filter tank, all of wood-stage construction, and was designed for treating hot water. Circulating water is discharged from the rabbles in the five mechanical calcining furnaces at an average temperature of 160 deg. F. and flows by gravity through a main to the pump pit near the treating tanks. In this pit are three motor-driven centrifugal pumps, which are used to deliver the raw water into the treating tanks and the treated water to the power house. The piping is so arranged that any one of the three pumps can be used for either service, and as only two pumps are required to do the work the third is held in reserve as a spare unit. A storage reservoir, built of reinforced concrete, is provided at one side of the pump pit. This is divided into halves, one side being used for raw water and the other for treated water; both reservoirs are on the suction side of the pumps. Treated water is carried through a 6-in. pipe from the calciner building through an underground tunnel into the power house and up through the turbine-room floor to the water heaters. There are two open-type heaters, built by Warren Webster & Co. and equipped with Lea V-notch meters and recorders. The larger of these heaters has a capacity of 200,000 lb. of water per hour, raised in

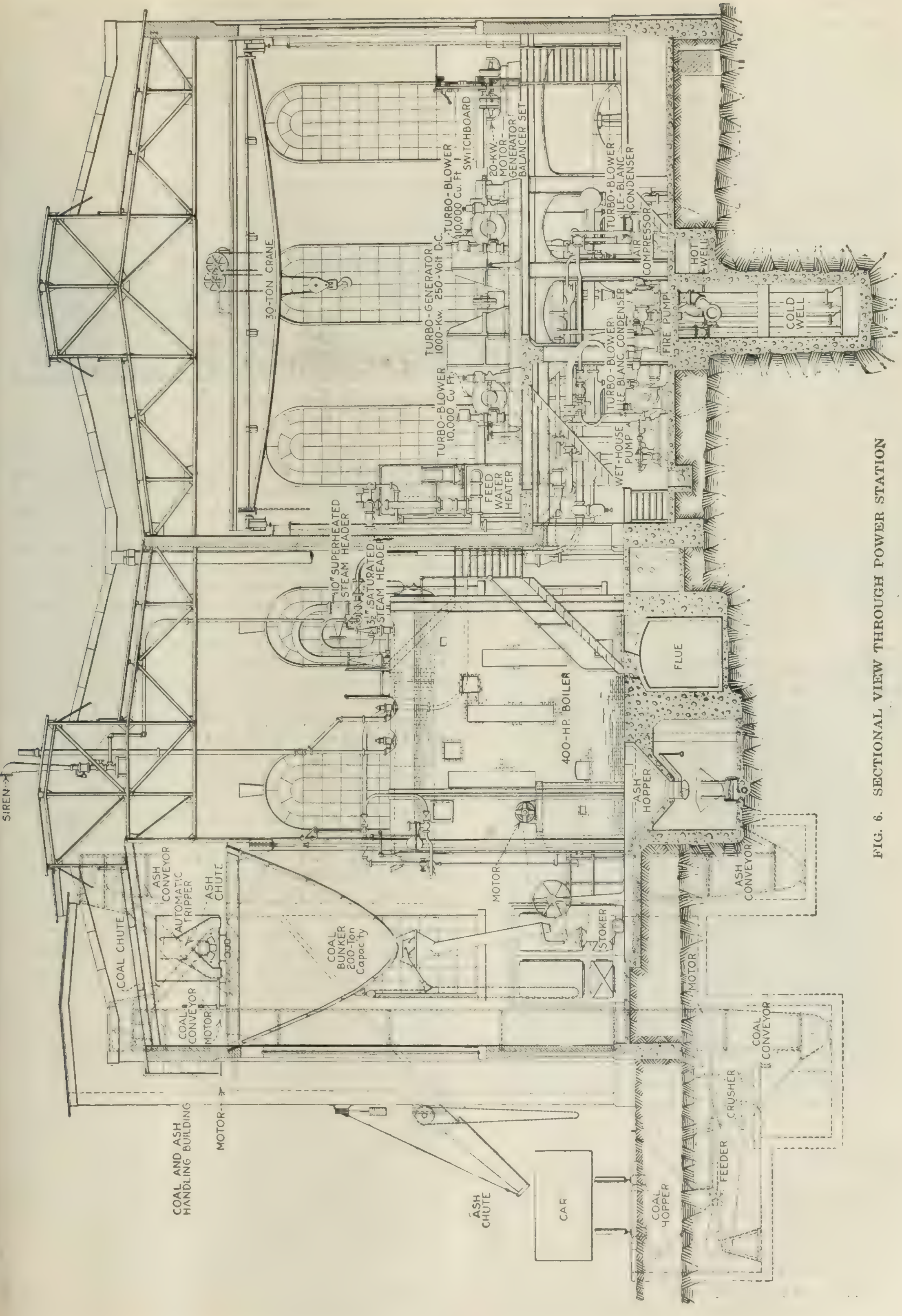

SIREN
30-TON CRANE
TURBO-GENERATOR 1000-Kw. 250-Volt D.C.
TURBO-BLOWER 10,000 Cu. Ft.
SWITCHBOARD
20-KW. MOTOR-GENERATOR BALANCER SET
TURBO-BLOWER 10,000 Cu. Ft.
TURBO-BLOWER LE BLANC CONDENSER
AIR COMPRESSOR
HOT WELL
TURBO-BLOWER LE BLANC CONDENSER
FIRE PUMP
COLD WELL
TURBO-BLOWER LE BLANC CONDENSER
WET-HOUSE PUMP
FEED WATER HEATER
10" SUPERHEATED STEAM HEADER
3 1/2" SATURATED STEAM HEADER
FLUE
400-HP. BOILER
ASH HOPPER
MOTOR
ASH CONVEYOR
STOKER
ASH CONVEYOR
AUTOMATIC TRIPPER
ASH CHUTE
COAL CHUTE
COAL BUNKER 200-Ton Capacity
COAL CONVEYOR
MOTOR
MOTOR
COAL CONVEYOR
CRUSHER
FEEDER
COAL HOPPER
CAR
ASH CHUTE
MOTOR
COAL AND ASH HANDLING BUILDING

FIG. 6. SECTIONAL VIEW THROUGH POWER STATION

temperature from 150 deg. to 210 deg. F. and supplies the hot water for the leaching tanks. Two turbine-driven centrifugal pumps in the pumproom are used for pumping this water to the leaching building. The smaller heater has a capacity of 80,000 lb. of water per hour under similar conditions of temperature and is used for heating the feed water for the boilers in the main power house and also for the waste-heat boilers in the refinery building. The difference in elevation between the pumps and the heaters insures a static head of about fifteen feet at the suction inlet to the pumps.

Exhaust for Heating Water

In the pumproom there are eleven small turbines. Four of these drive the pumps of the Le Blanc condensers used in connection with the turbo-generators and turbo-blowers. Two drive the main water-supply pumps, two the boiler-feed pumps, two the hot-water pumps, and one the fire pump; all these pumps being of the centrifugal type. In addition there is a cross-compound air compressor developing about 200 indicated horsepower at rated capacity.

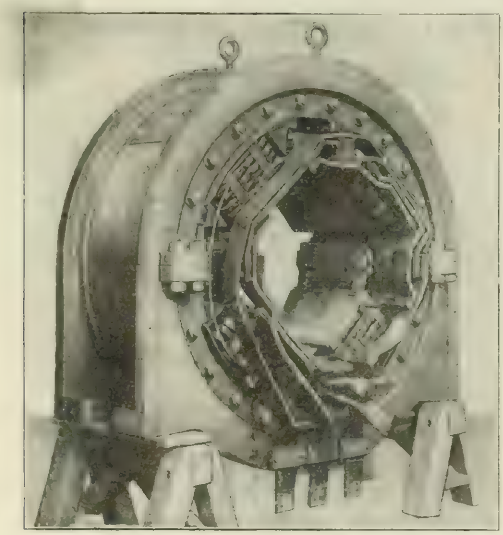


FIG. 7 DIRECT-CURRENT GENERATOR FIELD FRAME

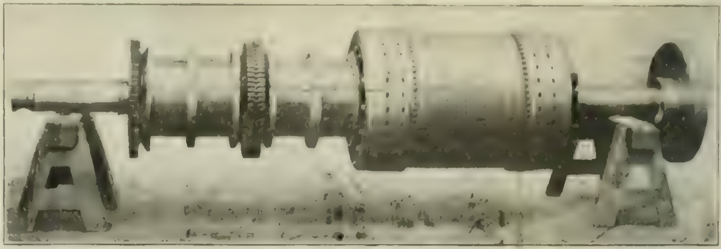


FIG. 8 DIRECT-CURRENT GENERATOR ARMATURE

Exhaust pipes from all these small turbines are connected into a main that runs through the pumproom, near the boiler room wall. A 12-in. branch rises from this main through the turbine-room floor and is connected into both water heaters through a single tee and two gate valves. Thus the exhaust steam from the pumps is used for heating all the hot water for the plant. On the bottom of each of the turbines driving the 1,000-kw. generators are two bleeder connections, and each of these is piped into the exhaust main. A 5-in. high-pressure bleeder connection is taken out of the third stage of the turbine, in which the pressure never goes below 15-lb. gage under any condition of operating load, and an 8-in. low-pressure bleeder connection is taken into the sixth stage of the turbine, in which the pressure never exceeds atmosphere. Automatic control valves in the low-pressure bleeder connections are adjusted for whatever back pressure it is desired to carry in the exhaust main connecting the auxiliary turbines and open heaters. Should the exhaust steam exceed the amount required to heat the water to the temperature corresponding to the back pressure, these valves open and permit the surplus steam to enter the main turbines, where it is expanded through four additional stages. If the quantity of exhaust steam from the small turbines is less than that required to heat the water, the pressure in the exhaust main drops, permitting other automatically controlled valves in the "high-pressure" bleeder connection to open and pass sufficient steam to make up for the deficiency. In this way an entirely closed system is obtained without loss of steam, and all surplus exhaust steam is made to do useful work in expanding from atmospheric pressure to the pressure in the condensers. The exhaust from the air compressor is connected into the low-pressure bleeder connections, closely adjacent to the bottom of each turbine, so that any cylinder oil in the exhaust steam may be prevented from entering the exhaust main and finding its way into the feed water or leaching water.

It is obvious that the low-pressure bleeder connections are not under control of the governors on the main turbines; consequently, if a heavy ground or short-circuit should occur anywhere about the plant, sufficient to blow the main circuit breakers in the generator leads, and if at the same time the turbine was bleeding in a considerable quantity of surplus exhaust steam, the unit would be in imminent danger of running away. The turbines are of course provided with overspeed trips, but these control butterfly valves in the main steam pipe and have no connection with the bleeder valves. To guard against a contingency of this kind an automatically controlled motor-driven valve, power for which was supplied from the storage battery, was provided for in the original design, in each of the low-pressure bleeder connections, so that in the event of loss of voltage the motor would be started and close the valve, thus diverting the surplus steam through the atmospheric relief valve. However, the bleeder on the turbo-generators was not placed in service at the time of installation due to the large quantities of high-pressure steam required in the leach house under forced production. Owing to the increased cost of coal since the plant was put in operation, it has been decided to dispense with high-pressure steam in the process, and use hot water from the large heater in the power house. This necessitates using the bleeders on the turbo-generators to give a sufficiently high temperature, so that all exhaust steam is used either in the feed water or the process with a make up from the turbo-generators. The exhaust from the air compressor is now carried to the heaters with an oil separator placed in the line to prevent oil from entering the feed water.

METHOD OF SUPPORTING MACHINERY

The method of supporting the turbo-generators and turbo-blowers is rather unusual, but has some marked advantages in the saving of concrete and the gaining of additional space around the condensers which might otherwise be occupied by heavy foundations. Each generating unit is carried on eight reinforced-concrete columns, 24 in. square, four columns under each side. A continuous girder runs longitudinally under each side, tying the columns together, but the space between these girders, under the turbine and the generator, is almost entirely open. The condenser is set directly under the exhaust opening at the bottom of the turbine.

Each turbo-blower is carried on two reinforced-concrete girders extending 30 in. below the floor line and with a clear span between columns of 15 ft. The entire floor is a reinforced-concrete slab 12 in. thick, and the complete construction of walls, columns, girders and floors is monolithic, without the provision so frequently employed of separating the machinery foundations from the building construction. It should be said not only to the credit of the designers and builders of the plant, but also to the credit of the builders of the turbo-generators and turbo-blowers, that there is no perceptible vibration in the floor or other parts of the building.

WATER-SUPPLY FOR THE PLANT

The water supply for the entire plant and the main air ducts to the turbo-blowers and to the generators are incorporated in this general construction. A cold well 16 ft. deep extends the length of the building under the pumproom floor. Running crosswise of the generating units, it passes directly under their condensers and between the condensers for the turbo-blowers. The supply pumps for water distribution throughout the plant, the fire pumps and all the condensers have their suction lines extending into this cold well, to a depth below the minimum lake level. An underground intake conduit 4 ft. square, cut partly in solid rock and lined with concrete, extends to a screen chamber at the side wall of the Welland Canal, more than half a mile away. Through this conduit the entire water supply for the plant flows by gravity; up to 50,000,000 gal. per day may be obtained.

At the power-house wall, where the intake culvert enters the cold well, is a sluice gate operated by hand from the pumproom floor. In case of extremely high water, which might occur during a severe storm from the southwest, this sluice gate may be partly closed to control the water level in the cold well. On the wall facing the gate wheel is an indicating liquid-level gage, showing the elevation of the water in the cold well. This gage is graduated to show the elevation above sea level and is equipped with both high and low water alarms which close a circuit to an electric gong.

The air supply to the turbo-blowers and turbo-generators enters the cold well at the end of the building opposite the water inlet, through a 66-in. ventilator supported on a circular well curb just above the ground level. Passing over the water, air is taken into the blowers and generators through elbows cast in the concrete and thence through galvanized-iron ducts which rise vertically from the floor to the inlets on the bottom of the machines. The discharge of warm air from the generators is handled in a similar manner, vertical ducts carrying the air from the discharge outlet on the bottom of the machine through the pumproom floor, where they pass into the hotwell and to the open air through one end of the building. These discharge ducts have dampers that may be set to divert any part or all of the warm air from the generators into the pumproom, thus heating this room and the turbine room in severe weather.

To prevent freezing of the water in the cold well in winter, due to a large volume of cold air passing over its surface, provision is made for diverting into the cold well any part of the discharged cooling water from either of the condensers serving the turbo-generators.

This article would not be complete without some reference to the sanitary system. All sewage is discharged to a disposal plant, located in the sand dunes near the shore of Lake Erie, and constructed on the activated-sludge process. This process provides for the äeration and clarification of the sewage, and the effluent is free from all objectionable matter. The air supply for the activated-sludge chamber is taken from the underground main through which air is supplied to the converters by the turbo-blowers in the power house. It is obvious, therefore, that the operation of this system is highly economical. The installation was made on the recommendation of the Provincial Board of Health of Ontario and has resulted in entirely eliminating any polluted water from the plant being discharged into Lake Erie.

Semi-Diesel and Hot-Bulb Engine Suggestions

Don't use a lubricating oil that does not flow readily. If very viscuous, the oil may fail to reach the crankpin.

When a crankpin bearing heats, it should be removed and the babbitt dressed. Examine the oil holes through the pin, for the melted babbitt frequently closes up the oil passage.

Semi-Diesel engines frequently gum the piston rings. If the fuel oil is heavy, the piston and rings will require cleaning every sixty days or less.

In removing rings don't extend them too far. Rings are very brittle, being cast iron. If four thin strips are inserted between the ring and piston, the removal is easy.

Don't have more than 0.01 inch play between the ring and the side of the groove. If it is more, the ring and groove will wear very rapidly. If the groove is worn, turn it up on a lathe and use wider rings.

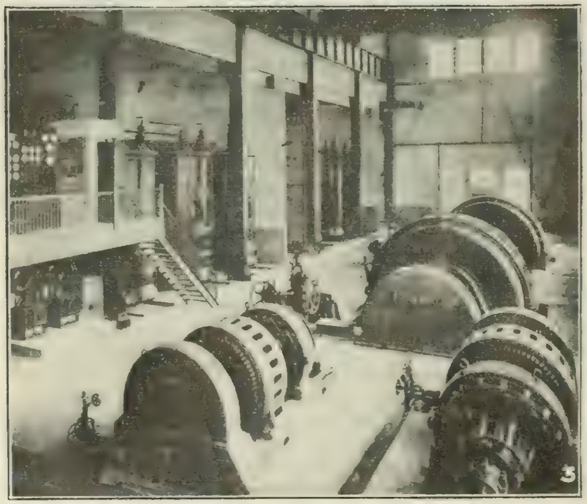
Fire-cracks in the piston head are best repaired by sewing.

If the engine pounds although the connecting-rod bearings are snug, probably the piston "slaps" because of wear. This "slap" will be quite violent if the piston and crankpin bearings are not in line.

No carbon deposits should be left on the piston head. Frequently, this carbon becomes intensely hot and will cause preignition.

If the engine pounds in the cylinder, the noise may be produced by either late ignition or preignition. If the former, the sound is dull, while early ignition causes a sharp metallic sound. Unless the preignition results in loss of power, it is not detrimental. In fact, usually the highest efficiency is secured while the engine is preigniting lightly.

Some Views of Pacific Gas and Electric Company's Properties, San Francisco, Cal.



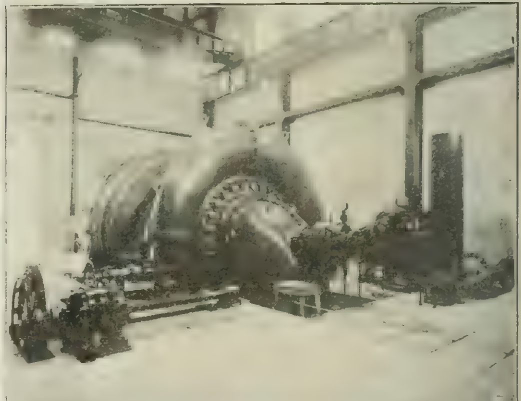


FIG. 1. "PACIFIC SERVICE" FLUME IN BUTTE CREEK CANYON CARRYING WATER FROM DE SABLE POWER HOUSE TO CENTERVILLE POWER HOUSE, EIGHT MILES DOWNSTREAM. FIG. 2. PACIFIC SERVICE STEAM ELECTRIC STATION ON SACRAMENTO RIVER. FIG. 3. INTERIOR DRUM POWER HOUSE. FIG. 4. THE WISE POWER HOUSE, 16,500 HORSEPOWER CAPACITY. FIG. 5. DRUM POWER HOUSE IN BEAR RIVER CANYON, CAPACITY 33,500 HORSEPOWER. FIG. 6. INTERIOR WISE POWER HOUSE

Overhead Arc Welding—Theory and Practice

Overhead Arc Welding Entirely Practical if Operator Understands Principles—Investigation of Failures of Welded Firebox Seams Has Resulted in the Conclusion that the Operators Were Unfamiliar with the Basic Requirements—Theory of Metal Deposition on Overhead Welds Explained—Results Given of Tensile Tests Made on Sections Cut from Overhead Welds

By O. H. ESCHHOLZ
Material and Process Engineer, Westinghouse Electric and Manufacturing Company

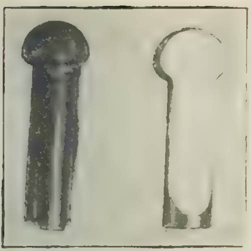


FIG. 1. LIQUEFIED GLOBULAR END OF WIRE ELECTRODE

A UNIQUE and important property of the metallic-electrode arc-welding process is the ability to deposit metal at will either on a flat (downward), vertical or overhead surface. Under the extreme condition of overhead deposition, when the force of gravity is opposing metal transfer, greater manipulative skill is required than when gravity partly or completely assists deposition, as in vertical or downward welding. The degree of skill required for overhead welding, however, is not prohibitive when the operator has been properly instructed in the characteristics and manipulation of the arc.

The enlarging field of welding has increased the demand for overhead welds, the most typical of which are encountered in locomotive, ship, tank and building construction. Many such welds are now giving excellent service. Examination of occasional failures reveals, as their primary cause, an improper use and manipulation of welding materials due chiefly to inferior or indifferent operators. In the repair of locomotive fireboxes it has been common practice to autogenously weld the overhead butt joint between the crown and flue sheet. The service records of many such welds clearly demonstrate the adaptability and value of the arc process. Nevertheless, owing partly to the greater skill required and partly to the characteristic exaggerated conception of ability possessed by undeveloped welders, unsatisfactory fusion may result when adequate supervisory control is lacking.

The failure in service of overhead autogenously welded firebox seams may involve a serious life hazard. Investigation of the few failures on record by members of the American Welding Society has resulted in the conclusion that the operators were unfamiliar with the basic requirements for obtaining fusion and preventing slag inclusions. It is evident that partly fused structures heavy with slag content are not welded and will rupture suddenly without appreciable elongation on the application of a small load. To prevent such isolated instances from retarding the normal growth of overhead arc welding, a wider dissemination of knowledge concerning the factors determining weld characteristics, welding procedure and inspection should be encouraged.

MECHANISM OF METAL TRANSPORT

Overhead deposition is chiefly dependent upon arc phenomena overcoming gravitational force acting on the material of the pencil electrode. The facility with which deposition is accomplished is a function of arc current and arc length, as well as choice of electrode diameter and electrode material.

Upon establishing an arc between an overhead surface and a suitable wire electrode, the material at each arc terminal is liquefied. The metal at the positive, or plate, terminal forms a pool, while that at the wire, or negative, terminal develops rapidly into a globule. Fig. 1 shows the appearance of the surface and section of a globule formed on the electrode end. This globule, however, is too large to facilitate deposition; that shown in the arc photograph, Fig. 2, is more typical of good practice. To convey this globule to the plate, the lifting force must exceed the retaining forces of gravity, cohesion and surface tension at the wire perimeter. Obviously, the problem of transferring the globule may be simplified by decreasing the forces tending to retain it on the electrode end. By producing only small globules, the weight of liquid metal may be held low. As the size varies, within limits, with arc length, the maintenance of a short arc of from $\frac{1}{16}$ in. to $\frac{3}{32}$ in. will therefore insure a controllable globule weight. Other factors determining the magnitude of the total retaining force are the unit surface tension, unit cohesion and the contact area between the liquid globule resting on the solid end of the pencil

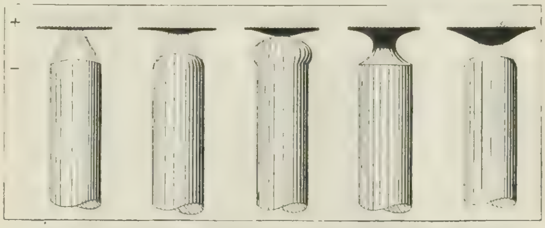


FIG. 4. SEQUENCE OF DEPOSITION PHENOMENA IN OVERHEAD WELDING

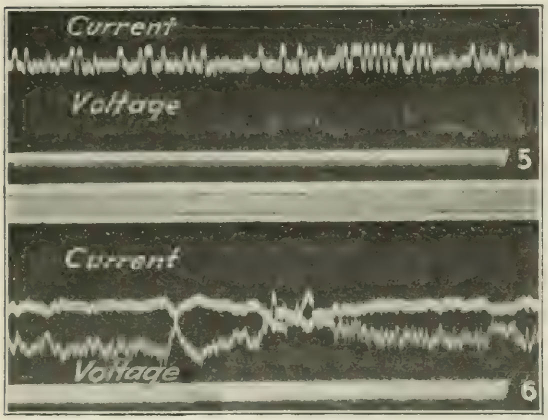
FIGS. 2 AND 3. APPEARANCE OF ARC STREAM, DEPOSITED MATERIAL AND ELECTRODE END

Fig. 2—Shows a short arc and the globular end of the electrode as well as the layer of deposited metal. Fig. 3—Long arc. No deposited metal is evident.

electrode. The surface tension and cohesion between the solid wire and its molten end is decreased by the presence of solid, liquid and gaseous impurities at the boundary. Quantitative information on this subject is not available. Experience, however, has shown that these forces are reduced by the phenomena occurring when small quantities of iron oxide, iron carbide, manganese, etc., and occluded gases are present in the electrode during the deposition process.

The total surface tension and the total cohesive force are proportional to the area of contact between the liquid and solid or plastic metal. It is obvious that these decrease with the diameter of the electrode and also with the total energy developed, and therefore with the arc current. The facility with which the electrode surface becomes "wetted," thereby affecting the contact area, varies with its analysis, melting temperature, physical properties of the surface and the current density. A satisfactory evaluation of the importance of all these factors has not been made, although it is well known that different types of electrodes employed for downward deposition vary greatly in their "wetting" action and therefore in their characteristic retaining force and ease of overhead deposition.

From this analysis it is evident that when the supervisor determines the material, size of electrode and welding current to be used, the only variable affecting the magnitude of the retaining force controllable by the operator is the arc length. Skill in the maintenance of the proper arc length may be readily developed while a check on its continuous employment may be secured by the meter indication of arc voltage or the ringing of a buzzer connected across the arc when the maximum permissible arc length has been exceeded.

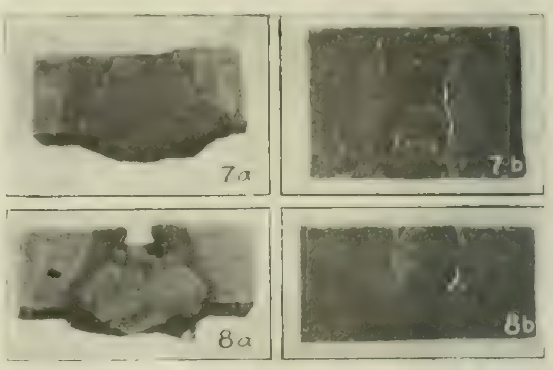


FIGS. 5 AND 6. EFFECT OF HOLDING A SHORT AND A LONG ARC ON VOLTAGE AND CURRENT

The lifting force is, comparatively, a fixed quantity, since the material and thermal characteristics of most overhead joints vary but little. The total lifting force is a function of the surface contour and of the area puddled by the positive crater. It is also dependent upon the "wetting" characteristic, which facilitates the adhesion and spread of the electrode globule on making contact with the puddled surface. The rate at which the plate metal absorbs heat energy from the deposited metal determines the rate of congealing of the electrode metal and therefore is a factor in determining the magnitude of the lifting force. Heating an overhead joint very locally, facilitates starting layer deposition, since it facilitates the initial production on a cold plate of a "wetted" surface to which the globule must be attached by the forces of surface tension and adhesion. However, if the joint temperature is uniformly increased to a high value, deposition will be retarded since the rate of congealing of deposited metal is decreased. The cycle of deposition appears to be as follows:

1. Metal at each terminal is liquefied upon striking an arc.

2. The molten electrode end assumes an approximately spherical form due to the well-known phenomena of surface tension causing a fluid material to contract into the smallest volume.



FIGS. 7 AND 8. CORRECTLY AND INCORRECTLY FUSED ABUTTING MEMBERS

Fig. 7a—Initial layers of weld completely fused. Fig. 7b—Surface view of Fig. 7a. Fig. 8a—Incomplete fusion of initial layers. Fig. 8b—Surface view of Fig. 8a.

3. This globule enlarges with continued application of energy, until with the aid of electrode manipulation its upper surface is brought into contact with the overhead pool, thereby short-circuiting the arc stream and causing the lifting forces to act upon it.

4. Forces of surface tension and adhesion, at the contact area between the overhead plate and the globule, cause the globule to change its form and spread over the plate surface.

5. As the metal spreads, the area in contact with the plate increases and therefore the lifting forces are also increased, causing an acceleration in metal transfer. These forces act until the globule is lifted off the wire electrode end, when the short-circuit is broken and the arc re-established.

This deposition sequence is shown graphically in Fig. 4. In Figs. 2 and 3 short ($\frac{3}{32}$-in.) and long ($\frac{5}{32}$-in.) arcs are shown respectively. Bare mild-steel electrodes were used for the deposit tests. The globular growth is visible on both electrode ends. However, the short arc employed in Fig. 2 permits, with the electrode manipulation, bringing the surface of the globule readily into contact with the plate during the period when the retaining force is small. To bridge the arc gap shown in Fig. 3, a larger globule is required. The size of this globule produces a retaining force that exceeds the lifting force and thereby prevents metal transfer. With continued application of energy and the maintenance of such a long arc the accumulating liquid metal either drops off the end of the electrode or flows down its side.

In Figs. 5 and 6 are shown instantaneous variations in arc current and arc voltage when holding short and long arcs shown in Figs. 2 and 3. The instant at which the globular growth short-circuits the arc is identified when the arc-voltage record drops to nearly zero and the arc current attains maximum value. The frequency with which this occurs indicates that approximately 25 globules are being deposited each second. In Fig. 6 the voltage and current records indicate the normal variation in arc length as determined by electrode manipulation and globular growth, but they do not indicate contact between the plate and the electrode as shown in Fig. 5. The deposition rate is therefore nearly zero, only metal being deposited by the condensation of a small amount of metallic vapor. As the amount deposited is small, it is not visible on the plate surface shown in Fig. 3.

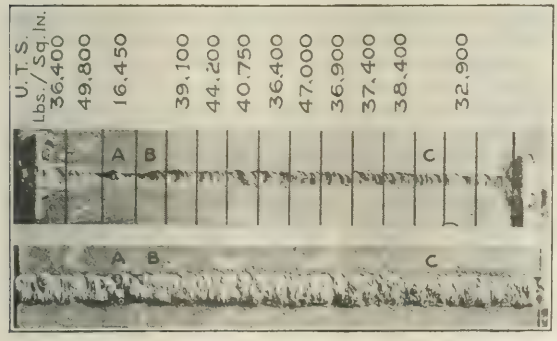


FIG. 9. APPEARANCE OF TOP AND BOTTOM OF OVERHEAD BUTT-WELDED PLATES

For instruction purposes, phenomena of overhead metal deposition may be readily simulated by employing a mercury analogy. This demonstration may consist merely in transferring a globule of mercury, resting in the cupped end of a steel rod, to an overhead amalgamated surface. When contact occurs between the globule and the amalgamated plate, mercury passes to the overhead surface with such speed that it appears to leap from the rod to the plate.

TRAINING OF OPERATORS

It is preferable to select candidates for overhead welding from operators who are competent downward welders. The first step in the training of such welders consists in demonstrating and explaining phenomena of metal transfer, the second step, the change in deposition facility with change in arc length, arc current, electrode diameter and electrode material. It will be found that the usual skilled downward welder is quick to appreciate and recognize the bearing of these factors on overhead deposition. Deposition skill should first be developed on a vertical surface, then on a plate inclined 45 deg. and finally on a flat overhead surface with the operator holding in each case, a short arc $\frac{1}{16}$ in. to $\frac{3}{32}$ in. or 18 to 20 volts, $\frac{1}{8}$ in. diameter bare mild-steel gas-free electrodes and an arc current of 100 amperes. The metal should be deposited in continuous layers on a $\frac{1}{8}$-in. thick plate. The employment of a light-weight electrode holder, designed to protect the operator from falling hot metal, as well as to remain cool in service with a minimum cable drag while holding the electrode perpendicular to the surface to be welded, will be found to both expedite and greatly facilitate overhead deposition.

Electrodes vary greatly in their overhead deposition characteristics. Metal may be deposited with some types at the rate of two globules a second; with others this may be as high as thirty a second. The penetration of the deposited metal into the plate appears, however, to decrease somewhat with increase in globular deposition rate. Owing to the facility whereby the surfaces of some types of electrodes become "wetted," the globular retaining forces are so large that overhead deposition is impracticable. In view of these differences in deposition performance the operator should become familiar with the characteristics and manipulation of a variety of bare and covered electrodes available on the market. To obtain fusion, it is necessary to secure penetration, crater depth, minimum overlap, etc., characteristic of downward deposition.

The use of a low current, of the order of 100 amp., produces a slow and easily controllable globular growth and deposition. After the operator succeeds in developing deposition control under this condition, arc current and electrode diameter should be gradually increased to values approximating those employed for downward welding. The operator, however, will then find that an electrode length of only six inches (approximately) will be readily deposited, the deposition of the remainder becoming increasingly difficult owing to the fact that the hot, inclosing convection currents of air and arc gases, as well as the internal energy consumption due to the resistance of the wire, serve to preheat the electrode and cause the melting rate of its terminal to increase. It has been found that the electrode may be kept comparatively cool, and therefore maintain an approximately constant melting rate throughout the deposition period, by giving it, as well as the arc terminal, either an oscillating or a circular movement. Such a movement disturbs the hot sheath of gas in contact with the electrode and permits the influx of cooling air. By employing this manipulative expedient, it is possible to deposit the metal continuously from 12-in. lengths of $\frac{1}{8}$-in., $\frac{5}{32}$-in. and $\frac{3}{16}$-in. diameter electrodes when employ-

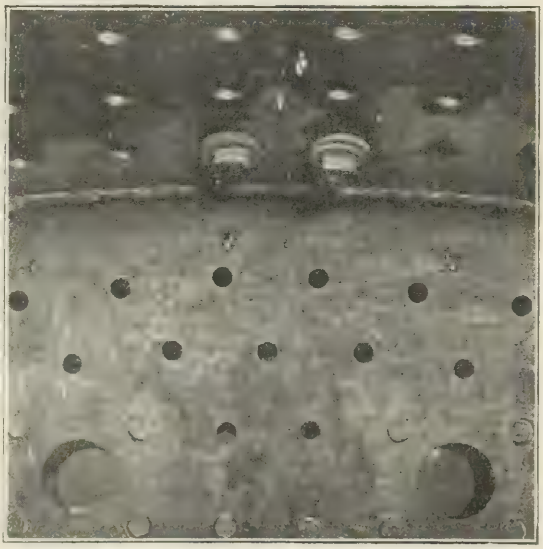


FIG. 10. OVERHEAD BUTT-WELD JOINING LOCOMOTIVE CROWN SHEET TO FLUE SHEET

ing are currents of respectively 125, 150 and 175 amperes.

Overhead welds are commonly butt or lap joints. In designing a structure, preference should be given to the lap joint because it is more easily welded. The overhead butt joint is prepared similarly to the downward butt joint. It is usually scarfed from 60 to 90 deg. and a "free distance" of from 1/16 in. to 3/32 in. separates the adjacent sections. To maintain these in place, the plates are tacked together at intervals of 2 ft., when the rigid assembly system is used, and the metal deposited in layers by the "step-back" method to avoid excessive heating of the plate and consequent high internal cooling stresses.

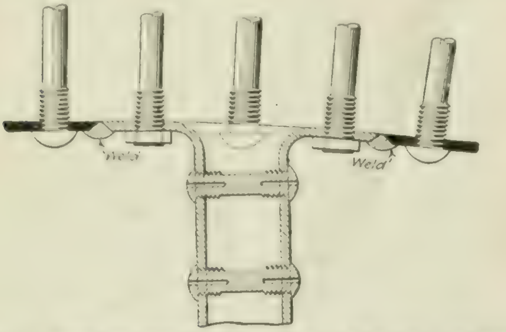


FIG. 11. SECTION THROUGH OVERHEAD WELDED CROWN SHEET AND SIPHON FLANGES, SHOWING POSITION OF WELDS

The successful welding of an overhead butt joint is chiefly dependent upon the completeness with which the initial layer fuses together the apex of the V. In Figs. 7a and 7b are shown sections through correctly fused abutting members. Figs. 8a and 8b illustrate the characteristic appearance of a section wherein the first layer failed to fuse the abutting plate edges. Such failure may be attributed to the indifference of the operator in controlling arc length and applying deposited metal, too low an arc current, and either too great or too small "a free distance." An inspection of the surface frequently reveals poor workmanship and suggests the cause.

In Figs. 7 and 8 are shown, respectively, the character of fusion obtained in zones *A* and *C* of the overhead butt-welded plates shown in Fig. 9. An examination of these exhibits shows that visual inspection of the joint during preparation and after completion may give a fair indication of the weld properties.

It is now recognized that in downward welding, layer and tier deposition of metal give the most satisfactory joint characteristics. This is due to the fact that each deposit is reheated by the superposed metal and then cools at a slower rate than if exposed fully to the atmosphere. This partial annealing serves to refine the grain and relieve internal cooling stresses. The writer therefore wishes to advocate a similar procedure for overhead welding, particularly as it is now general practice to completely fill the area between scarfed surfaces as the welder progresses along the joint. It is known that this procedure increases internal stresses, decreases ductility and facilitates warping of the structure.

The plates shown in Fig. 9 were welded after the operator had had but two days' practice in overhead deposition. After several days' further practice the same operator butt-welded ¼-in. and ½-in. boiler plates overhead, scarfed to 90 deg., employing mild-steel electrodes 5/32-in. in diameter, and 125 amperes. The results of tensile tests on strips cut from these plates are given in the table. These data show that a conscientious and properly instructed operator will produce overhead welds having characteristics comparable with those made in more favorable positions, and if the basic fusion requirements are observed by even a relatively inexperienced overhead welder, a quite satisfactory weld will be obtained.

In Fig. 10 is shown the usual overhead butt weld joining the crown sheet of a locomotive to the flue sheet. This type of weld should be intrusted only to skillful overhead operators, since a low water level in the boilers may subject a poor joint to excessive heating and stress. The demand for improvement in locomotive performance had led to the development of means for increasing the boiler capacity and efficiency, one scheme is to use thermic siphons extending from the crown sheet down into the firebox. The top flange of these siphons may be joined to the crown sheet by overhead butt welds. In Fig. 11 is shown a section through the crown sheet and siphon flange. The welds are placed midway between parallel rows of staybolts so that the crown stays carry the greater part of the load. The performance of ten locomotives equipped with arc-welded siphons by the Chicago, Rock Island & Pacific R.R. is being followed with great interest by welding engineers.

TEST DATA ON STRIPS CUT FROM OVERHEAD WELDED BOILER PLATE; WELDS UNMACHINED

Test No.	U. T. S. Lb. per Sq. In. ½-In. Plate	Per Cent. Elon. Inches	Test No.	U. T. S. Lb. per Sq. In. ½-In. Plate	Per Cent. Elon. Inches	Test No.	U. T. S. Lb. per Sq. In. ¼-In. Plate	Per Cent. Elon. Inches
1	47,700*	15.0	1	34,600*	7.2	1	40,300*	10
2	40,300	6.8	2	40,300	7.2	2	45,000	10
3	48,800	7.2	3	42,500	7.5	3	44,300	9
4	47,000	7.2	4	39,600	12.5			
5	50,000	8.0	5	40,500	9.1			
6	50,600	3.5	6	38,000	6.8		. . .	
7	43,400	8.5	7	45,300			.	
8	37,000*	7.2	8	34,800*				
Avg.	45,600	7.9		39,450	8.4		43,200	9.7

*Plate ends.

The time has arrived in our national development when we must have a definite national program in the development of our great engineering problems, all of which cry for some broad-visioned national guidance. We must create a national engineering sense of provision for the nation as a whole. If we are to develop this national sense of engineering and its relations to our great human problems, it must receive the advocacy of such institutions as this. The Federated American Engineering Societies, composed of the various engineering societies, represent the engineers of the United States. It is our duty as citizens to give voice to those critical matters of national policy which our daily contact with this, the fundamentally constructive profession, illuminates to us. Just as our medical associations voice the necessity of safeguards to national health, as the bar associations offer safeguards to our judiciary, so the engineers should exert themselves in our national engineering policies. We have none; but we need some, or the next generation will face a lower instead of a higher standard of living than ours.—*Herbert C. Hoover.*

Refrigeration Study Course—XVII
Applications of Refrigeration—Ice Making

By H. J. MACINTIRE
Professor of Refrigeration, University of Illinois, Urbana, Ill.

PERHAPS at present refrigeration is the least generally understood of engineering subjects. Steam engines and steam turbines are simply means of utilizing the stored energy in steam, becoming kinetic by means of a drop of pressure and by doing work on a piston or a set of moving blades. The gas and oil engine is simply a substitute for the combination steam boiler and steam engine, whereas the air compressor is more or less a gas pump. Electric motors and generators, although complicated, are understood by the simple fact of their becoming commonplace through universal application. And yet the refrigerating system still acquires and maintains its frost-covered pipe lines because ammonia "expands" in the pipe like steam in a turbine; at least that is the popular explanation.

Engineers must get out of the habit of speaking of "expansion of ammonia" and must consider the action as boiling. In the steam heating system steam at from 1 to 10 or 15 lb. is admitted to the steam coils or radiators. It gives up some of its heat to its surroundings, the air, and in so doing it is condensed. The steam radiators are a sort of condenser. Likewise the refrigerating coil is a boiler, for the liquid is boiled into a gas, and as a gas or vapor it passes out of the coil and into the compressor again. If the boiling temperature of the ammonia in the refrigerating coils is too high, as when the suction pressure rises too much, the liquid will lie stagnant in the pipes like water in service pipes. It can boil and refrigerate *only* when the surrounding brine or air or other fluid is at a greater temperature than the boiling temperature of the ammonia in the pipes at that moment.

In this Study Course it has been shown that the compressor and the high-pressure side are only a means of using the same refrigerant continuously, and that the piston displacement per minute determines the tonnage possible; also that the valves, passages and headers affect the economy of operation. Likewise the condenser and the condensing water affect the head pressure, which should be as low as possible, everything considered, as more *work* is done during compression and the volumetric efficiency is decreased (the capacity of the compressor is lowered) by an increase of condenser pressure. In a similar manner the suction pressure must be kept as high as practical because the work done in the compressor, the volumetric efficiency, and the displacement of the piston per unit of refrigeration are affected adversely by a suction pressure which is lower than that which is really required.

Therefore, there has been a discussion of the compressor, the condenser, stage compression, ammonia, fittings, as well as the brine system, refrigerants and condensing water. So far in this course greatest emphasis has been given to the compressor room.

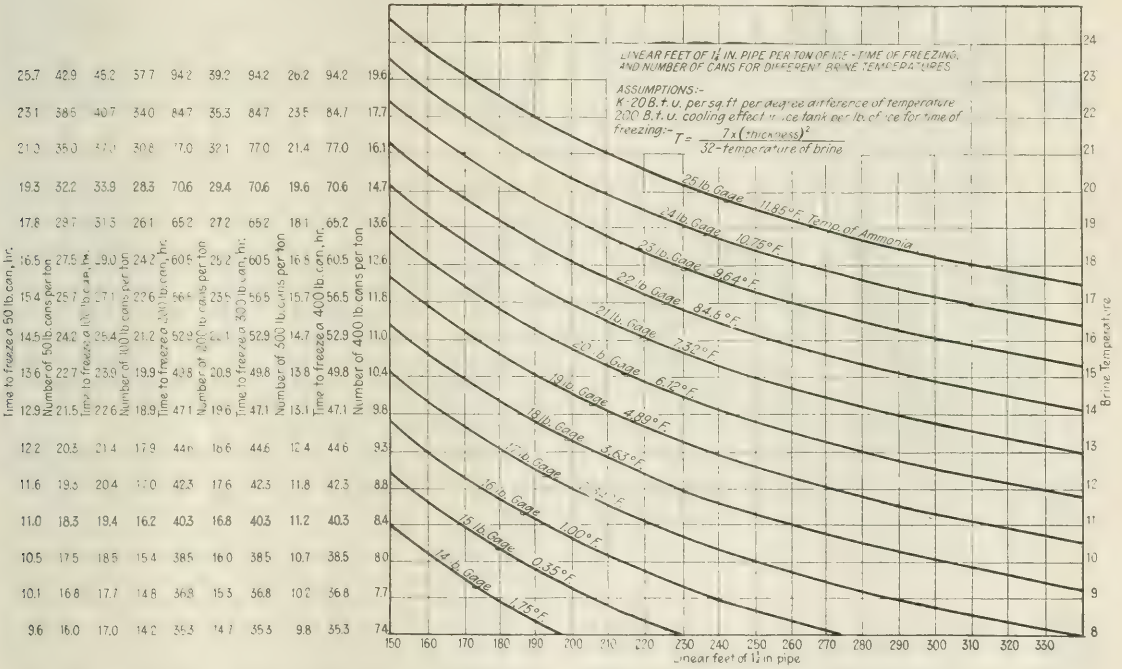


FIG. 1. TIME TO FREEZE WATER TO ICE UNDER VARIOUS COMMERCIAL CONDITIONS

The applications of refrigeration are independent of the form of compressor or condenser and affect only the low-pressure side. Even the use of brine does not affect particularly the engine-room equipment except in the required use of a brine cooler and the necessary brine pumps. Of course the suction pressure for indirect refrigeration by the use of brine has to be lower than when direct expansion in the expansion coils is used. This is because the ammonia cools the brine, and then the brine cools the air or other goods requiring refrigeration. This makes a *double* temperature difference, or heat transfer and it has been shown that for maximum efficiency of operation the suction pressure (and therefore the boiling temperature of the ammonia) should be as high as is practically possible. The applications of refrigeration, then, are different in the manner of using the cooling coils (either brine or ammonia) and the details of the equipment which goes with them. It will be the purpose of this and the next article to show how these applications affect the details of the equipment.

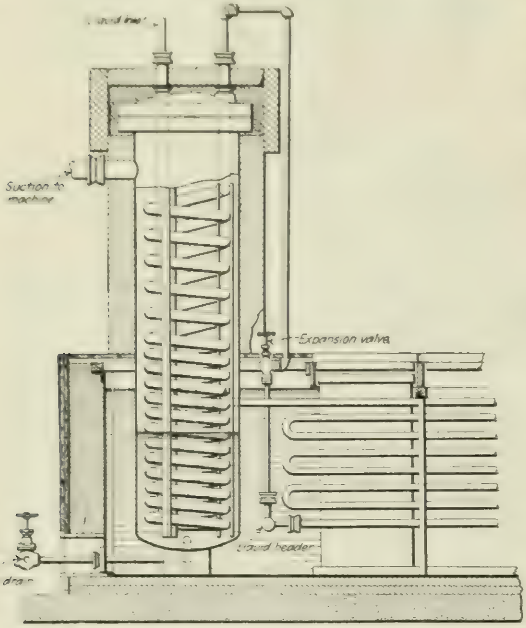


FIG. 2. AMMONIA PRECOOLER

The largest applications of refrigeration at present in this country are ice making, cold-storage and packing house refrigeration, pasteurizing and other dairy work, and, finally, refrigeration in certain chemical industries. These will be taken up more or less in detail.

APPLICATION OF REFRIGERATION TO ICE MAKING

Ice making by means of mechanical cooling is at present one of the largest applications of refrigeration. It is increasing in its use, even in the regions where a natural ice crop is convenient and cheap, because it usually looks better and may be manufactured conveniently near the place where it will be used. On account of its bulk and rapid melting or shrinkage, it cannot usually be transported very far without the cost increasing beyond the economic point.

At first ice was made by freezing on one side of a flat plate immersed in a tank of water until 8 to 12 in. thickness of ice was formed, the plate having a means of feeding in liquid ammonia and allowing the gas to return to the compressor in the usual manner. This is a raw-water system, which is highly satisfactory and is still used with success. The plate ice system is seldom installed now because of the greater first cost required, greater headroom necessary and lower back pressure carried on the machine. Large cakes of ice are frozen, from 3 to 5 tons, and this requires heavy handling apparatus, a suitable saw and table for sawing into convenient (300-lb.) cakes. The time of freezing increases greatly with the thickness of the ice made and usually requires six days. All water has air in solution, the amount depending on the temperature of the water and other conditions. If this water is frozen quietly, the air will be pocketed in the ice and the ice formed will have the appearance of marble, and is called "tombstone ice." It may be as valuable as clear ice so far as cooling effect is concerned, but it does not look as well. In consequence water to be frozen into plate ice is agitated by means of air under a few pounds pressure which is allowed to bubble up the freezing surface of the ice and thereby prevent the air of solution adhering to the ice surface.

THE CAN ICE METHOD

Parallel with the development of plate-ice systems came the *can ice* method, using distilled water. If steam is condensed (and reboiled slightly while exposed to the atmosphere) then cooled without exposure to the air, it may be frozen into a cake without producing a core, and becomes almost as clear as crystal. In the early days of refrigeration, and at present where the water is very heavy in salts, the use of distilled water for ice making was popular. Being distilled and reboiled it was considered hygienic and therefore appealed to the household retail trade.

In the can system of ice making, a galvanized iron can of rectangular cross-section but of slight taper toward the bottom is filled with water and lowered into a brine tank. The brine is usually maintained at about 14 deg. F. by means of ammonia expansion piping inside the tank in stands on two sides of the can, or is cooled in a brine cooler either inside the tank or entirely separate from the tank. The brine is circulated by means of propellers, with either horizontal or vertical shafts. These propellers are designed in a similar manner to a ship's propeller and are used to keep up a rapid circulation of the brine in and about the cans, thereby maintaining a uniform temperature of brine and also increasing the coefficient of heat transmission through the can to the ice and water. Heat is abstracted from the water, and the ice is formed rapidly, at first all around the surface of the can and then progressively slower as the center is approached. Evidently, with good agitation, the time of freezing of a certain size can depends on the brine temperature and the cross-section of the can. The brine temperature depends on the boiling temperature of the ammonia (the suction pressure) and the linear feet of direct expansion piping in the tank. All these variables are given in the diagram, Fig. 1. This diagram is recommended by the author for conservative practice, but the tonnage of a plant designed by the diagram should be greater if care is taken with the operation details and a flooded system is installed.

The flooded system for can-ice plants has been successful. The essential feature of this system is a device to precool the liquid ammonia to a temperature equal to that of the boiling ammonia in the coils (corresponding to the suction pressure). The coils may be fed by gravity or by the usual expansion valve (Fig. 2). In either case the coils are much more nearly filled with liquid ammonia and the heat conduction from the brine to the liquid ammonia is better than would be the case with the old system. The flooded method does not give more refrigeration per pound of ammonia; it simply reduces piping in the tank.

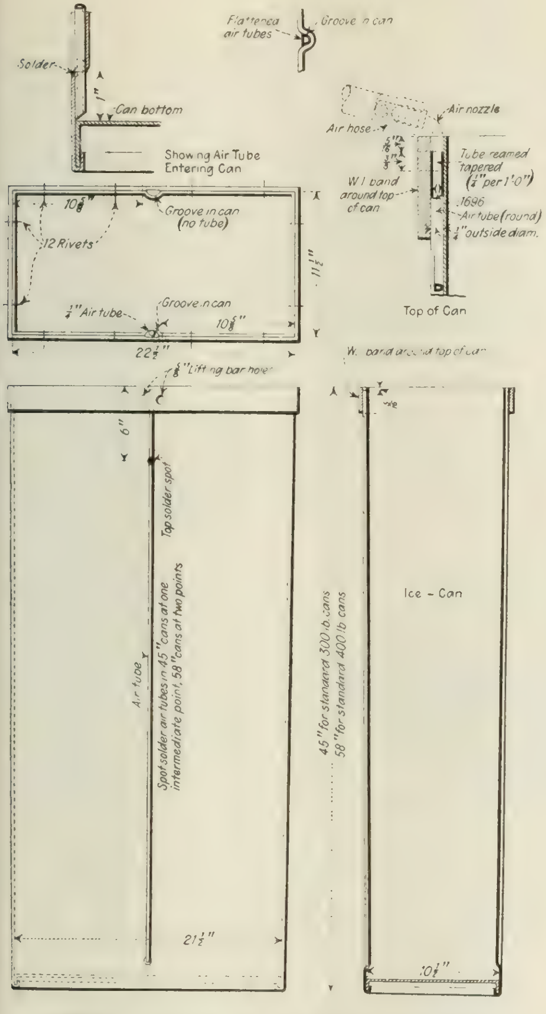

Flattened air tubes
Groove in can
Solder
Can bottom
Showing Air Tube Entering Can
Air nozzle
Air hose
W. I. band around top of can
Tube reamed tapered (¼" per 1'-0")
.1696
Air tube (round) ¼" outside diam.
Top of Can
10⅛"
Groove in can (no tube)
12 Rivets
11½"
¼" Air tube
Groove in can
10⅛"
22½"
W. band around top of can
1⅛" Lifting bar hole
6"
Top solder spot
Air tube
Spot solder air tubes in 45" cans at one intermediate point, 58" cans at two points
45" for standard 300 lb. cans
58" for standard 400 lb cans
Ice - Can
21½"
10¼"

FIG. 3 SECTIONS OF COMMERCIAL ICE CANS

RAW-WATER CAN ICE

One of the great advances in refrigeration during the last decade has been in the methods of ice making. The universal use of electric power, generated by steam as well as hydro-plants, has created a demand for an ice plant which has no ready means of securing steam for distilled water. Also the mounting cost of fuel, notwithstanding the reduced steam consumption of the steam engine, as well as the application of Diesel and semi-Diesel engines as compressor drives, has resulted in a great demand for a raw-water can-ice system which will provide a clear crystal-like cake of ice.

As already mentioned, agitators of raw water during freezing will provide a crystal plate ice, and the same is true to a certain extent in the case of can ice. However, a residue is left in the can (a core) which is likely to contain all the impurities of the can of water. Very good water (free from suspended and dissolved solids) need be agitated only by air under pressure until it is nearly completely frozen, but water containing much solids not removed by previous treatment must have a core-pump. This pump will remove the remaining small part of the original canful of water. The resulting cavity may then be refilled with distilled water.

The methods of providing agitation and securing clear ice are numerous. One way is to provide drop pipes into the center of the can and to allow air under 2 to 3 lb. pressure to bubble up. This is one of the simplest and cheapest first-cost constructions, but requires constant care on the part of the operator as the drop pipe will freeze into the ice if it is not removed before the cake is entirely frozen. To prevent this annoyance, the high-pressure system is used, the air being compressed to 25 lb. or more and precooled before being allowed to get to the can so as to remove as much of the moisture content as possible. Fig. 3 shows one system where the pipe inside the can is soldered to one corner and becomes an integral part of the ice can. The main objection to this arrangement is the difficulty of removing from the air a sufficient quantity of its water content to prevent the formation of frost at the needle valve and in the feed pipe, thus choking up the air supply to the can and preventing agitation. Also it is necessary to have 100 per cent continuous operation, as otherwise the feed valve will freeze solid and (without agitation) will form opaque ice.

There are numerous other systems of more or less merit. The main points in raw-water ice are all the same, however. "Water good enough to drink is good enough to make ice," and clear ice must be agitated during freezing.

No 300-Lb. Cans per Ton Condenser Pressure,	Horsepower Input to Motor, Belted Compressor, with Varying Condenser Pressures				Kilowatt-Hours per Ton Ice, for Compressor Only, with Varying Condenser Pressures			
	145 lb	165 lb	185 lb	205 lb	145 lb	165 lb	185 lb	205 lb
14	2 08	2.38	2.59	2.84	38 8	43 8	48 3	52 9
15	2 01	2 28	2 56	2.78	37 5	42 6	47 8	51 8
16	1 96	2 21	2 48	2.74	36 5	41 2	46 3	51 1
17	1 94	2 18	2 43	2 68	36 2	40 6	45 3	49 9

In all cases it is assumed that water at a temperature of 70 deg. F. will enter the storage tank for freezing purposes.

The Argentine government has inaugurated a survey preliminary to the construction of a power plant at the Iguazu Falls, in the northeastern corner of the country. It is reported that an international power plant, with a capacity of 150,000 hp. will be erected jointly by the governments of Argentina, Uruguay and Brazil. At present La Compania Hidro-electrica de Tucuman (English) is the only power plant established in Argentina. La Empresa de Luz y Fuerza (German) has a concession for the construction of a power plant at Mendoza. Work on this plant was begun several years ago, but was indefinitely suspended because of a dispute over the concession. The municipality of Mendoza is to construct a power station at the Falls of the Rio Blanco.

Operation and Adjustment of Turbine Machinery-XI

Main Bearings and Their Lubrication

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

When a turbine is in proper mechanical condition, a main bearing should operate well with a total net clearance of 0.002 to 0.003 in. above the shaft no matter how large the diameter. Of course the clearance of a shaft, in a large bearing particularly, must be great enough to allow for proper lubrication when at running heat. In practice the lower half of the liner is fitted close to the shaft, while the cap has an appreciable clearance which varies from 0.0005 to 0.002 in. per inch of diameter. The weight holds the shaft in the lower part under normal conditions so that the top of the liner is never actually touched by the shaft except when unusual vibration occurs. The cap is necessary for the proper distribution of the oil film and prevents oil from leaking excessively out of the ends of the bearings. In large turbines the cap is often bored out over most of its area so that several ridges are left to touch the shaft and the clearances in such cases are usually the greatest found.

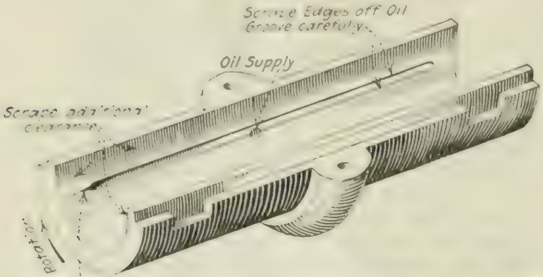

Scrape Edges off Oil Groove carefully
Oil Supply
Scrape additional clearance
Rotation
Channel sometimes placed at End of Groove

FIG. 1. LOWER HALF OF BEARING SHELL

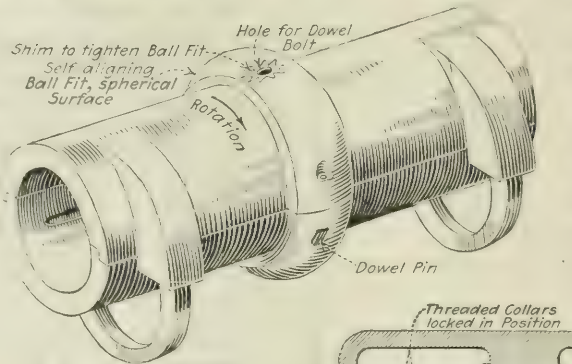


FIG. 2. SELF-ALIGNING BEARING SHELL

In scraping a bearing, the high spots which are brightened by contact with the shaft should be removed. Be careful that the metal is taken away at the edge of the oil groove where the oil leaves to follow the shaft, so that the oil film will not be restricted in any place. It is customary to scrape a clearance of 0.002 to 0.004 in. on each side of the liner to help in distributing the oil film. (See Fig. 1).

Oil grooves in bearings equipped with oil rings only are for the purpose of collecting the oil and distributing it. A straight oil groove is employed by some manufacturers, while others prefer a curved groove or perhaps two such grooves crossing each other. Where oil is forced to the bearing, the oil groove is straight and should be placed about halfway from the bottom to the middle of the liner on the side in the direction of rotation. When placed in this position, the action of the shaft carries the oil in the direction of flow so that there is a slight tendency to suck the oil supplied. When the groove is on the side against rotation, the oil film is discharged directly into the groove and there is a tendency to force it down the pipe. Turbines have been built with this arrangement and were found to operate better with a check valve in the oil pipe to prevent back flow under abnormal circumstances.

A word of caution is well here. Turbines run at such high speeds that obstructions in oil passages are serious.

The oil groove, Fig. 1, should not extend all the way to the end of the liner, but should stop about one-quarter inch more or less from each end. This confines the oil so that the pressure is available to produce the proper oil film. It is generally considered good practice to make a small channel from the end of the groove to the end of the bearing. This provides an oil film for the area outside of the groove itself and also permits a larger flow of oil, which has an appreciable effect in keeping the bearing cooler. Always examine the oil groove and be ready to scrape both the leading and trailing edges in case high spots appear, this to insure a good oil film. Turbine bearings are usually made of a hard nickel babbitt. In case of an emergency, where it is difficult to purchase proper metal, it can be secured from street-railway repair shops. High-speed turbine bearings that the writer has measured indicate a total wear of 0.0005 to 0.001 in. per year. At this rate a bearing should last from six to twenty years, depending on the type and design of the machine. Wear in the bottom liner eventually results in one or more of the following effects: General misalignment of machine; shoulders along the oil groove which cuts off lubrication and

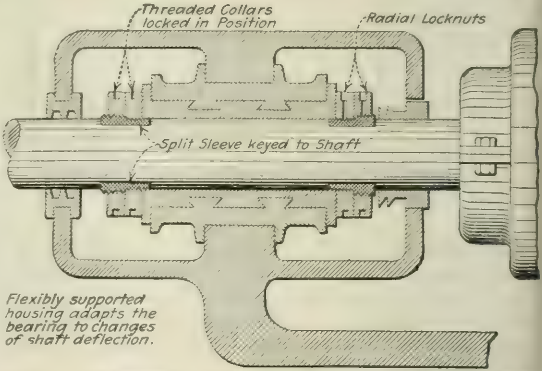

Threaded Collars locked in Position
Radial Locknuts
Split Sleeve keyed to Shaft
Flexibly supported housing adapts the bearing to changes of shaft deflection.

FIG. 3. FLEXIBLY SUPPORTED HOUSING ADAPTS THE BEARING TO CHANGES OF SHAFT DEFLECTION

causes heating; oil deflector rings touching stationary parts; revolving collars in thrust bearings touching parts of liners; other points of contact between moving and stationary parts; high spots forming on the surface and causing heating; hard parts of the babbitt wearing the shaft irregularly; excessive clearance in the bearing cap causing the oil to be thrown out from a bearing. It seems that high-speed bearings which are often subject to temperatures continually at the boiling point wear almost unappreciably. In a reciprocating engine the lost motion must be continually guarded against, but in turbine machinery this factor is a minor trouble. Self-aligning bearings, Fig. 2, should be tightened so that they can be moved with a lever two to four feet long. If the self-aligning fit is too tight, the bearing will not adjust itself to the shaft position so that in some cases heating or vibration will result. If too loose it will not usually cause any particular trouble under normal conditions; in many cases a slight vibration and pounding noise develop at this point.

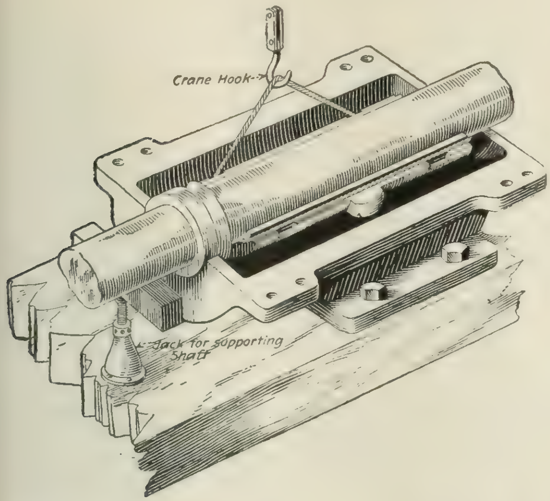


FIG. 4. TURNING OUT A HEAVY LOWER LINER BY USING A CRANE

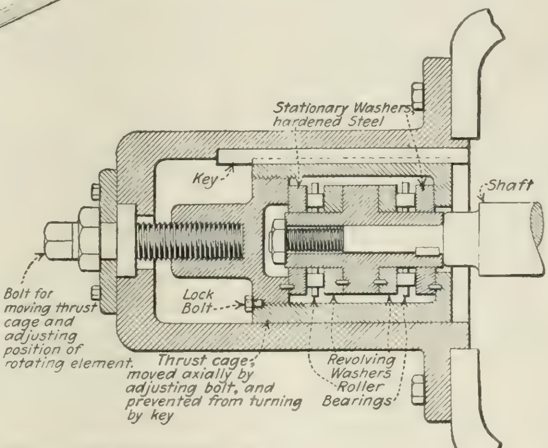

Stationary Washers, hardened Steel
Key
Shaft
Bolt for moving thrust cage and adjusting position of rotating element.
Lock Bolt
Thrust cage; moved axially by adjusting bolt, and prevented from turning by key
Revolving Washers
Roller Bearings

FIG. 5. THE THRUST CAGE IS MOVED AXIALLY BY THE ADJUSTING BOLTS AND PREVENTED FROM TURNING BY A KEY

When the ball is too loose, it is customary to tighten this up by placing a small shim on top of the ball, Fig. 2, so that the bearing cap will pinch it to the desired amount. It is convenient to beat out a piece of fuse wire and place this where the shim is required and pinch it by placing the cap in place. The thickness of the lead can be measured with a thickness gage and a shim of the same thickness installed.

Turbine bearings are not always self-aligning, as in some cases the bearing housings are sufficiently flexible to take up the difference in alignment. (See Figs. 2 and 3).

Turbine bearings can be disassembled by removing the upper half and then lifting the shaft about 0.010 in. above the lower half and supporting it in this position while the lower half is rolled over the shaft and then lifted off, as shown in Fig. 4.

Be sure that all water and oil pipes which screw into the liner are removed before attempting this job.

Thrust bearings used by various manufacturers consist of roller bearings, friction collars, ball bearings, marine-type thrusts, piston-type thrust bearings and step bearings.

Machines usually employ a mechanical method (one shown in Fig. 5), for changing the position of the shaft, enabling it to be shifted in an axial direction to properly adjust the blade axial clearances. Other types of thrust bearings require to be disassembled more or less to adjust the position of the shaft. Figs. 3 and 6 are examples.

To adjust the former type of bearing, as Fig. 5, it is safer to keep the machine revolving at a slow rate of speed while the shaft is being shifted in an axial direction so that in case a revolving part should contact with a stationary part, it will be immediately made apparent by a rubbing noise. It is convenient to locate the proper shaft setting by shifting the rotor in one direction until rubbing first begins and then setting permanently in the middle of this travel. Finally, this adjustment should be made immediately after running the turbine at normal speed. When thrust bearings are at normal temperatures, they should run with a clearance of 0.002 in. for each revolving element that bears against a stationary element. Ordinary thrust bearings are given a clearance of approximately 0.001 in. per inch of length between the ends of the thrust. In practice, it follows that too much clearance will allow the shaft to work backward and forward in an axial direction, which can be seen plainly. In extreme cases rubbing occurs. Too little clearance will cause heating or vibration and, in extreme cases, damage to the bearing. Plenty of clearance is desirable.

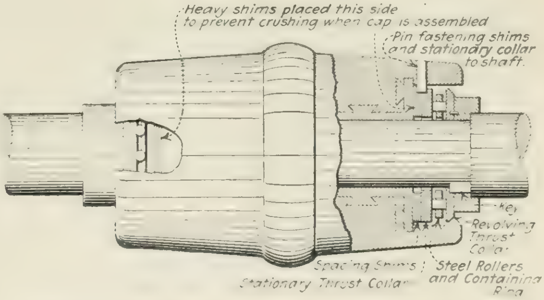

Heavy shims placed this side to prevent crushing when cap is assembled
Pin fastening shims and stationary collar to shaft.
Key
Revolving Thrust Collar
Spacing Shims
Steel Rollers and Containing Ring
Stationary Thrust Collar

FIG. 6. SECTIONAL VIEW OF A THRUST COLLAR

Ball bearings can be readily assembled by using heavy grease to hold the balls in place. Collar thrusts using babbitt or other bearing material are not difficult to assemble except where shims are used for settling the shaft. These shims are often necessarily very thin, but space is provided in most cases so that a heavy shim of about $\frac{1}{16}$ in. can be placed where the top cap will contact with it in being assembled. A great deal of skill is used in assembling such bearings, and small shims are likely to get misplaced if they are put where the cap will slide on them.

Marine-type thrust bearings are too well known to require special comment here. Piston-type thrust bearings are required to balance the thrust caused by the reaction-type turbines.

Thrust bearings for governors consist of ball races or roller bearings. The principal operating feature is to keep the clearance as small as possible to prevent bad effects in the operation of the governor. Bearings are sometimes made with removable shims for adjusting this clearance. A total clearance of 0.001 to 0.002 in. is usual.

Forty Years of Boiler Explosions

The *Locomotive*, the house organ of the Hartford Steam Boiler Inspection and Insurance Co., contains in its October issue a summary of that company's statistics on boiler explosions that have taken place in the last forty years. The total number of explosions covered is 14,281, in which 10,638 lives were lost and 17,085 persons injured. These figures are not, of course, complete, especially in regard to the number of boilers in use, for no means are available of securing complete records of boilers throughout the country. They may, however, be taken as fairly representative and indicative in a general way of conclusions that would be drawn from a more comprehensive survey.

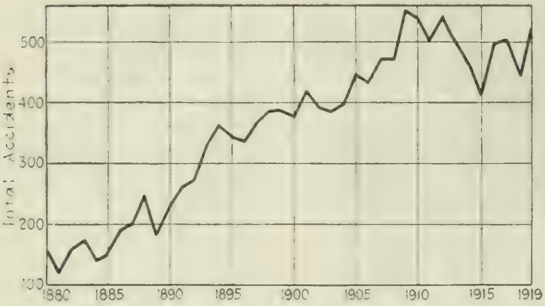


FIG 1 TOTAL EXPLOSIONS PER YEAR

The figures comprising this summary have been put into graphic form, as in this way their significance is more readily grasped. It should be remembered, however, that charts of this nature must be taken in a very general way. That is, the "saw-teeth," or sharp, extreme changes, are not in themselves of much importance. The general trend of the lines, however, shows more clearly than figures possibly can, just what the situation is.

Fig. 1 shows the rise in the number of explosions per year since 1880. This chart must be considered in the light of the obvious fact that the number of boilers in use has increased steadily; but whether that increase has been less than, equal to, or greater than the increase in the number of accidents cannot well be determined. However, it will be noticed that from 1909 on, a slight and widely varying, yet decisive drop is apparent; and it scarcely seems possible that the number of boilers in use since 1909 could have decreased or even remained constant. That it has, on the other hand, increased, is a reasonable assumption. This of course leads directly to the conclusion that the ratio of the number of accidents to the number of boilers in use has decreased since 1909.

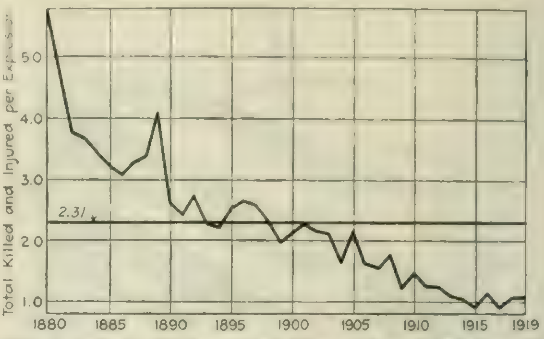


FIG. 2. TOTAL KILLED AND INJURED PER EXPLOSION

Fig. 2 shows a very marked decline in the number of persons killed and injured per explosion. The line marked 2.31 represents the average of the totals for each year. It can be seen that whereas in 1880 more than five persons were killed or injured in each accident, this figure came down to about one in 1919. This curve is of especial interest because of its very pronounced downward trend and because of possible speculation as to its cause.

Fig. 3 represents the changes in the ratio between those killed and those injured in each explosion. While this curve does not fall so rapidly as that in Fig. 2, still it does drop appreciably. It shows that at first there were almost as many killed as injured, and that now the killed are about half of those injured.

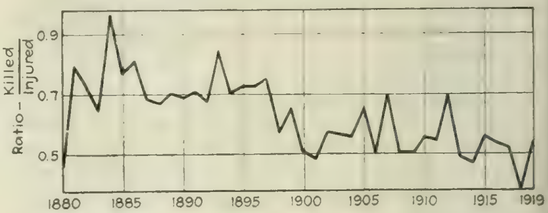


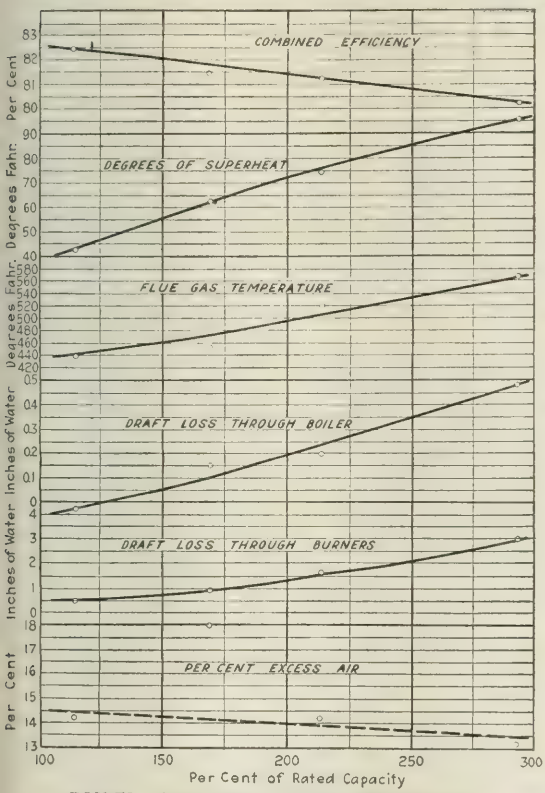
FIG. 3. RATIO BETWEEN KILLED AND INJURED

Taken as a whole, these facts are rather gratifying than otherwise. Though they are incomplete, they indicate with a fair degree of certainty a trend in the right direction. The apparent decrease in explosions relative to the number of boilers in use, the reduction of casualties per explosion and the smaller proportion of fatalities point to increasing care in the construction and operation of boilers.

Unusual Efficiency in Oil-Fired Boiler

A series of tests on a mechanical oil burner manufactured by the Babcock & Wilcox Co. were conducted by the Stone & Webster Corporation at the Riverside plant of the Savannah, Ga., Electric Co. The results of these tests are discussed in the Stone & Webster *Journal*, from which the curves shown in Fig. 1 have been taken.

The oil burner is of an entirely new design, being purely mechanical in action. No steam or air is used in atomizing the oil; this action is secured by the shape of the fluted cone tip. The burner is set in the furnace wall at the center of an air register, which is designed to impart a whirling action to the air. The air is supplied under pressure, and calibrations have been made to determine the proper oil pressure for each reading of the air-blast gage. The regulation of the oil spray is, consequently, very easily secured; the fireman need only set the oil pressure to conform to the air blast being carried.



BOILER EFFICIENCY WITH MECHANICAL FUEL-OIL BURNER

The results of the efficiency tests appear in the illustration. No other plant, so far as known, has secured over 80 per cent efficiency at 300 per cent rating. The efficiencies shown are gross values, no deduction having been made for steam to operate the air blower and oil pump. The exhaust of these units is used to heat the boiler-feed water; the difference between gross and net efficiency is, then, very small. One interesting feature is the decrease in excess air with the lower ratings and higher efficiency.

Steam-Turbine and Diesel Operating Costs

In the several European countries central stations and industrial power plants of large size have installed Diesel engines in preference to steam turbines. Without doubt, the high price of coal and the availability of coal tar for the Diesels have largely dictated the choice made. In the United States, while many large gas engines have been installed in past years, the oil engines, when installed in other than small plants, have been chosen, as a rule, on account of cheap oil, lack of water or considerations other than actual comparative efficiencies.

It is unfortunate that more information is not available as to costs of steam-turbine plants and Diesel plants when operating under like conditions. In the table shown below are given the comparative power-plant operating costs of a 600-kva. steam turbine and a 365-hp. Diesel engine. These two units are installed in an industrial power plant, receiving the same attention and operating under like conditions. Both units are driving generators, enabling the output of each to be accurately determined. The steam for the turbine is supplied by water-tube boilers using oil as fuel. Since the boiler efficiency is generally higher with oil than with coal, the B.t.u. per kilowatt-hour is lower than the result obtained with coal.

The Diesel exhaust line is equipped with a heater that heats the boiler-feed water and the Diesel should have been credited with the heat so added. The turbine circulating-water and air pumps are motor-driven, and no deduction has been made for this power. In all respects the turbine has been favored.

In the figures given, the labor per kilowatt-hour with the Diesel is from two to six times as high as with the turbine. This is due solely to the small output of the Diesel; an engine twice as large would have the labor cost reduced 50 per cent. The lubricating charges contradict the prevailing belief that the Diesel uses excessive amounts. That the oil engine is particularly adapted to central-station work is shown by the variation in efficiency with change in load. A 25 per cent change of load in the turbine produced a 20 per cent change in efficiency; on the other hand, the Diesel shows a 100 per cent load variation with but 3 per cent change in the efficiency. It should be remarked that the average load on the steam turbine was 568 kw., while the engine's load averaged only 200 kw., or approximately half-load. If the Diesel had been fully loaded the labor and lubricating oil per kilowatt-hour would have been reduced by at least 6 mills.

COMPARATIVE OPERATING COSTS OF DIESEL AND STEAM TURBINE

	Turbine					Diesel				
Week (132 hr.)	1	2	3	4	5	1	2	3	4	5
Kw.-hr. output	58,210	66,050	42,359	64,025	74,925	10,590	25,725	15,680	21,215	24,240
Fuel oil, gal.	23,455	25,950	19,389	24,474	26,836	1,026	2,413	1,524	2,047	2,363
Kw.-hr. per gal.	2.48	2.55	2.23	2.61	2.79	10.3	10.6	10.2	10.3	10.2
B.t.u. per kw.-hr.	51,320	50,000	57,200	48,800	45,300	12,370	12,000	12,300	123,700	12,300
Fuel per kw.-hr., mills	14.1	13.7	15.7	13.4	12.9	3.4	3.3	3.4	3.4	3.4
Lub. oil per kw.-hr., mills	0.1	0.1	0.2	0.15	0.15	0.2	0.1	0.15	0.1	0.11
Labor per kw.-hr., mills	2.4	2.2	3.4	2.2	2.00	13.0	5.6	9.30	6.6	5.6
Operating cost per kw.-hr., mills	18.6	16.0	19.3	17.75	15.05	16.6	9.0	12.85	10.1	9.1

Production of Gasoline

GASOLINE, at one time a byproduct of the refining industry incident to the production of kerosene, has advanced to a stage where it is the most important product obtained from petroleum. In quantity it now represents more than one-fourth the volume of all products obtained from petroleum and in value is practically equal to the total value of all other products. The 1919 refinery production of gasoline and naphtha (3,957,857,097 gal.), if collected at one point, would fill a storage tank one mile in diameter and twenty-five feet high, or if moved in standard tank cars of 8,000 gal. capacity would require a train more than 3,500 miles in length. On Jan. 1, 1920, there were registered in this country approximately 7,500,000 automobiles and trucks having an estimated value of more than $5,000,000,000, which were almost entirely dependent on gasoline as a source of motive power. This estimate does not take into consideration the value of the large number of stationary, marine and airplane engines that use gasoline as fuel.

The economic importance of gasoline is at present more generally realized than ever before owing to the fact that the domestic supply threatens to become exhausted within a relatively short time and no satisfactory substitutes to replace it have been developed on a sufficiently large scale. One of the largest industries in the country, the automobile industry, has been built up on the belief that there would always be available sufficient quantities of fuel for its product, and the future growth of that industry is entirely dependent on the increased production of motor fuel. It is evident, therefore, that extended efforts must be made to increase the production of gasoline, and since the supply of raw material from which it is made is limited, these efforts must be along the line of increased efficiency in the refining of crude petroleum and in the elimination of waste in utilization of gasoline.

This is the first of a series of articles on gasoline and is published by permission of the Director of the Bureau of Mines. The material for these articles has in large measure been taken from the manuscript of a bulletin on "Commercial Gasoline," by H. H. Hill and E. W. Dean, which will be published at a later date as Bureau of Mines Bulletin No. 191.

REFINERY PRODUCTION OF GASOLINE

The only available figures which show the refinery production of gasoline for the years prior to 1916 are those given by the Census Bureau in the census of manufacturers, which is taken every five years; since this time the Bureau of Mines has received monthly reports from practically all the refineries. The amount of crude run to the refineries and the refinery production of gasoline, as given by Census Bureau and Bureau of Mines data, is shown by the figures in Table I.

TABLE I. SHOWING REFINERY PRODUCTION OF GASOLINE FOR PERIOD OF SIXTEEN YEARS, 1904 TO 1919, INCLUSIVE

Year	Crude Run to Refineries, Bbl.	Production of Gasoline, Bbl	Yield of Gasoline Per Cent	Yield of Gasoline Gals. of Gasoline per Bbl. of Crude Run
1904	66,982,862	6,920,000	10.3	4.3
1909	120,775,439	12,900,000	10.7	4.5
1914	191,262,724	34,915,000	18.3	7.7
1916	246,992,015	49,020,967	19.8	8.3
1917	315,131,681	67,870,153	21.6	9.1
1918	326,024,630	85,007,451	26.1	11.0
1919	361,520,153	94,234,693	26.1	11.0

Since the statistics make no distinction between gasoline and naphthas, the figures on gasoline production used throughout this paper include the production of naphthas and other petroleum distillates more volatile than kerosene. The production of naphthas is, however, relatively small when compared to total gasoline production.

The figures for refinery production of gasoline include that manufactured by cracking processes, but do not include any of the gasoline recovered from natural gas, with the exception of that portion of the casinghead gasoline production which goes to the refineries and is there blended with other gasoline. In 1919 the amount of casinghead gasoline used by the refineries was given as 2,956,781 bbl., which is probably less than 40 per cent of the total production of that product.

The distillation of crude petroleum is by far the most important source of gasoline. Although a large percentage of the gasoline as now marketed is a blended product, approximately 80 per cent of the total gasoline produced is manufactured by the "straight refining" process. In order to determine the amount of gasoline obtained from the distillation of crude petroleum, it is necessary to subtract from the figures on refinery production, as given in Table I, the amount of gasoline produced by cracking processes and the amount of casinghead gasoline that was blended at the refineries. In 1919 this difference amounted to approximately 76,000,000 bbl. This, of course, includes the production of naphthas, as the reports received by the Bureau of Mines do not make a distinction between gasoline and naphtha.

GASOLINE FROM NATURAL GAS

A considerable proportion of gasoline is now obtained from natural gas by compression and absorption processes. This type of product, known as casinghead gasoline, is exceedingly volatile and is rarely if ever marketed in its original state. It is usually blended with naphtha at the plant where it is manufactured, but in the last few years a certain percentage has been shipped to the refineries and there blended with straight-run or cracked gasolines of low volatility. It is sometimes blended with kerosene, but the resulting product is not at present regarded as a very satisfactory motor fuel.

The production of natural-gas gasoline has been increasing rapidly, the production for 1917 being approximately thirty times that for 1911, and it is possible that the 1919 production was forty-five times that for 1911. This product has been of immense value in increasing the total amount of motor fuel as it has rendered available quantities of naphtha and heavy gasolines which in their original state did not contain a sufficient proportion of low-boiling constituents to make them satisfactory as motor fuels.

A relatively high percentage of the gasoline now produced is made from gas oil and other heavy petroleum fractions by decomposition under heat and pressure. This product, known as "cracked gasoline," differs from "straight-run" gasoline in that it contains a much higher percentage of "unsaturated" hydrocarbons. "Cracked gasoline" is seldom marketed as originally manufactured, but is blended with "straight-run" or "casinghead" gasoline.

No accurate statistics are available which indicate the total yearly production of gasoline by cracking processes. A statement by President Teagle of the Standard Oil Co. to the effect that in 1919, 15 million barrels was produced by the Burton process, was recently published in *The Lamp*, the official organ of the Standard Oil Company of New Jersey. These figures indicate the importance of the cracking process as a source of motor fuel.

THE YIELD OF GASOLINE

The figures in column 3 of Table I show that in the past years there has been a decided increase in the amount of gasoline obtained from a given amount of crude. In 1904 the gasoline produced amounted to 10.3 per cent of the crude oil run to refineries, whereas in 1919 the yield was 26.1 per cent. In other words, 4.3 gal. of gasoline was produced from each barrel of crude in 1904, while 11 gal. was obtained from each barrel of crude in 1919, an increase in gasoline yield amounting to 155 per cent.

Increases in the yield of gasoline have been due partly to the improvements in refinery equipment and to relative increases in the production of light crudes, but the principal causes have been the extensive use of cracking processes and changes in the volatility of gasoline. The more general use of casinghead gasoline is also a factor of great importance.

Users of gasoline are inclined to condemn the present grades of motor fuel and discuss the "good old days" when 75-deg. gasoline was one of the less-volatile products on the market. It is not generally realized that the demand for gasoline has increased at a much more rapid rate than has the production of the raw material from which gasoline is derived. Refiners have been forced to get more gasoline out of the crude, and the most effective method of accomplishing this result is to "cut deeper into the crude" and market as gasoline certain fractions that were formerly included with kerosene.

That there have been decided changes in the volatility of gasoline during the past few years is very evident, but that such changes were necessary in order to meet the increased demand is not generally realized. Several years ago it was customary to market gasolines having gravities of 70 to 76 deg. and end points of 300 to 350 deg. F. The present average grade of motor gasoline has a gravity of 56 to 60, depending on the type of crude oil from which it is made, and an end point of 410 to 450 deg. F. It is generally admitted that this change has not been an improvement, particularly from the standpoint of convenience in operating automobile engines, but it has, nevertheless, been a decided advantage to the user as it has permitted him to obtain an abundant and well-distributed supply of motor fuel. If the higher standard of quality had been maintained, there would have been unavoidable shortages and an increase in price of an entirely different order than that which has occurred.

In a report to the Director of the Oil Division, United States Fuel Administration, on "Potential Production of Airplane Gasoline," the Bureau of Mines estimated that if all gasolines now produced were of a volatility equivalent to that of the so-called 76-deg. grade, the yield would be reduced approximately one-half, and if of the same volatility as motor gasoline marketed four or five years ago, the production would be reduced approximately one-quarter. This estimate indicates the importance that the change in volatility has had on the yield of gasoline from crude oil, for if no change had been made, instead of a gasoline production in 1919 of more than 94 million barrels there would have been a production of less than 50 million barrels of 76-deg. gasoline or less than 75 million barrels of the grade that was in general use four or five years ago.

IMPORTANCE OF CRACKING PROCESSES

The use of cracking processes has had a noticeable effect on the yield of gasoline. It is estimated that the Burton process has furinshed more than 10 per cent of the total gasoline produced since the process was first put into operation on a commercial scale. This added amount of gasoline has been rendered available without increasing the consumption of crude petroleum and has been of prime importance in preventing shortages of motor fuel and in conserving the supply of crude. More than 150 million barrels of crude oil would have been required to yield an amount of gasoline equivalent to that produced by the Burton process since its development.

If the demand for gasoline keeps increasing at a rate more rapid than the increase in production of crude petroleum, it is highly essential that cracking processes come into even more general use than at present. In this connection it will be interesting to observe the effect of the recent offer of the owners of the Burton process to lease the process to independent refineries. If the process is installed in refineries throughout the country, there should be a decided increase in the yield of gasoline without proportional increases in the consumption of crude, provided, of course, that there is sufficient difference between the price of gasoline and the price of fuel oil to make the operation of the process profitable.

IMPORTANCE OF CASINGHEAD GASOLINE

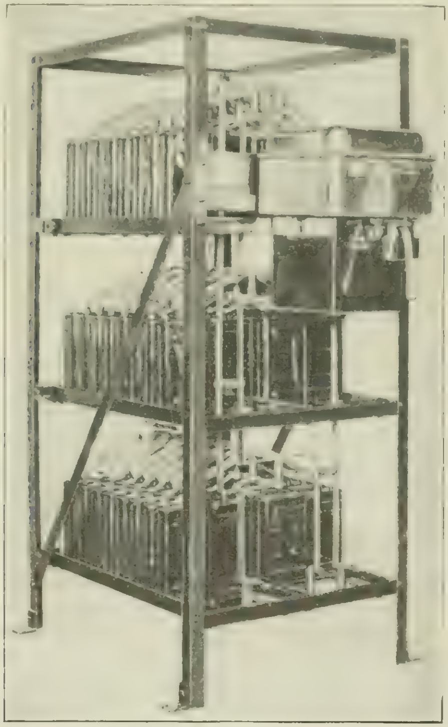
Casinghead gasoline has been of more importance in increasing the total supply of motor fuel than its production would indicate. The amount of raw casinghead produced represents only about 8 per cent of the total gasoline production, but this amount rendered available for motor fuel a quantity of naphtha or heavy gasoline at least equal to the production of raw casinghead. Without the addition of casinghead these products could not have been used to good advantage as motor fuel, as they do not contain sufficient low-boiling constituents.

A considerable percentage of the casinghead now being produced is being shipped to the refineries, where it is added to straight-run products that are deficient in low-boiling material. This method of utilization allows the refiner to "cut deeper into the crude," as he can supply the necessary percentage of low-boiling constituents by the addition of casinghead, and for that reason can increase the amount of motor fuel that can be obtained from a given amount of crude. A more even distribution of casinghead would aid in increasing the percentage yield of gasoline, for at present some gasolines on the market are deficient in low-boiling constituents, while others contain percentages apparently higher than necessary.

Static Condensers for Power-Factor Correction

The stationary, or static, condenser has been developed by the General Electric Co. to meet the demand for a means of correcting the power factor for small loads and where an attendant is not available. Condensers of this type have been standardized for installations ranging in frequency from 40 to 125 cycles, in voltage from 220 to 2,300 volts, and in capacities from 30 to 300 kva.

For the correction of power on circuits exceeding 2,300 volts, transforming apparatus consisting of a transformer or auto-transformer of sufficient capacity to step the voltage down to 2,300 volts, and a suitable oil circuit breaker to control the equipment from the line side of the transforming apparatus are provided. Those for 2,300-volt service consist of a number of condenser units, a reactance for damping out harmonics in the voltage wave which would affect the corrective capacity of the units, a discharge resistance for draining the condensers when disconnected from the line, and an oil circuit breaker for the control of the equipment. For 220-, 440- and 550-volt service an auto-transformer is provided designed to step the voltage up to 1,200 volts for the condensers in order to provide more economical use for the active material. In the figure is shown a 240-kva. 60-cycle three-phase unit ready for installation.



THREE-PHASE STATIC-CONDENSER EQUIPMENT FOR POWER-FACTOR CORRECTION

The number of condenser units which comprise an equipment are directly proportional to the capacity required. Each unit has a capacity of 5 kva. at 60 cycles. The unit itself consists of a large number of couples of metal foil with paper laminations as a dielectric, similar to the standard construction of low-voltage condensers. These couples are treated in a vacuum to remove all moisture and immersed in oil in a container which is hermetically sealed to prevent possible absorption of moisture from the air. In practice the units are connected in parallel across each phase, one terminal being connected through a fuse which has a threefold purpose: First, to provide protection for the units from damage due to any abnormal potential; second, to open the circuit of the unit to the bus in case of failure of that unit; and third, to provide an easy way of reducing the capacity of the condenser equipment in case of seasonal changes in the load when the full corrective capacity is not required.

The principal advantages of the static condenser are small losses, ease of installation, absence of moving parts and the fact that no attendant is required for its efficient operation. When one considers the evil effects of poor power factor on operating conditions, it is easy to realize that such a device, which is a highly efficient corrective, is a most valuable asset, both from the standpoint of the central station and that of the factory owner with a load of low power factor.

Two Mammoth Waterwheels for Fall River (Cal.) Plant

The Mount Shasta Power Corporation, a subsidiary company to the Pacific Gas and Electric Co., of San Francisco, Cal., has recently placed orders with the Allis-Chalmers Manufacturing Co. for two large hydro-electric units. Each waterwheel will be rated at 40,000 hp. and is to operate under a normal effective head of 421 ft. at a speed of 275 r.p.m. The water will be led to the unit through a penstock 9 ft. in diameter and at the entrance to the turbine will be controlled by a butterfly valve 9 ft. in diameter, forming a part of the turbine. Each unit has a vertical shaft 24 in. in diameter. The spiral casing is of cast steel and will be made in five sections. Each machine is to be equipped with a telescopic draft tube, directly connected governor, and a pressure regulator with a 48-in. connection to the spiral casing. The pressure regulator is designed to discharge 80 per cent of the capacity of the turbine, which means that for the few seconds that the governor must operate, it must divert completely and largely dissipate 32,000 hp., and maintain a very carefully graduated control. An efficiency of 89 per cent has been guaranteed by the builders, this high guarantee being justified by the use of the White Hydraucone Regainer.

Each of the turbines drives a 35,000-kva. 1,835 ampere 11,000 volt three-phase 60-cycle 275 r.p.m. generator. The two units are to be installed in a new station known as Fall River Plant No. 1, Fall River being a branch of the Pit River, which drains the region north of Mount Lassen and south of Mount Shasta in California. The power is to be transmitted to the Pacific Gas and Electric Company's transmission systems in and around San Francisco by means of a transmission line about 210 miles long. It is contemplated to transmit the current at 210,000 volts.

Power is glad to be able to promise its readers some interesting information as to the details of the apparatus going to make up this unusual development as soon as the machines are completed and placed in service the early part of next year.

EDITORIALS

Economy in Industrial Power Plants

MODERN development in power plants has resulted in economy not only in fuel, but also in equipment and building space. In the boiler room the introduction of the mechanical stoker has made possible the forcing of boilers three hundred to three hundred and fifty per cent of their normal rating; thus the same load may be carried with approximately one-third the number of boilers as required where hand-fired units are used of the same normal rating, besides resulting in much better fuel economy. In the power plant the steam turbine has made it possible to reduce the space per horsepower of installed capacity many times below that required by the reciprocating-engine-driven units. Not only is this true of the main units, but it also applies to the auxiliaries. In industrial plants where large quantities of waste heat from processes are available, the utilization of this heat has resulted in large coal savings. The leading article in this issue describes the power plant of the International Nickel Company of Canada, where the foregoing is very nicely exemplified, in an industrial plant.

Fuel economy accomplished by the utilization of waste heat in this plant is of particular interest at this time, in view of the high price of fuel and the difficulty in obtaining it. By installing a four-hundred-horsepower waste-heat boiler on each of the two nickel-refining furnaces, it has been possible to operate with one less coal-fired boiler in the power plant. The utilization of the cooling water from the rabble arms of the calciner furnaces for boiler feed and the large quantities of hot water used in the processes also results in a large saving in fuel, amounting to the equivalent of approximately another six-hundred boiler-horsepower, and indicating some of the possibilities of waste-heat utilization. Fuel saving, although the most important, is not the only thing accomplished; there is also the saving in cost in the boilers by a reduction in the number installed and also in the size of the boiler room. The power-plant equipment throughout operates at speeds that make the space occupied per unit capacity very small, and this makes for economy in plant dimensions. Some of the old reciprocating blowing engines of one thousand horsepower capacity occupied a space approximately the same as required for this plant having a capacity of five thousand horsepower of high-speed turbo-blowers and turbo-direct-current generators. One-thousand-kilowatt direct-current generators operating at seventeen hundred revolutions per minute and one-thousand horsepower turbo-blowers operating at eight thousand five hundred revolutions per minute such as used in this plant, even in this period of high-speed equipment have not as yet become general practice, although they indicate what the future may hold.

Metal-refining industries, along with many others, are generally offensive to most communities on account of their smoke and obnoxious gases and also because of the pollution of streams with the water from their processes. The plant under discussion is a good example of how these objections can be overcome by giving them proper consideration in the design. Instead of the water from the processes going back into Lake Erie polluted, it is subjected to a treatment that gives an effluent free from objectionable matter, and all solid matter is removed from the gases before they reach the stacks.

Feed-Water Heating

THE design of power stations with turbo-generators of large size has introduced a number of new problems connected with feed-water heating.

High-pressure integral economizers or steel tube economizers, now used in standard practice, require feed water to be at a temperature of about two hundred and ten degrees Fahrenheit. There are several methods available to heat the feed up to this temperature and maintain a proper heat balance on the plant.

The method that has been popular in this country for many years requires the use of non-condensing steam driven auxiliaries with their exhaust steam used in an open heater. There are two objections to this system: First, it is very difficult, if not almost impossible, to maintain a heat balance under all load conditions, and secondly, the heat energy of the steam available to produce work can be only partly utilized in these small units.

Electric motors can be used efficiently for practically every auxiliary service, and their use has been greatly extended in the newer power plants. There are three possible methods of heating feed water with all electrically driven auxiliaries, the first of which is as follows: A non-condensing house turbo-generator tied electrically to the main generator busbars can be installed to furnish exhaust steam to heat all the feed water in an open heater to two hundred and twelve degrees Fahrenheit. When the main generating units are large, this involves a large house turbine, which, in heating the feed water to the required temperature, may develop much more power than is needed by the auxiliaries. This surplus power passes out onto the system over the main busbars.

A second method is to bleed the main turbine at a point near the exhaust end where the pressure will be about twenty inches of vacuum at normal load. This bled steam is used in a closed heater to heat the condensate on its way to an open heater. A non-condensing house turbine is installed just large enough to carry all the electrically driven auxiliaries and to heat the feed water through the remaining temperature range in the open heater into which it exhausts. Double auxiliary busbars are provided, one set connected to the house turbine and the other to the main generator. The heat balance and desired feed-water temperature at the open heater may be maintained at all times by shifting the load of the auxiliary motors to or from the house turbine to the main generator busbars.

The third method consists of bleeding steam at two or more points on the main turbine, so that at normal load the steam leaving the connected closed heaters will be at the required temperature. No open heater is used in this system. In fact in both this and the previously described systems the only steam-driven auxiliaries are usually a boiler-feed pump and sometimes a forced-draft fan. The condensate pump forces the condensate through both heaters on its way to the hotwell, where any necessary makeup water is added. The disadvantage of this system is that the pressures vary at different stages as the load changes and at light loads the temperature from heaters so connected will probably be quite low. On the other hand, this latter method is most economical at rated load of all three systems if one considers the gross steam demand on the boilers in each case. In the third system the greatest amount of the available heat energy resulting from expansion of the steam is recovered as work in the highly economical main unit. This system is under consideration for several large new stations.

Several engineers favor the second system, since it is generally only slightly less economical in gross steam demand on the boilers than the third system, while it has the advantage that the heat balance can be adjusted at all loads.

Feed-water heating is an individual problem in every large station and must be studied carefully to get best results.

Social Engineering at A. S. M. E.

TO THOSE who are wont to regard the mechanical engineer as a sort of glorified mechanic the program adopted for the celebration of the fortieth anniversary of the founding of the American Society of Mechanical Engineers may seem a little beside the mark. It was, however, demonstrative of the broad view which the society has lately taken of its functions and of the inclusiveness of its field. In considering The Opportunity and Responsibility of the Engineer the program dealt with him as the administrator rather than as the designer and creator.

An address by J. Herbert Case, acting director of the Federal Reserve Bank of New York, threw up a fitting background for the engineer in this rôle. The workingmen's side was presented by Samuel Gompers, president of the American Federation of Labor. The high point of his discourse was the thought that the workman should be considered as the real product of industry, the goods or service produced as the by-product. His address was moderate and conservative.

William B. Dickson, vice-president of the Midvale Company, Inc., captain of industry and large employer of labor, expressed in his address the convictions that have been growing in the minds of an increasing number of responsible thinking people who can see out over their immediate personal interests into the real problems of our industrial life. "The feudal system," he said, "was based upon the ownership of land and its appurtenances, such as highways, mines, streams, fisheries, etc., by the barons, and it was effective in securing autocratic control of the workers because the vast majority were tillers of the soil or workers in other industries controlled through land ownership.

"The tendency of our modern industrial system is toward autocratic control of the workers through ownership of what our socialistic friends call the 'tools of production,' which include not only the natural resources, but also the furnaces, mills, factories and transportation systems."

He cited two cases where, in order that prices might be maintained in the face of a diminishing demand, great companies had decided to shut down their plants. The result was disaster to the communities where they were located. Merchants were driven out of business, real estate values were depreciated, and workers had to break up their homes and seek employment elsewhere. None of these persons had any voice in the momentous decision, made in a New York office.

"By reason of this condition we have the unstable situation of a government founded on the suffrages of men who for all practical purposes are industrial bondmen.

"The Carnegie labor policy was highly autocratic as is that of its successor, the United States Steel Corporation, a benevolent autocracy, if you please, in many splendid ways, but however large you write the word benevolent you must always write after it the word autocracy.

"Any manifestation of autocracy is repugnant to the American people whether it proceeds from a president of a corporation, a president of a labor union, or a president of the United States.

"The answer is industrial democracy."

And the looks of intelligent approval with which the address was followed indicated no less than the hearty applause which came upon its conclusion that the big intellectual audience that filled the auditorium found such broad views and fearless utterances good to listen to.

How About Boilers?

ON PAGE 786 of this issue there is printed a short analysis of data on boiler explosions covering the period from 1880 through 1919. This material is presented more with the idea of showing what may be done than for the purpose of giving precise information.

The figures upon which this analysis is based are not precise—they could not be under the circumstances. For forty years the Hartford Steam Boiler Inspection and Insurance Company has painstakingly been compiling them, and now vouches for their accuracy as far as they go. But this company was one among many and had neither the authority nor the facilities for searching out all the facts in connection with every explosion, much less for keeping track of every boiler installed.

The company that made this survey did so on its own initiative, at its own expense and for its own purposes. The results are helpful and welcome. Yet nobody has so far been given the responsibility and the means of securing precise and all-inclusive data; "let George do it" has been the rule of procedure.

Every ten years Uncle Sam counts noses to see how his family has grown. A great many other things are counted, too; in fact, the Government keeps records of pretty nearly everything except, perhaps, boilers. It may be that boilers are not important enough, as their toll of dead and injured is reported to be only 695 per year. Perhaps, too, the registration of boilers would make too much red tape and would cost too much.

Meanwhile the state insists that every dog shall have a license, and a careful record of licenses is kept. Motorcycles are registered; so are automobiles.

But boilers are different.

CORRESPONDENCE

Pit Holes in Feed Pipes

In *Power* of Sept. 28, 1920, page 514, C. W. Wallace writes that he is having trouble with pit holes in his feed piping. This is fairly common with steel feed pipes and occurs with most waters, the quality of steel having little apparent effect on the corrosion. There appears to be no doubt that the trouble is caused by the combined chemical and electrolytic action due to dissolved oxygen in the water, and the obvious remedy is to get rid of the oxygen before the water is pumped through the pipes.

An apparatus to accompish this is described by F. W. Speller and R. C. Knowland in the *Journal* of the American Society of Heating and Ventilating Engineers, pages 249-59, January, 1918, also on page 426 of the Sept. 14, 1920, issue of *Power*.

The corrosion of feed pipes is very ably dealt with in *Power*, Feb. 26, 1918. In this article the activity is said to be at a maximum when the temperature of the water is approximately 14 deg. F., decreasing as the temperature of the water rises.

The following case shows how far this agrees with practice. A certain boiler plant consisting of six Lancashire boilers 8 ft. 6 in. in diameter and 30 ft. long, working at 120 lb. pressure, was arranged with 4-in. steel feed piping, lapwelded, with flanges screwed and expanded on. Each pair of boilers was served with an economizer having 192 tubes. The feed pump was of the vertical direct-acting type, drawing water from an open feed tank. The average temperature of the water entering the economizer was from 130 to 140 deg. F., the average temperature of the water leaving the economizer from 260 to 270 deg. F.

After the piping had been in use about twelve months several pit holes were observed in the pipes leading to the economizer, necessitating putting on clamps until the pipes could be replaced.

An examination was then made. Six pipes leading to the economizer were found to be in a very badly pitted condition internally, and five leading from the economizer were practically as good as new. The trouble was remedied by fitting cast-iron pipes leading to the economizer.

It is nearly three years since the steel feed pipes were first put in, and those leading from the economizer re just beginning to show signs of pitting, which will necessitate replacing them with cast-iron ones in the near future.

The cast-iron pipes are made of hard, close-grained metal, are ¾ in. thick and were tested to 350 lb. before eing used. The water supplied to the boilers was from the town supply and was not treated in any way; the analysis showed five to six degrees of hardness.

Personally, I have found that cast-iron feed pipes are satisfactory up to 160 lb. pressure provided they are of even thickness all the way round and that a spring-loaded relief valve is placed on the discharge side of the feed pump to take care of any sudden pressure due to shock. With turbo-feed pumps shock is practically absent, and in my opinion they are preferable in every way to piston pumps. W. M. HEBBLETHWAITER.

Haddersfield, England.

Fuel Waste Causes Failure of Central Heating Station

Referring to the article by William M. McNeill on page 476 of the issue of Sept. 21, I think that he worked with the wrong idea. He certainly could have turbined the 600-hp. boiler, cleaned the tubes of soot, put the baffles in shape, repatched the brickwork where required, and stopped the leaks in the boiler setting, all at a small expense. As to the chain-grate stoker, there was no reason why the bent shaft could not have been straightened, and owing to the success that we are having now with oxyacetylene, thermit and electric welding it would not be wise to throw good castings away when they could easily be repaired.

It would have been possible to run the plant with the 600-hp. boiler in first-class order, and using the hand lance twice a day results could have been shown right away, and the chances are the repairs for the three other boilers would have come much easier.

In every plant there is a certain amount of fuel loss that is out of the control of the operator; this depends largely on the efficiency of the stoker machinery used. It should be the practice to operate the boiler plant at the highest efficiency possible. Then if something new is brought out that will save enough above the old method to make its installation profitable it is time to go before the executive officers and argue the case.

There are plenty of good operating engineers, but few real chief engineers, and after the way the man who pays the bills has been stung it is a wonder that improvements are not harder to get than they are.

There is one mistake that the majority of companies make—they do not take their chief engineers into their confidence enough, whereas they should consider them as acting officers and should keep in touch with them, for they are the connection between the executive officers and the men. To get the best results they must all work together. C. D. DISPENNETTE.

Columbus, Ohio.

Excess Furnace Air Supply

Several communications have been published recently regarding excess air leaking into boiler furnaces through the cracks in the brick setting. Even though the setting may be in the best of shape, most furnaces are operated with too large an amount of excess air. Proper furnace operation, such as to obtain the best combustion of the fuel, should be had with not more than 40 per cent excess air. Air above the amount required for proper combustion, dilutes the gases and carries heat up the chimney; and not taking into account the heat that is lost in the chimney gases, the admission of excess air also causes furnace losses due to incomplete combustion because of the low temperature created in the furnace.

Most engineers, if asked to give an opinion, would say that a cracked boiler setting is a sure sign of excess air. This does not necessarily follow because it can be considered only when compared with the air entering the furnace from the ash pit or through the furnace doors while firing. If the pressure in the furnace is greater than that on the outside, air will pass out of instead of into the furnace.

Air readily passes through a clean fire, and therefore a large amount of fuel can be burned and what air leaks in through the setting will, under such conditions, be but a small part of the total admitted to the furnace. If the fire becomes dirty and filled with clinkers, a less volume of air will pass through the fuel bed and the air leaking into the furnace through the setting will be a much larger part of the total used.

Air leaking through the brick fittings is of much less importance than that leaking into the furnace through holes in the fire. Therefore, firemen should be careful not to carry too thin a fire and also to keep the fire evenly distributed on the grate. There is a large amount of combustible gases rising from the fuel, and it is therefore, essential that the proper amount of air be supplied above the fuel bed.

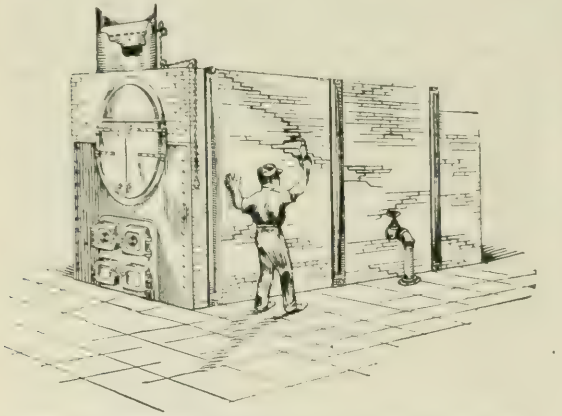


FIG. 1. DETECTING AIR LEAKS IN BRICK SETTING WITH A LIGHTED TORCH

What has been said does not mean that air should be allowed to leak through the setting. All air leakage should be stopped and all air admitted to a furnace should be under control of a fireman. Every crack is admitting air to cool the heating surface of the boiler. It has been estimated that the loss due to air leaking into a furnace is 10 per cent of the heat generated in the furnace in the average heating plant.

There are various ways of determining where the brick setting is leaking air. One is by holding a lighted candle at the cracked places, Fig. 1, around the boiler drums, clean-out doors and where the blowoff-pipe comes out through the setting. If the damper is in the "wide open" position the flame of the candle or torch will be drawn into the crack. Another method is to fire up with fresh fuel with the damper wide open and then close it tight, when smoke will issue from the cracks and crevices. Marking such spaces with chalk will enable one to make repairs to the setting whenever the opportunity arrives.

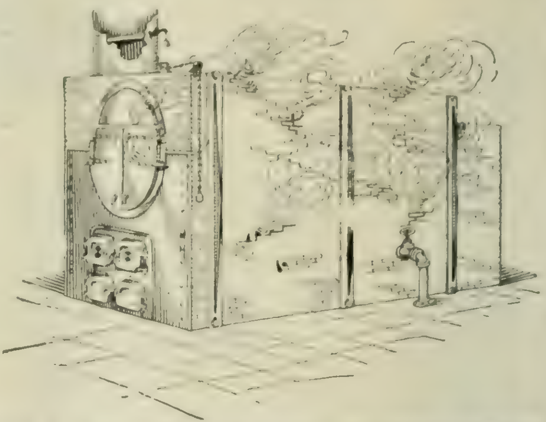


FIG. 2. SMOKE FROM FRESHLY FINE FIRE DISCLOSES AIR LEAKS

When repairing cracked fittings, do not smear mortar into the cracks, but first remove the old mortar in the joints of the brickwork to the depth of at least one inch and clean off the face of the brick with an old bastard file. Then point up the brick with cement mortar and fireclay to which enough ammonia has been added to give off a strong odor. The ammonia retards the setting of the mortar and makes it more able to resist the changing temperature of the brickwork. If possible, allow the mortar to stand for three days before firing up the boiler. A coat of asphalt paint makes a very good finish for the brickwork. C. E. ANDERS.

Cleveland, Ohio.

Air Kept Centrifugal Pump Cool

We are operating a five-inch two-stage centrifugal pump several hours per day with no load, on account of its being belted to an engine that drives other machinery.

When the unit was first started, we closed the suction and the discharge lines, and opened a 2-in. pipe connection to the atmosphere. The small amount of water that was discharged into the pump casing from the thrust bearing and from the two lanterns in the stuffing boxes would not keep the pump casing cool enough. It was found out by one of our engineers that by opening all six of the air cocks on top of the pump enough air would be drawn in to keep the pump cool.

Canton, Miss. JOHN T. SHARP, JR.

Ventilation of Coal in Storage

Possibly if I knew more about the subject I would not be writing this letter, but the article "Ventilation of Coal in Storage," page 618 of Oct. 19 issue, is very interesting and the idea occurred to me that coal might be ventilated by means of compressed air. Not having data on hand as to the importance of this subject, of the capacity of storage wherein the problem presents itself, and other information on which to base figures, I cannot say whether compressed air would be commercially feasible.

As the service of compressed air to ventilate coal would undoubtedly be required at infrequent intervals, simply at such times as heat in stored coal becomes excessive, the idea may be practical. CURTISS MAIN.

New York City.

Why Does a Leaky Compressor Valve Get Hot?

I am operating, along with other machinery, a motor-driven air-compressor that runs against a 300 lb. per sq.in. discharge pressure.

This compressor is a two-stage machine and we often have trouble from leaky valves. Whenever the gage on the discharge line drops I know a valve is leaking, but I can never tell which one. Since it means removing a dozen valves to find the bad one, it was a help when the chief told me that a leaky valve always gets hotter than usual and that I could always depend on this to locate the leak. As it is usually one of the high-pressure discharge valves that leaks, I would like to know just why it gets hot. Will some *Power* reader explain to me the reason? DONALD MCFEE.

New York City.

Diesel Indicator Cards

I am operating a 500-hp. Diesel oil engine which runs at 164 revolutions per minute and am sending two indicator diagrams for criticism by *Power* readers. These diagrams are from No. 1 and No. 4 cylinders and were taken while the engine was carrying 480 brake horsepower.

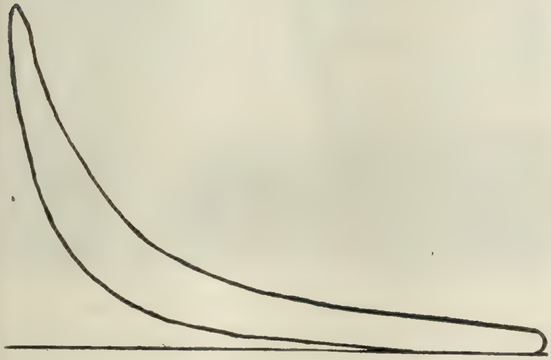


FIG. 1. FROM NO. 1 CYLINDER, 89 LB. M.E.P.

I have seen a number of diagrams published in *Power* and in various books. All that were classed as good had a fairly flat combustion line. In the cards which I send there does not appear to be any combustion line at constant pressure. In fact, they look to me as though the combustion was an explosion, as in the Otto-cycle engine.

I would like to have someone who is familiar with Diesel engines explain this to me and give some information as to how to avoid the sharpness of the diagram and to give a flatness to the combustion line.

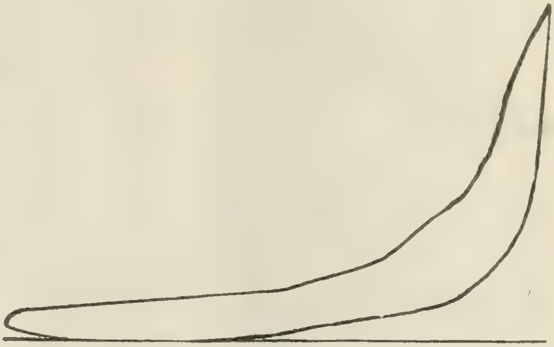


FIG. 2. FROM NO. 4 CYLINDER, 90 LB. M.E.P.

Kansas City, Mo. G. POWELL.

Pounding in Two-Cycle Gas Engine

The several letters appearing in *Power* concerning pounding in a semi-Diesel oil engine recall to mind similar difficulties I once had with a two-cycle gas engine.

This gas engine had a throttling governor on the gas supply; the engine used a qualitative mixture. On low loads the mixture was weak since the governor throttled the gas supply. On full load the governor increased the richness of the mixture and after running a few minutes the engine would begin to pound; as the load increased the thumping grew stronger, and if overloaded, the noise was such that to the uninitiated it seemed the engine would break to pieces. In fact, I shut it down more than once, thinking something was broken inside the crankcase.

The only thing that would stop the pounding was the partial closing of the gas throttle on full load. In this way the engine drew in a leaner mixture and the pounding ceased. Often, as the engine began to die down, I closed the throttle a slight amount and the machine immediately came up to speed.

It is apparent that on heavy loads the mixture was so rich that it exploded early in the stroke when the compression rose above the self-ignition temperature. The pounding, of course, came from the preignitions.

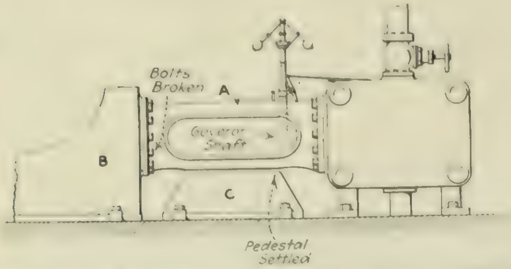
I also found that if the ignition timing was late with a weak mixture, the engine would not carry so much load and pounded badly. This was due to the crank passing dead center before the gas ignited; any looseness in the bearing was made evident by the pound.

A "sticky" or seized piston will also cause a pound. In such cases the piston has a close fit and, as it expands from the heat, grips the cylinder walls. The remedy is to turn off a few thousandths of an inch, beginning at the second ring from the top and making the cut a taper. EARL PAGETT.

Cherryvale, Kan.

Peculiar Thump on a Corliss Engine

I was called upon recently to overhaul a 600-hp. double-eccentric non-condensing Corliss engine that had given considerable trouble. On dismantling the engine, I discovered that the connecting rod had been rubbing against the crank disc while passing the back center, and by the appearance of the rod it must have been run for some time in that position, as there was an impression on the side toward the disc six inches long and from nothing to one-fourth-inch deep. This was caused by the crankshaft being out of alignment. The peculiar part of this incident is that the operating force claims that the bearings never overheated under these conditions.



STUD BOLTS BROKEN, CAUSED BY PEDESTAL SETTLING

It was necessary to turn the crankpin and put in new brasses and new shoes, brasses and a pin in the crosshead and line up the engine. When the engine was again put in operation, it ran very smoothly and gave no trouble for about three months; then it started to develop a thump that sounded very much as though the piston was striking the back head, but on stopping the engine and locating the striking points we found them to be all right. When it was started again, there was no knock or thump for two days; then it started to thump at intervals of about three or four minutes for about an hour, when it stopped. This continued off and on for three months, and during this time I visited the plant every Sunday to work on the engine when it was down, and once or twice a week when it was under load. I indicated the engine several times under different loads and steam pressures, but this did not bring me any nearer to solving the difficulty.

Then I decided to call in two engineers in consultation to see if we could locate the difficulty, but after spending eight hours going through all the procedures we could think of that would overcome the trouble, we were no nearer a solution than when we started.

While putting the indicator on, I heard a faint squeaking noise as though something needed oil; I asked the oiler what that was, and he said it was the governor pulley rubbing the safety guard. On looking at it, I saw that the pulley was striking on one side, and by watching it I noticed that it would strike when the engine was on the back stroke, and as the governor shaft is fastened to the crosshead piece *A*, it showed that the connecting piece was moving first one way and then the other at right angles to the stroke of the engine.

On closer inspection I discovered that of the twenty bolts holding the distance piece to the frame *B* of the engine all were broken but three, two on the bottom and one on the top, caused by the pedestal *C* settling about a quarter of an inch, which allowed the distance piece to spring, causing the crosshead to twist on the back stroke and throwing the crank end of the rod against the disc when the load was at a certain point. After the bolts had been renewed and the pedestal raised to place the thumping ceased. C. J. MILLER.

North Tonawanda, N. Y.

Prevented Steam in Compressor Water Jacket

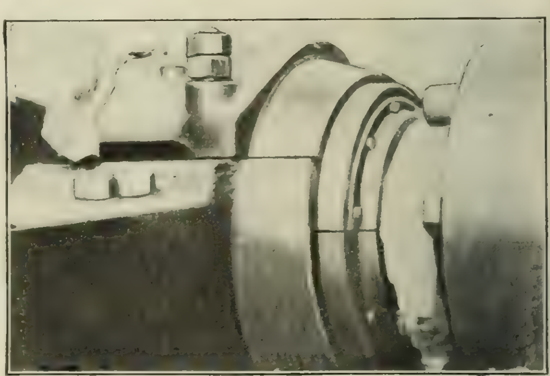
A well-known type of cross-compound air compressor was sent out from the factory with a ¼-in. pet-cock screwed into the highest part of the water jacket on the low-pressure cylinder for releasing the steam that might accumulate at this point. It was found that in practice this cock was seldom opened, and to obviate this non-automatic feature, it was removed and enough ¼-in. pipe and fittings used to run this discharge to the funnel that catches the cooling water coming from the cylinder. A small part of the cooling water is discharged from this pipe and thus prevents any accumulation of steam.

Canton, Miss. JOHN T. SHARP.

Repair to a Diesel Main Bearing

Fractured Diesel crankshafts are not of everyday occurrence. When one does let go, usually some other engine part suffers.

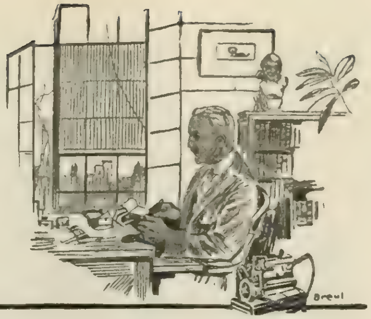
In a recent crankshaft failure the section next to the flywheel was thrown to one side, breaking the end main bearing. The upper half of the bearing housing was broken away, taking with it a part of the lower housing. The upper half, with an entire new shell, was secured from the manufacturer. To repair the fracture in the lower part, electric welding was resorted to. The surface was thoroughly cleaned and a row of steel studs inserted into tapped holes along the break. The welding material was then built up around these studs. From an examination of the repair it seems that the added material has not actually united with the cast iron of the base. The steel studs apparently were welded into the added material and serve to bond the two parts together. The bearing is perfectly satisfactory in service, and the weld shows no signs of giving way. E. E. SNOW.



WELDED DIESEL BEARING

New York City.

INQUIRIES OF GENERAL INTEREST



Advantage of Multi-Valves for Pumps—Why are many small valves used in a pump instead of a few large ones?
C. T. C.

Small valves have less lift and therefore can open and close quicker and are subjected to less wear from pounding on their seats; there is less friction, and the shorter studs or spindles are less likely to become broken from shocks or unequal distribution of pressure; they are cheaper to construct and repair, and the valve seats are easier to replace than those of larger valves.

Burning Mixed Sizes of Coal—For hand-firing boilers, is it better to stoke mixed sizes of coal or fire with one size at a time?
R. N. G.

The best results are obtained when there is greatest uniformity in size of the coal. When large and small sizes are mixed together in equal proportions there is more obstruction to the draft than from use of only a smaller size, as the fire becomes dirty before the larger sizes have been consumed and in cleaning the fire there is greater waste of unburned coal. Greater economy is to be obtained by suitably firing the different sizes separately, and if that is not practicable for obtaining the necessary boiler capacity the different sizes should be stoked in alternate layers with changes of size and thickness of the layers so timed as to obtain complete combustion.

Advantages of Early Release—What is the advantage of releasing steam before the end of the expansion stroke?
W. B. G.

Since some area of the indicator diagram must be lost in expelling the exhaust it is better that the loss should be above than below the expansion line, for in bringing the piston to rest at the end of the stroke there is no object in keeping up the forward pressure near the end of the stroke at the expense of requiring higher compression on the opposite side of the piston. When a condenser is used release before the end of the stroke insures prompter realization of the vacuum for the return stroke with a larger percentage of the load thrown on the condenser, as the larger area in the vacuum portion of the diagram calls for earlier cutoff and less initial steam.

Hunting of Shaft-Governed Engine—What makes a shaft-governed engine hunt?
A. H.

The force of governor springs and effective centrifugal force of the weights are unbalanced and alternate in overcoming each other. The remedy is to give less tension on the springs to decrease sensitiveness, and changing the weight to get the desired speed. Hunting and racing may be caused also by friction of the governor parts or connections. When caused by friction the weights will remain on their inner position until the speed developed is so high as to throw them out with a noise; or when the engine is above speed they will stick where they are until the speed is reduced enough for the springs to draw the weights back again.

Safe Temperature for Storage of Ammonia Drums—What is the safe temperature for storage of ammonia in drums?
A. H.

Liquid-ammonia drums are supposed to be made strong enough for handling the ammonia without danger of rupture of the drums from pressure of ammonia that would be due to ordinary atmospheric temperatures. The safe temperature for storage of ammonia in drums, therefore, should be considered as not higher than about 80 deg. F. But to insure against absorption of heat to a high temperature, ammonia drums should not be exposed to the direct rays of the sun; that is, they should be kept in the shade and the drums should not be stored in a place like an engine or boiler room, where they may become heated to a higher temperature than about 80 deg. F.

Horsepower Required to Raise Water—What number of horsepower would be required to raise 2,500 gal. of water to a height of 60 ft.?
W. S. R.

Horsepower is a rate of doing work, and the number of horsepower required to be developed while raising 2,500 gal. of water to an elevation of 60 ft. at a uniform rate would depend on the time employed. A gallon of water weighs 8.33 lb., and 2,500 gal. would weigh $2{,}500 \times 8.33 = 20{,}833$ lb. If the pumpage of 2,500 gal. is performed in one hour, then there would be $20{,}833 \div 60 = 347.2$ lb. of water pumped per minute; and if elevated 60 ft. the net work would be $347.2 \times 60 = 20{,}833$ ft.-lb. per minute. As one horsepower is development of work at the rate of 33,000 ft.-lb. per minute the net power developed would be at the rate of $20{,}833 \div 33{,}000 = 0.6$ hp. Neglecting pipe friction, the power required to be developed on the steam end of a pump to develop an actual or net horsepower, would depend on the mechanical efficiency of the pump. For pumps of the size required the mechanical efficiency would be about 60 per cent, and the power required to be developed on the steam end for development of 0.6 hp. in the water end would be about $0.6 \div 0.6 = 1$ i.hp.

Drier Steam With Reduction of Pressure From Wiredrawing—How does steam become drier or superheated by the process of wiredrawing?
E. M.

When steam flows through an aperture the discharge takes place in consequence of the difference in pressure on opposite sides of the aperture, and in its passage through a reducing valve or other form of opening, without doing any external work, there is practically neither loss nor gain of heat per pound of the steam. There is relatively small loss due to work required for overcoming inertia, and the heat that is converted into work required for overcoming friction is restored to the steam or, under favorable conditions, a portion of it may be lost by radiation. Hence, ordinarily, after thus expanding to a reduced pressure, each pound of the steam contains more heat than necessary for the same percentage of dryness that it had at the initial pressure; so that the process of wiredrawing, whether performed by passing the steam through a throttled valve, a pressure-reducing valve or other form of aperture, converts wet steam into a drier steam at the lower pressure, dry steam to steam that is superheated for the lower pressure, or may convert superheated steam to steam at a lower pressure with more degrees of superheating for the lower pressure than it had for the initial pressure.

Notable Meeting Marks 40th Anniversary A.S.M.E.

Four Founder Societies Join in Celebration—"Opportunity and Responsibility of the Engineer" Discussed—Prominent Representatives of Capital, Labor and Management Heard—William B. Dickson Startles His Hearers

"AGE is an enfeebling influence in the lives of men, but to associations of men it may give ever-increasing vitality, strength and influence." With this aptly chosen thought, President Fred J. Miller opened the Anniversary Meeting of the American Society of Mechanical Engineers on the evening of Nov. 5. After a few introductory remarks, he presented the first "speaker," the Magnavox. This is an electrical sound-reproducing instrument which has been developed by Prof. Bristol, a member of the society. A double-faced record was used; the first side gave a message of greeting from Ira N. Hollis, past president of the A. S. M. E., and when the second side was used, President Miller had the unique experience of listening to himself making a speech.

The subject of the evening had been announced as "The Opportunity and Responsibility of the Engineer," but before introducing the principal speakers, President Miller called upon the representatives of the four founder societies for brief addresses.

FOUNDER SOCIETIES PARTICIPATE

The first of these speakers was Henry R. Towne, the oldest living past president of the A. S. M. E. Mr. Towne gave some reminiscences of the early days of the society. He recalled that he became a member in 1882 and attended his first meeting in October of 1883. The attendance at that meeting was 150, and the number of members was about 600. For the year 1883, continued Mr. Towne, the society's income was $7,560; of this $7.56 was a balance carried over from the previous year. These figures provide an interesting comparison with the $500,000 budget proposed for the coming year. Mr. Towne discussed a paper which he had presented at a Chicago meeting of the society in 1886, entitled, "The Engineer as an Economist." At that time he proposed that engineers take up the responsibility of the study of economic and allied subjects. The idea has since taken root, and indeed, the interest of engineers in the subject of economics was amply demonstrated by the program which was to be presented that very evening. As a result of this responsibility, which engineers have accepted, it becomes their duty not only to secure efficiency of methods and machines, but also to work for co-operation among those who direct the processes of industry and those who perform the work.

A. P. Davis, president of the American Society of Civil Engineers, presented the greetings of his organization, which is the oldest engineering society in the United States, and congratulated the A. S. M. E. on its rapid growth and ever-widening activities. He expressed strongly the hope that the American Society of Civil Engineers and other associations would join the Federated American Engineering Societies, and in this way expand the usefulness of engineers all over the country. "The minds of mankind," he said, "are in a state of flux." It is the duty of engineers to crystallize the thought and guide the energy of men in the right direction.

W. L. Saunders was introduced as the past president of the American Institute of Mining and Metallurgical Engineers, and also as the representative of Herbert Hoover, president of that society. Mr. Saunders pointed out that the object of the meeting was to bring home the achievements of the past forty years, but suggested that the members should devote their attention also to retaining the advantages that have been won and carrying them to greater usefulness. He gave it as his opinion that the profession of mechanical engineering is a basic one and is even of more importance than any other branch of engineering. The big men of the civil, electrical and mining branches, he said, must have a thorough knowledge of mechanical engineering as a foundation, because in all their work they must depend upon machinery of one kind or another. He felt that the spirit of collectivism versus individualism is admirably represented by the four Founder Societies.

Mr. Scott, past president of the American Institute of Electrical Engineers, illustrated his speech with lantern slides, showing a comparison between the increase in population in the United States during the past forty years and the increase in the use of various products of the engineer's resourcefulness. These slides demonstrated the speaker's point that engineering progress has been extremely rapid, until now, with the creation of the great forces liberated by engineering genius, has come a very great responsibility of the engineer in the way of controlling these forces and keeping them in operation. As to the opportunities of the engineer, he pictured the field as most inviting. Our methods, though we have continually improved them, are still wasteful and inefficient, and in this lies the engineer's great opportunity. The solution of labor troubles is another opportunity before the profession today, and when Mr. Scott said, "The modern engineer is a director of human activities as well as of inanimate operations," Mr. Gompers voiced his approval by starting the applause.

Mr. Miller then drew a laugh from his audience by saying that engineers sometimes have some business to do with banks and that, therefore, they should be interested in hearing an address from the next speaker, whom he introduced as J. Herbert Case, acting governor of the Federal Reserve Bank of New York.

THE BANKER A FINANCIAL ENGINEER

Mr. Case congratulated the society upon its forty years of progress and upon the fact that its list of members represents a roster of men who are leaders in thought and action. He pointed out that three directors of the Federal Reserve Bank of New York were drawn from the membership of the American Society of Mechanical Engineers. Mr. Case's address was a thoughtful one, carefully prepared and notable for its frequent use of analogies. In fact, his entire speech was based on the parallel which he drew between the engineer and the banker. In this connection he called the attention of his hearers to the fact that the constitution of the Federated American Engineering Societies defines engineering as "the science of controlling the forces and of utilizing the materials of nature for the benefit of man." He then went on to develop his idea that bankers have essentially the same problems before them as engineers; he referred to bankers as financial engineers and said that they are now coming to use essentially engineering methods. He felt strongly that the recent period of inflation, which we are apparently passing in safety, might have developed into a very serious crisis had it not been for the preparations made by bankers to meet just such a contingency. These preparations consisted principally in the establishment of the Federal Reserve system, by which one-third of the number of banks in the country, representing two-thirds of our banking resources, have practically pooled their resources to the end that individual failures may be averted. This action Mr. Case compared to the allowance made by engineers for a "factor of safety"; the idea being, in both cases, to provide beforehand whatever strength will be needed to cope with any emergency that may arise. The speaker suggested that it is not unreasonable to suppose, that as a result of improved financial methods, we have probably seen our last general panic. "But," he continued, "I look farther ahead than that." As engineers are never satisfied with the machines they have created, but continually work and strive to improve upon them, so bankers will finally improve their methods to such a point that they can avoid not only catastrophies such as panics, but even the minor crises and financial disturbances which trouble us so greatly today. It ought to be possible in this way to restrain American enthusiasm from going beyond the safety point and to apply the brakes efficiently, yet gradually; it should be possible to develop a smoothly working governor that would free us from our present troubles with fluctuations in prices. Mr. Case emphasized the point that if we can do this, we shall have gone a long way in the elimination of social and labor disturbances; and in conclusion said:

"You have given American engineers and American engineering the highest place in the world. Some of your achievements, the feats that you have accomplished, are among the marvels of mankind. You have set a wonderful and, I may say, a difficult example to follow. What I wish you to know is that much the same ideas, much the same aims and methods, are at work now in the development of the Federal Reserve System of the United States."

The Labor Point of View

Samuel Gompers, president of the American Federation of Labor, was the next speaker. The keynote of his address was to the effect that "One of the difficulties that arise nowadays about our discussion of responsibility is that we fail to realize that professional men, whether doctors, lawyers or engineers, should be in a very real sense agents of society and not merely masters in their particular professions." He thought it unnecessary to review the achievements of engineers in mechanical ways, but declared that a very serious error is frequently made in describing manufactured articles as the product of an industry. It is not the inanimate objects produced in the factory that count; it is the men developed there. In other words, "men, not things, are the true goal of civilization." In a realization of this fact lies the engineer's opportunity to develop co-operation between capital and labor. There is a great future ahead for both capital and labor if they will join hands with engineers and make an effort to improve the conditions of labor, to give the workman a chance for self-expression in his daily work and to relieve the deadly monotony of repetition work, which is the principal cause of labor troubles. In our mad rush for efficiency we have allowed the man to become too greatly a part of the machine. The old spirit of craftsmanship has gone, so that men's work today tends to become mere toil. Mr. Gompers drove home his point with this vivid warning: "Beware that the machines you create do not become a Frankenstein and enslave the human race." The avoidance of this danger is a part of the coming responsibility of the engineer. In conclusion Mr. Gompers said: "If you will study the laws of humanity with the same degree of intensity that you study the laws of material science, you will render a tremendous service, and as president of the American Federation of Labor it is my firm conviction that the labor movement not only welcomes, but invites, your co-operation."

Radical Stand Taken by Mr. Dickson

The next speaker was William B. Dickson, the vice president of the Midvale Steel and Ordnance Co. Mr. Dickson's address was remarkable for the fact that he so frankly and so whole-heartedly espoused the cause of the workingman. In fact, he was hardly less emphatic than Mr. Gompers himself. For this reason his speech may be said to have been the feature of the evening. Mr. Dickson expressed the same thought which had just previously been spoken by Mr. Gompers; namely, that our modern system of the division of labor, consisting in the assignment of a highly specialized task to each individual workman, has deprived men of the joy which they once secured through the exercise of creative instinct in their work. The result of this condition, he said, will tend to stunt men mentally, morally and physically, unless it is counteracted by some other vital force. It cannot be met by reverting to original and obsolete methods; our factories must continue to produce efficiently, but not at such a sacrifice of individuality. "This is a human problem," said Mr. Dickson, "and I have not been able to solve it, so I am leaving it to you." He then read a poem on efficiency by Walter Prichard Eaton. "It has been said," he continued, "that free government is more important than good government. I believe that this is substantially true; and I would say that if there must be a choice, it is better to be free and inefficient than to secure efficiency by having men become mere cogs in a complex social machine, operated by a so-called superior class. I am afraid that we are making a fetish of efficiency." There is, however, another broader and more important question than this; it is the great issue between democracy and autocracy. We have been accustomed to consider that this question was solved in 1776, as indeed it was, politically; but in industry the present tendency is to revert to the feudal system of despotism. This has been exemplified in the past few months by restriction of production, and even the closing down of plants, with the object of holding prices up. An example that is still fresh in our memory is that of the large textile mills which were shut down completely, resulting in great suffering to the entire community. It is this "unconscious insolence of conscious power" which is at the root of our industrial difficulties. "Consider, for a moment," said Mr. Dickson, "the despotic power which our modern system of industry gives a few men over the lives and fortunes of hundreds of thousands of their fellow citizens. By reason of this condition we have the unstable situation of a government founded on the suffrages of men who, for all practical purposes, are industrially bondsmen." We are approaching the time when we shall need an industrial Lincoln, to say: "A house divided against itself cannot stand; this nation cannot continue to exist politically democratic but economically autocratic." The appreciation of the audience at this point resulted in a round of applause, which was again led by the president of the American Federation of Labor. In fact, Mr. Gompers, after the first few moments of Mr. Dickson's address, seemed to be enjoying himself thoroughly.

Constructive Recommendations

Mr. Dickson declared himself to be in favor of a fair system of collective bargaining and of giving workmen some share in the conduct of business, probably through applying a portion of their wages to the purchase of stock in the company. These systems, of course, must be designed to meet the needs of the particular plants which are to use them; and unless they are permeated with democratic principles there can be no solution of our labor troubles. To paraphrase St. Paul, "Though they pay the highest wages, give pensions, and furnish every modern convenience and safeguard to their workmen, and have not democracy, it profiteth them nothing." Some people may claim, however, that they are satisfied with present conditions and do not desire a change. This is only an evasion of the issue. The choice does not lie between industrial democracy and the present way of doing things; it lies between industrial democracy and a condition of chaos and feudalism such as we see in Russia today.

The speaker offered two suggestions to meet the situation. First, he said that we should democratize industry, giving recognition to management and labor as equal partners with capital; and second, we should teach democracy in the schools as thoroughly as we now teach reading, writing and arithmetic, so that the coming generation will be thoroughly grounded in democratic principles.

"I am not looking forward," concluded Mr. Dickson, "to the new era of industrial democracy as a period of peace and serenity, but rather as a time in which the way has been cleared for a further toilsome climb up the spiral of evolution."

Between the speeches President Miller read a number of congratulatory telegrams, notably those from Herbert Hoover, E. S. Carman, the president-elect of the society, Governor Coolidge and Senator Harding.

The best thing about this meeting was that it had what the college boy calls "pep." The speeches were not idly flattering outpourings of verbiage; they represented the carefully thought out and deliberately expressed opinions of some very able men. The American Society of Mechanical Engineers deserves great credit for having arranged and conducted such a successful meeting.

Revision of Standard Petroleum Specifications

The revision of the standard specifications for petroleum products which guides all Government petroleum purchases is under consideration by the committee which represents the various Government departments, as designated by the President to participate in this work in the original order of July, 1918. The public conference on this matter which was held Oct. 18 in Washington was attended by representatives of all the Government departments interested, state oil inspectors, oil producing and refining interests, and automotive interests.

The specifications particularly under consideration were those for gasoline, kerosene, burning oils, fuel oils and a wide variety of lubricants. In executive session the committee continued consideration of the proposals for the two days following the public conference, and it is expected that the revision of the standards will be completed within a short time and revised standards published covering all these materials. In this connection it should be understood that the committee will continue only until six months after the proclamation of peace, as it is one of the wartime agencies still functioning. Nominally, the specifications which it adopts relate only to Government purchases of petroleum, but in practice a number of states are adopting the specifications, particularly those for gasoline, and a number of large purchasers outside the Government also use them. They are, therefore, of much wider significance and interest than otherwise.

STATE ADOPTIONS OF FEDERAL STANDARDS

Four states have already adopted the motor gasoline specifications of this Federal committee, and others give evidence that they are likely to do so. Some states are writing the specifications into the state law; others simply provide that the latest specification of the committee shall govern, or place the matter in the hands of a commissioner. The question of states rights as compared with Federal supervision of course enters as a factor. The question also is raised as to what will be the significance of these state laws when the present committee no longer exists.

The advantage of state regulation in contrast with Federal legislation seems to be wholly with the smaller refiners, who like to have different standards which will permit disposal of their poorer products in states where less rigid requirements prevail. It was the consensus of opinion that in every state whose laws do specify gasoline standards, the refiners, and particularly the larger operators, are very careful as to the quality of material shipped into that state. It seemed to be generally agreed that a uniform law for the entire country would not in any way reduce the total gasoline production. It would interfere, however, with careless operations in interstate traffic, especially by tank-wagon practice near certain state border lines, and would also necessitate improvement of plant practice by some of the smaller operators. The large advantage in uniform standards for all of the country would be economy in storage and handling, for only a single set of gasoline-handling equipment would be essential under such circumstances, except of course for special gasolines such as aviation fuel, dry-cleaning gasolines, etc.

The question was raised whether the companies would all actually comply with a general standard were it adopted. Almost unanimous opinion prevailed that there would be no difficulty in securing compliance, despite the fact that at the present time much of the gasoline does not comply with existing standards as shown by the recent reports of the Bureau of Mines. The characteristics of gasoline now supplied were believed to be the result of the freedom in practice which is possible rather than the result of any necessity.

GASOLINE SPECIFICATIONS

The original motor-gasoline specifications proposed by the committee in October, 1918, were revised and a new form made effective Nov. 25, 1919. This revised specification provides for a distillation test as the chief requirement.

Refiners present agreed that careful preparation of gasoline to comply with the specifications in the proposed modified form would permit large increases in output. It was stated that small refiners could increase their output by more careful plant operation, since the same bad plant practice which gives a high maximum temperature in distillation also results in leaving a larger percentage of gasoline in the higher oils than is necessary or desirable.

It is evident that the committee will take pains to increase the definiteness and simplicity of the specifications as to how the distillation test will be made. The committee feels that it is even more important to have uniform and significant methods of testing than it is to get exactly uniform specifications. No conclusion was indicated by the committee nor was a general agreement in opinion of the refiners evident on the question of the number of olephines permissible in a cracked gasoline.

NAVY FUEL-OIL SPECIFICATIONS

It was proposed that the specifications for navy fuel oil, which now are based largely upon the specific gravity tests, should be changed and viscosity of the oil substituted as the important criterion. It was pointed out that a 16 deg. Bé. fuel oil made from Pennsylvania crude could not be handled in any way except with shovels because of its very high viscosity. Agreement seemed to be unanimous that the gravity means even less with fuel oils than with motor gasoline, and that the viscosity requirements should be chosen to be those corresponding to the fuel oils now received by the Navy under grades A, B and C, these being made from Mexican crude.

It was agreed that the viscosity requirements should be based upon tests with the new type of Saybolt fuel-oil viscosimeter used at 122 deg. F. This is the temperature for which this apparatus is commonly built for testing road oils; at this temperature it gives results in from seven to ten minutes, which cannot be obtained in less than two or three hours with the older types of viscosimeter.

DIESEL-OIL REQUIREMENTS

It was pointed out that the present requirements of no asphaltum in gas oil for Diesel engines have no real significance, as there is no means of knowing either what this signifies or how to test for asphaltum. The question was discussed at length as to whether a distillate oil was essential for this work, and it was pointed out that in general distillate oils burn cleaner than crude residues. The committee indicated that some adjustment of this specification would be made after further consideration.

REQUIREMENTS FOR LUBRICANTS

The question of color requirements for lubricants raised some criticism of present specifications, and it was recommended to the committee that they consider transparency rather than color as the important factor. For this purpose the transparency of a quarter-inch layer should be sufficient to enable one to read ordinary print through it, according to one suggestion made.

The refiners emphasized particularly that cup-grease specifications should make no distinction between animal fats and vegetable fats nor between animal fats and fatty acids. The present requirements permit only pure animal fats for use in blending these greases, and it is believed that this would result in prohibitive cost if attempted. As a matter of fact, it is practically impossible to tell after blending what has been used, and in general the use exclusively of animal fats is no longer practiced.

Specifications now include provisions for a variety of miscellaneous lubricants, among which are the following: Aircraft machine-gun oil, buffer oil, transmission lubricant, steam-cylinder oils, compounded steam-cylinder oils, chain or wire-rope lubricant, gun and ice-machine oil, hydroline oil, aëro and motorcycle oil, marine-engine oil and oil and grease for the recoil mechanism of guns. It was pointed out that most of the specifications for these materials were very satisfactory. The large steam-evaporation losses from certain compounded cylinder oils were discussed, but no modification in specification was recommended as a remedy.

Progress Being Made in Adopting the A. S. M. E. Boiler Code

The administrative council of the American Uniform Boiler Law Society in its annual report has given encouraging news of its efforts for the adoption of the A. S. M. E. Code in the various states. These efforts have consisted in presenting the matter before the officials of different states, explaining the provisions of the code, smoothing out misunderstandings and giving out information of value to those interested. In regard to legislation, however, it was pointed out that only five state legislatures other than those which have already accepted the code have convened this year; it has been what might be termed an off year in legislation.

An interesting development is that the code is coming into general use in colleges and universities. The following universities now use it as a textbook: Massachusetts Institute of Technology, Sheffield Scientific School, Yale University, Armour Institute of Technology (Chicago), Case School of Applied Science (Cleveland), University of Vermont, University of Cincinnati, Johns Hopkins University (Baltimore), University of Michigan, University of Minnesota, Rensselaer Polytechnic Institute, Rutgers College and University of Texas. The code is being used as a reference book at the following universities: Vanderbilt University (Tennessee), New Mexico College of Agriculture and Mechanic Arts, Tulane University of Louisiana, University of Colorado, University of Washington, University of Maine, University of Wyoming, Virginia Polytechnic Institute and Washington University (St. Louis).

This is a most promising sign as it means that young men who will be engineers a few years hence will be conversant with boiler code practice; hence the adoption of the code should become a natural and easy step.

PROGRESS IN SEVERAL STATES

In Indiana there had been certain restrictions placed upon boilers which practically eliminated uniformity. This question was taken up in November, 1919, with the Industrial Board and the chief inspector, with the result that the board removed the restrictions and agreed to accept the A. S. M. E. Code in full.

In the same month a misunderstanding arose in California over the specifications that were required for boilers during the war period. The chairman of the Boiler-Law Society's committee, Charles E. Gorton, entered a conference with the state officials and two of the largest boiler manufacturers on the coast, upon their request. After a discussion covering several days the question was satisfactorily settled; and it was due to that fact that these two prominent manufacturers have since co-operated with the society so that it was possible to secure the adoption of the code in the state of Oregon.

On his way back from this conference in California Mr. Gorton stopped off in Little Rock, Ark., and had a meeting with the Hon. Thomas A. Wilson, State Labor Commissioner, and J. D. Newcomb, Jr., State Boiler Inspector. The outcome of this was that on March 1 Arkansas adopted the code and put it into full effect.

Progress has been made in Virginia in the way of collecting facts and figures relating to the boiler situation, although it has not yet been considered advisable to introduce a bill. Recommendations are being prepared for the coming session of the legislature.

Although it was declared impossible to secure a statewide law in Maryland such a law was introduced and passed, the provisions of which for the organization of the Board of Boiler Rules are to go into effect Jan. 1, 1921.

The state of Washington is expected to adopt the code within the next few months, and the city of Seattle has already done so.

There are now seventeen states which have adopted the A. S. M. E. Boiler Code, and of these Oregon, Utah, Arkansas and Maryland have been added this year. Eleven cities also now use the Code, Scranton and Seattle having accepted it this year.

Progress is being made in reconciling the more important points of difference between the Massachusetts Rules and those of the A. S. M. E., as reported in the account of the semi-annual hearing, elsewhere in this issue.

Power Scarcity a Factor in Electric Heat Treatment

Electric heat treatment was the subject discussed by the members of the Philadelphia Section, Association of Iron and Steel Electrical Engineers, at the Engineers' Club, Philadelphia, Nov. 6. A. J. Standing, section chairman, in opening the meeting, pointed out that the successful development of electric heat treatment required large quantities of cheap power, and the tying together of power plants will assist materially in accomplishing this end. The wide application of electric heat treating was explained by G. P. Mills, who also with lantern slides showed the construction of modern furnaces, method of control, etc. The control for electric furnaces has been developed to a state where it is possible to automatically maintain the temperature at within $\frac{1}{4}$ of 1 per cent of that required. An electric furnace is an ideal load for a power plant since it is balanced and has a high power factor and in many cases they can be used as off-peak loads. These furnaces have a thermal efficiency as high as 90 per cent and have been constructed for temperatures up to 1,800 deg. F. Power consumption ranges from 40 to 225 kw.-hr. per ton of metal treated.

J. E. Wilson told of his experience using oil for heat treating and expressed the opinion that the electric furnace was to be preferred to the oil-heated furnace. Mr. Wilson's experience had been with both the low-pressure and high-pressure type of furnaces, and he thought that there was a little preference between the two types. With the oil-type furnace it has been found necessary to reline it twice a year; the temperature is not easily controlled; care must be taken to have complete combustion; the furnaces are very hot to work around, especially in the summer time, and they are not all that could be desired from a safety-first standpoint. With oil at 15c. per gal. cost of heat treating was given ranging from 0.6 to 2.4 mills per pound of product treated.

In his paper J. R. Brown discussed the application of electricity to heating rivets. The electric rivet heater consists of a transformer having one turn in the secondary arranged so that the two ends of this turn are closed by placing the rivet in circuit. In heating rivets, as in heat treatment, the electrical method has many advantages over other methods. It is easily moved from one location to another, is sanitary, is easy of operation, etc. It has been found that the power consumption per 100 lb. of rivets heated is 14 kilowatt-hours.

Considerable discussion was centered on the possibility of obtaining power at this time for operating electric heat-treating furnaces, it being argued by some that there was a real power shortage and that burning a few tons of coal was an easy way to solve the heat-treating problem. Others pointed out that going around to the users of electric furnaces did not show any scarcity of power. As an illustration of the development in electric furnaces attention was called to those installed in 1913. To keep these in shape for operation took more time than they were in service, whereas the present furnace gives practically no trouble. In presenting the central-station side of the question, the opinion was expressed that the electric furnace load was a favorable one.

With the object of determining the possibilities of alcohol as a motor fuel the Empire Motor Fuel Committee of the Imperial Motor Transport Council, in England, has recently appointed small technical committees to consider the modification of custom and excise regulations pertaining to alcohol; to experiment for determining the best conditions for developing the alcohol engine, and the types of alcohol pure, alone or in mixture best suited for industrial purposes; and to develop methods of denaturing alcohol; that is, rendering it unpotable.

Coal Production Continues High

Production of soft coal during the week ending Oct. 30 not only continued above the 12,000,000 ton mark, but rose quite appreciably, according to the weekly report just received from the Geological Survey. In fact, a new maximum for the year was established by the total for the week of 12,338,000 net tons. This was 97,000 tons more than the preceding week, and except for the corresponding week of October, 1919, which was just before the great coal strike, has not been exceeded since the Armistice. It is predicted that production for the week ended Nov. 6 will fall considerably below this, on account of Election Day and religious holidays.

Reports showing the percentages of full-time output have been delayed, so that the latest figures available on that phase of the question are for the week ending Oct. 23. According to these figures, which are fairly representative of the country as a whole, losses attributed to labor amounted to 7 per cent of full time, out of a total loss due to all causes of 31.9 per cent. Transportation disability was the most important of all, causing losses of 20.8 per cent. The week was marked by an improvement in car supply, notably in West Virginia.

The Geological Survey bases its figures upon statements received from about 3,000 mines, which represent approximately 60 per cent of the total capacity of the country.

The *Bituminous Coal Bulletin* of the Federal Trade Commission for June, just now received, covers reports from only 555 operators, but contains some interesting figures on costs. There is some doubt as to whether these data are truly representative, as so few operators have reported; but it seems probable that the costs of those who refused to report are no greater, and possibly lower, than the costs of those who responded. Accordingly, they are presented here for what they are worth, together with corresponding figures for the year of 1918. The first number in each set given here represents the cost per ton for the year 1918, and the second is for the month of June, 1920: Labor cost, $1.49 and $2.02; supplies, $0.26 and $0.31; general expenses, $0.29 and $0.37; total cost, f.o.b. mine, $2.04 and $2.70; sales realization, $2.65 and $3.44; making a "margin" of $0.61 and $0.74. It should be remembered that margin is not profit, for selling expenses, interest, etc., must be deducted from it before the actual profit may be found.

As announced in *Power* last week, these bulletins of the Federal Trade Commission are to be suspended until the courts decide whether the commission can force operators to turn in reports instead of requesting it, as at present.

Semi-Annual Hearing of Massachusetts Board of Boiler Rules

The semi-annual hearing of the Massachusetts Board of Boiler Rules was held at the State House, Boston, on Nov. 4. John H. Plunkett, chief of inspections of the Department of Public Safety, of which department the boiler-inspection service became a part in the recent reorganization, is, by virtue of his office, chairman of the board, and presided at the hearing. The other members present were: Frederick A. Wallace, representing the boiler-using interest; Henry H. Lynch, representing the boiler-manufacturing interest; and John A. Collins, representing the boiler-insurance interest.

Mr. Plunkett explained that the purpose of the present hearing was a dual one—first, to hear petitions from those who desired changes in or interpretations of the Rules, and second, to submit for public discussion changes in the Rules which had been proposed on the initiative of the board itself, copies of which proposed changes had been published and made available to those interested.

The only petitions to appear under the first division of the program were the Buffalo-Springfield Road Roller Co., in reference to the location of the stamp upon their boilers, and the Keystone Driller Co., petitioning for the favorable consideration of the Porcupine Boiler which they manufacture.

The principal changes proposed by the board were the adoption of specifications for boiler plate steel, boiler-rivet steel, staybolt steel, steel bars, steel castings, gray-iron castings, malleable castings, boiler-rivet iron, staybolt iron, wrought-iron bars and lap-welded and seamless boiler tubes These specifications are, for the most part, those of the American Society for Testing Materials, which is the highest authority upon the subject, and as these specifications of the A. S. T. M. are used in the Boiler Code of the American Society of Mechanical Engineers, their adoption by the Massachusetts Board of Boiler Rules reduces the points of difference between these two codes. There were no engineering considerations urged against the adoption of the proposed changes, the only opposition being from Massachusetts boiler manufacturers who stigmatized the revision as "an entering wedge for the A. S. M. E. Boiler Code," to any attempt in the direction of uniformity with which they appear to be implacably opposed

French Hydro-Power Plants for the Rhine

The Comité économique regional de l'Est has submitted to the French government plans for the exploitation of the water power of the Rhine. These plans have been approved and will in the course of the near future be put into operation. It is proposed to build ten power plants between Hüningen and Strassburg, each estimated at 80,000 hp As Switzerland has certain rights relating to navigation on the Rhine, the plants will necessarily be erected some distance from the banks. The plans provide for a canal running parallel to the Rhine, which will feed the power stations. The total cost is estimated at 350,000,000 francs, but will probably be very much higher. The power thus obtained will be used for supplying the mining district of the French East, especially the Briey district.

The Versailles peace treaty provides that the water power of the Rhine along the German-French frontier is common property of both countries. In the case of new power plants the country building them has to recompense the other country up to half of the value of the produced power either by supplying power or by the money equivalent.

The Engineer, of London, reports a recent economizer explosion that was caused by improper handling. The economizer, which was in reasonably good condition, was used to heat feed water for three Lancashire boilers, and the flues were so arranged that the gases could be bypassed directly to the chimney. The accident was evidently caused by a sudden change in the temperature of the economizer tubes, which took place when the engine was started up in the morning. Just previous to this while the steam pressure was being raised but no demands made on the boilers, the economizer undoubtedly became very hot. When the engine was started, the feed pump, which was belt-driven from the main engine, forced the cold water into the economizer. The resultant contraction of the tubes cracked them, and they blew up under the steam pressure. The proper way to handle the plant would, of course, have been not to pass the hot gases from the fires through the economizer until feed water was needed by the boilers, and it might even be necessary, on account of leaky dampers, to keep down the temperature of the economizer during the night by giving it a little feed water. Added to these considerations it would be better, for the sake of economy in coal and for the prevention of external corrosion of the economizer tubes, if the feed water was warmed before being led to the economizer in the ordinary course of working.

That the coal situation is improving, in the opinion of the Interstate Commerce Commission, is shown by the order releasing 25,000 open-topped cars from the coal trade. Certain cars suitable for handling steel, sand, gravel, and other building and road materials were released from the coal priority order on Nov. 6. The cancellation of the Lake order and the maintenance of production in excess of 12,000,000 tons a week are doing a great deal to relieve the general situation.

Specific Heat and Dissociation in Internal-Combustion Engines

At the meeting of the Engineering Section of the British Association Committee on Gaseous Explosions, on Aug. 25, a paper relating to the subject of specific heat and dissociation in internal-combustion engines was presented by H. T. Tizard and D. R. Pye.

In this paper it was pointed out that the British Association Committee on Gaseous Explosions devoted a good deal of attention before the war to the question of the specified heat of the working fluid and the possible effects of dissociation of carbon dioxide and water vapor at high temperatures. Unfortunately, this work was interrupted by the war, and there had been in recent years very little advance in the thermo-dynamical theory of internal-combustion engines. On the other hand, there had been great practical advances, and the actual efficiency of a modern high-speed engine was higher than the theoretical efficiency calculated on the old specific heat figures of Clerk and Langer, even if no allowance was made for loss of heat. The relative advantages of different fuels, increase in efficiency to be expected from an increase in compression ratio, and the reasons for the change in power with different "mixtures" were, said the authors, all problems which had not yet been satisfactorily solved. For these reasons the authors were led to take up the subject afresh.

CALCULATING THERMAL EFFICIENCY FROM SPECIFIC HEATS

A method for calculating thermal efficiency from a knowledge of specific heats was worked out very completely by the late Professor Hopkinson in his paper on "The Thermal Efficiency of Gas Engines," but all work on these lines had suffered under two great disadvantages: (1) The specific heats of the gases concerned were not known at all accurately above 1,500 deg. C.; (2) the dissociation of CO_2 and H_2O in the cylinder was unknown, and no attempt had been made to separate the two effects of specific heat and of dissociation. As to the first point, there was ample evidence that the maximum temperature reached in a petrol engine was of the order of 2,500 deg. C. As to the second point, the Committee on Gaseous Explosions pointed out rightly that it was the "apparent" specific heat that was of primary importance for the theory of engine efficiency, and this included any effects of dissociation. But as the dissociation of CO_2 and H_2O was accompanied by an increase in the number of molecules, its extent depended considerably upon the pressure as well as the temperature. Further, since they had one dissociation product in common—namely, oxygen—dissociation in a mixture of the two was not the same as when they were separate; the extent of the dissociation of each would in fact depend on the ratio of the amounts present, and the "apparent" specific heat of a mixture might be very different to the sum of the "apparent" specific heats of each measured separately. The only possible way to attack the problem was to find the true specific heats and to measure the dissociation under definite conditions, from which it was possible to obtain sufficient data to calculate equilibrium conditions in any mixture. Sufficient data, we were reminded, already existed for this purpose. It was assumed in the first place that the only molecular species present after an explosion and during the expansion were CO_2, H_2O, CO, H_2, O_2, N_2, and at the high temperatures reached the reaction velocity was such that chemical equilibrium was always maintained throughout the working stroke. There was considerable evidence in favor of the substantial accuracy of this assumption. Mixtures of pure benzene with air were the subject of experiment. It was shown that the power curve should show a sharp maximum when benzene was present in the correct proportion for complete combustion to CO_2 and H_2O and should fall off steadily for both weaker and rich mixtures. This was contrary to observations, which in itself was evidence of "dissociation." When dissociation was taken into account it was shown that the power should remain constant to within about 1 per cent for mixtures ranging from the correct mixture to about 30 per cent rich mixtures. This was entirely confirmed by experiment. It was further predicted that the same curve of an engine running on a paraffin mixture should fall off more sharply with the richness of mixture than if benzene were used This had also been confirmed by experiments on Mr. Ricardo's experimental engine.

MAXIMUM THERMAL EFFICIENCIES WITH WEAK MIXTURES

Maximum thermal efficiencies in practice were obtained with mixtures so weak that any further weakening resulted in misfiring. Experiments by Watson and others had shown that that occurred when the amount of fuel present was only about 80 per cent of that required for complete combustion of the air. It was shown that if the compression ratio were 5 to 1 the theoretical efficiency, if there was no heat loss, should be 38 per cent of the heat of the fuel. Indicated thermal efficiencies as high as 70 per cent of the "air cycle efficiency"—equal to 33 per cent—were said to have been obtained in engines working at this compression ratio. The highest thermal efficiency under these conditions that the authors had been able to obtain was 32 per cent of the heat of the fuel. The difference between the calculated and observed values corresponded to a loss of heat during the working stroke of about 13 per cent of the heat of the fuel. Since the total loss of heat to the cylinder jackets was found to be about 25 per cent the correspondence between calculated and observed values must be considered very satisfactory. It was interesting to note that with weak mixtures the theoretical efficiency was about the same whether the gases were assumed to be dissociated or not. The effect of dissociation—which was about 20 per cent of the CO_2 present at the maximum temperature—was to lower the maximum temperature without affecting appreciably the work done on expansion. The maximum temperature for a benzene-air mixture was 2,700 deg. C., but was much lower for a paraffin-petrol-air mixture.

As regarded maximum power with different fuels, it was shown that when all factors were taken into account the maximum power with perfect distribution should be the same within 1 per cent for any kind of hydrocarbon fuel, if the initial charge temperature—or volumetric efficiency—and the compression ratio were constant. The maximum power with alcohol should be slightly lower, but as the latent heat of alcohol was high the charge temperature in practice was lower, and the maximum power reached the same as, or slightly higher than, that reached with hydro-carbon fuels. These conclusions had also been confirmed by experiment. Finally, it was shown that no other gases besides N_2, O_2, H_2, CO, CO_2, H_2O could exist in appreciable quantities in equilibrium during the explosion and expansion stroke. Methane could be formed during the exhaust stroke, and also aldehydes if the mixture was rich. The ratio of carbon monoxide to hydrogen in the exhaust gases under different conditions could be calculated. If a paraffin petrol was used the ratio H_2/CO was calculated as 0.4, whereas Bannatyne's empirical rule gave 0.36. With aromatic fuels this ratio would be very different.—*The Engineer.*

All restrictions against the use of power, except skip-stops in the operation of street railways, have been removed recently by the California state power administrator, H. G. Butler. Recent rains have made possible the lifting of the ban, and there will be no return to the restrictions unless there is a dry fall. In this event the power companies and the public will again be placed on a limited allowance of electricity. The present order, however, does not relieve the power companies from the necessity of operating their steam plants to capacity. There is still need for steam-generated power, the recent rains being sufficient only to relieve the immediate strain.

The American consul at Newcastle, New South Wales Australia, reports that the total amount of coal mined in that district in September was 468,000 tons, of which 117,600 tons was exported overseas; the remainder was for Australian consumption.

Water Power Applications

Additional applications have been made to the Federal Power Commission for preliminary permits as follows (the serial number, the name and address of the applicant, the type of project works, their location, and the use to which they are to be put are shown):

73. J. G Van Zandt, care W. L. Huber, First National Bank Building, San Francisco; Bear Creek and Santa Anna Creek, Cal.; reservoirs, conduit and power house; purpose, not given.

74. Electro-Metals Co., care W. G. Devereaux, 729 Call Building, San Francisco; dam, reservoir, tunnels, penstocks, power house; Salmon River; reduction of ores.

75. R. G. McDonald, Williams, Cal.; two power plants, reservoir, conduits; Convict Creek, Inyo Forest Reserve; mines, mills, pumping.

76. J. Harvey Pierce, 4838 Elmwood Ave., Los Angeles; three dams, three power houses; Mammoth Creek, Inyo Forest Reserve; mining and lighting.

77. Snow Mountain Water & Power Co., Standard Oil Building, San Francisco; two dams, conduits, reservoir, location not shown; public utility.

78. Western States Gas & Electric Co., Stockton, Cal.; enlargement American River conduit; South Fork, American River, El Dorado National Forest, Cal.; public utility.

79. William C. Albertson and Stephen L. Mershon, care Fort, Hunt & Shipman, Newark, N. J.; dam and power house; Delaware River at Foul Rift, two miles south of Belvidere, N. J.; use not stated.

Amazon-Dixie Mining Co., Wallace, Idaho; license; to construct transmission line over Lolo National Forest, Montana; use, mining.

Granite Falls Manufacturing Co., Granite Falls, N. C.; preliminary permit; dam, reservoir, conduit, power house, and transmission line on Wilson Creek, Caldwell County, North Carolina; use, public utility.

Alabama Power Co., Birmingham, Alabama; license; dam, power house and transmission line; Coosa River, at Duncan's Riffle, Ala.; use, uublic utility.

Paving Granite Quarry Co., Rapid City, S. D.; license; transmission line in Black Hills National Forest Preserve; use, quarrying.

Town of Ronan, Mont.; preliminary permit; dam, power house and transmission line; Crow Creek, Mont.; use, public utility.

Information About the State License Board

Engineers throughout New York State have for some time been anxious to know the names of the members of the new state board which is to have charge of granting licenses to professional engineers and land surveyors. **Power** has been able to secure these names from an authoritative source and presents them herewith. The members of this board have been selected with the object of providing representation for every important branch of the engineering profession. Their names, together with the branches which they represent, are: For mechanical engineering, Virgil M. Palmer, of the Eastman Kodak Co., Rochester; civil engineering, Col. W. J. Wilgus, consulting engineer, of New York City; mining engineering, Major Percy E. Barbour, consulting engineer, of New York City; electrical engineering, H. A. Reist, of the General Electric Co., Schenectady; electro-chemical engineering, A. H. Hooker, of the Hooker Electro-Chemical Co., Niagara Falls. The board's first meeting is set for Nov. 23.

A summary of the law through which this board will operate follows. It has been condensed from a longer abstract prepared by Engineering Council.

A candidate for an engineering license must have had at least six years of active professional engineering work, one of which shall have been in responsible charge, of a character satisfactory to the board. At least four years of active engagement in land-surveying work are required of a candidate for a surveyor's license. Each two years of study of engineering in an engineering school of standing satisfactory to the board, however, will be considered as equivalent to one year of active practice. A candidate for the surveyor's license must be a citizen of the United States or must have declared his intention of becoming one; this provision does not apply to engineers. The applicant must be at least 21 years of age, of good character and repute, and to practice surveying, must speak and write the English language. Candidates may be required, however, to furnish further evidence, which may include the result of a required examination. The fee for either license is $25, and for license to practice both engineering and surveying is $35.

Two years after the act takes effect, no county, city, town or village, or other political subdivision shall engage in construction or maintenance of any public work involving professional engineering or land surveying for which plans, specifications and estimates have not been made by, and construction and maintenance supervised by, a licensed engineer or land surveyor, unless the expenditure for the completed project is less than $2,000. Plans, specifications, plats and reports may be stamped with a seal the design of which shall have been approved by the board. State and municipal employees are exempted only until their term of office expires. Employees of the United States are entirely exempt. A non-resident may practice in this state if he is legally qualified for professional service in his own state or county, where the necessary qualifications meet the requirements of the board. He may practice for such reasonable time as the board requires for considering his application for a license. The board may revoke a license for cause only after a hearing at which the accused has the right to be represented by counsel, to introduce evidence and to examine and cross-examine witnesses. Penalties for violation of the law, after it has been in effect for two years, may be a fine of between $100 and $500, imprisonment for three months, or both.

The law covers all those practicing or offering to practice professional engineering or land surveying in a supervisory capacity.

A. S. C. E. Votes Against Joining Federated American Engineering Societies

A referendum vote of the members of the American Society of Civil Engineers on the question of accepting membership in the Federated American Engineering Societies has resulted in the defeat of the proposition by a vote of 3,278 to 2,330. The total number of votes was therefore 5,608, representing 57 per cent of the membership, which is 9,773.

For some time a small group in the society has been very active in its opposition to the Federated American Engineering Societies and has been circularizing the members of the A. S. C. E. and spreading propaganda in a way that now appears to have been very effective. While this vote is subject to review by the society's council, it is doubtful whether that body will reverse the expressed instructions of a majority of the members.

The civil engineers have always been extremely conservatice; it will be remembered that it was only a few years ago when they finally joined the other three so-called Founder Societies and moved into the Engineering Societies Building. It is to be hoped that here again better judgment will eventually prevail.

City Engineer M. M. O'Shaughnessy, of San Francisco, has announced that plans for the city's new $6,000,000 electric power plant at Hetch-Hetchy are under way, and that construction of this plant may be followed by the establishment of auxiliary plants at other points. The main plant is to be built at Priest's Hill, where the water will have a sheer drop of 1,200 ft. and 400,000,000 gal. of water a day will pass through the weirs to the turbines. It is expected that 66,000 hp. can be developed.

The London *Morning Post* for Sept. 2 published some particulars of a very important oil transaction in Rumania. The Anglo-Persian Oil Co., allied with some other British and foreign financial interests, has acquired the control of one of the large oil properties in Rumania. It is expected that a company will be floated with a capital of more than £2,000,000.

Personals

Ralph T. Bratt has left Olney & Warrin, Inc., and is now employed in the industrial department of the Locomotive Superheater Co., New York.

David S. Wegg, Jr. has left the Allis-Chalmers Manufacturing Co. to become associated with W. A. Gilchrist, of Chicago, as electrical engineer.

H. M. Lowenstein, formerly designer with the De La Vergne Machinery Co., is now designer for the Babcock & Wilcox Co., Bayonne, N. J.

A. Pohlman, well known in the combustion field, is now with the engineering department of the Diamond Power Specialty Co., Detroit, Mich.

Elias Schlank has opened offices in Newark and is prepared to advise silk manufacturers and allied industries on engineering problems pertaining to plant operation and maintenance.

Wallace H. Martin has resigned as associate professor of mechanical engineering at the Pennsylvania State College and is now professor of heat engineering at the Oregon Agricultual College.

John Breslau, formerly sales engineer, manager of publicity and production manager of the Terry Steam Turbine Co., of Hartford, Conn., is now owner of the J. B. Engineering Sales Co., of Hartford.

James D. Mooney, until recently assistant to A. P. Sloan, Jr., vice president of the General Motors Corporation, has been made general manager of the Remy Electric Division of that corporation, Anderson, Ind.

Webster Tallmadge, who has been connected with the Westinghouse Electric and Manufacturing Co., South Philadelphia Works, Lester, Pa., is now manager of the Power Division, Thomas A. Edison Industries, Orange, N. J.

Robert Lacy announces his resignation from the Geo. T Ladd Co, Pittsburgh, and appointment as sales engineer by the Rush Machinery Co., Pittsburgh, to act as representative for steam equipment specialties and water-tube boilers.

W. H. Moore has resigned as chief operating engineer of the electric plant of the Society for Establishing Useful Manufactures, at Paterson, N. J., to accept the position of chief engineer of Dartmouth College, Hanover, N. H.

Mayo D. Hersey, who for over ten years has been a physicist at the United States Bureau of Standards, and recently chief of the Aëronautic Instruments Section, Washington, D. C., is now with the Massachusetts Institute of Technology, as associate professor of Properties of Matter in the Department of Physics

Thomas B. Wilson has been appointed steam engineer in charge of the newly organized department of steam engineering at the plant of the Bethlehem Steel Co., Sparrows Point, Md. He was formerly steam engineer for the Cambria Steel Co. and for the past two years has been on combustion work for the Du Pont Co., Wilmington, Del.

Society Affairs

The American Society of Civil Engineers is to hold a meeting Nov. 17, at 8:30, at its rooms in the Engineering Societies Building, New York City. The subject will be "Urban and Suburban Passenger Transportation."

Memorial Exercises for Dr. Samuel Sheldon are to be held in the main auditorium of the Engineering Societies Building, New York City, on Nov. 17, 8:30 p.m. Arthur W. Berresford, president of the A. I. E. E., will preside, and will introduce the following speakers: William N. Dickinson, Bancroft Gherardi, Dr. Arthur E. Kennelly, T. Commerford Martin and Dr. William H. Nichols.

The Chicago Section of the A. S. M. E. will celebrate the fortieth anniversary of the society on Nov. 22 in the auditorium of the Western Society of Engineers, Monadnock Building, at 7 p.m. Short addresses will be made by Herbert S. Philbrick and Captain Robert W. Hunt, after which Dr. G. O. Smith, director of the United States Geological Survey, will speak on "Industries' Supply of Energy."

American Engineering Council, the governing body of the Federated American Engineering Societies, is to hold its first meeting on Thursday and Friday, Nov. 18 and 19, at the New Willard Hotel, Washington. Thursday morning will be devoted to registration, appointment of committees and other preliminary business, and the afternoon to an address by J. Parke Channing, followed by discussion of the field of activity for the societies. On Friday reports will be received from committees, and the election of permanent officers will take place. Friday evening Herbert Hoover will make an address, after which an informal reception and smoker will be held.

Business Items

The J. B. Engineering Sales Co. has been appointed Connecticut sales agents of the Conveyors Corporation of America, formerly American Steam Conveyor Corporation. Offices are at 60 Prospect St., Hartford, Conn.

The Powers Regulator Co., of Chicago, which began business in 1890 in a 12 x 16-ft. room, has recently moved into its new factory, a fireproof building containing 40,000 sq.ft. of floor space. The company manufactures a line of temperature-regulating apparatus for use in heating processes and the heating of rooms

The Monarch Soot Remover Co., Inc., of Troy, N. Y., having closed its Troy factory, has established a new machine shop and brass foundry in Wollaston, Mass., and has incorporated under the laws of Massachusetts. Bradford L. Ames, of Boston, is the president, and Leonard W. Newell, treasurer of the Wollaston Foundry Co., is the treasurer.

Trade Catalogs

The Packard Electric Co., of Warren, Ohio, has issued a bulletin on "Metering Transformers" in which are described the weatherproof and switchboard types of the single- two- and three-phase potential and current transformers. The weatherproof, or outdoor type of oil-insulated transformer, has been developed in compliance with the demand from the central manager, who is anxious to avoid the building of a housing to protect the transformers from the weather.

New Construction

PROPOSED WORK

Me., Old Town—The Bangor Ry. & Electric Co., 90 Harlow St., Bangor, plans to build a 2 story, 70 x 75 ft. pumping plant and substation, here. Crowell & Lancaster, Exchange Bldg., Bangor, Archts.

Mass., Boston—The American Can Co., 120 Bway., New York City, plans to build a factory here, including a steam heating system. About $250,000.

Mass., Charlestown—The Charlestown Terminal Bldg. Co., 27 State St., Boston, will soon award the contract for a 7 story, mercantile building including a steam heating system on City Square, here. F. O. Lewis, 50 Bromfield St., Boston, Archt. and Engr.

Mass., Springfield—The Masonic Hall Assn., Masonic Bldg., is having plans prepared for a Masonic Temple on State St. About $750,000. E. A. Blodgett, Pres.

Conn., Hartford—The Conn. Gen'l. Life Insurance Co., 64 Pearl St., is having plans prepared for a 6 story office building including a steam heating system on Elm St. James Gamble Rogers, 367 Lexington Ave., New York City, Archt. and Engr.

Conn., Newington—The Conn. Children's Aid Society, 926 Main St., Hartford, plans to build a new 1, 2 and 3 story children's home, here. About $500,000.

N. Y., New York—The Missionary Sisters of the Sacred Heart, c/o St. Lawrence Hospital, 457 West 163d St., plan to build a 6 story, 165 x 228 x 244 ft. hospital on Edgecomb Ave. between 163rd and 164th Sts.

N. Y., New York—Dept. Pub. Wks., Albany, received bid for the installation of a steam heating system in the Barge Canal Terminal headhouse at Pier 93, West 53d St., here, from the Austin Engineering Corp., 121 West 42d St., at $4,875.

N. J., Atlantic City—The City will soon award the contract for a 3 story fire house including a steam heating system. About $250,000.

N. J., Vineland—The State plans to build a 40 x 64 ft. power plant here, including 2 boilers. About $21,500. F. H. Bent, 142 West State St., Trenton, State Archt.

Pa., Altoona—The Catholic Diocese of Altoona, c/o Rt. Rev. Bishop John J. McCort, 1211 13th St., is planning for a 100 x 150 ft. cathedral on 12th Ave. About $1,000,000. Archt. not selected.

Pa., Franklin—The Franklin Exch. Nat'l. Bank will soon receive bids for a 3 story, 100 x 100 ft. addition to bank including a steam heating system. W. L. Stoddart, 9 East 40th St., New York City, Archt. and Engr.

Pa., Freemansburg—The New Jersey Zinc Co. plans to install additional motors, make changes in power equipment and in the method of firing boilers, etc.

Pa., Philadelphia—The Hotel Walton Co., R. W. Goelet, Pres., Broad and Locust Sts., is having plans prepared for a 20 story, 70 x 130 ft. hotel and store building including a steam heating system on Broad St. About $1,700,000. A. M. Gray, 1402 Bway., New York City, Archt. and Engr.

Md., Aberdeen—The Constructing Quartermaster, Aberdeen Proving Grund, will receive bids until Nov. 18 for a generator house, steam heating system, etc.

Md., Baltimore—The Bd. of Awards received lowest bid for a 3 story, 76 x 271 ft. school at Fort Ave. and Latrobe Park from the Standard Constr. Co., 1713 Sansom St., Philadelphia, Pa., at $485,000. Contract for steam heating plant will be sublet. O. G. Simonson, Maryland Casualty Tower, Baltimore, Archt., H. F. Adams, Calvert Bldg., Engr.

D. C., Bellevue (Washington P. O.)—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., plans to install a turbo-generator, switchboard equipment and a reciprocating air compressor, here

W. Va., Bluefield—The Baptist Educational Comn. plans to build a college consisting of 18 buildings. About $750,000. Archt. not yet selected

N. C., Smithfield—The City plans to build a 4 story, 79 x 117 ft. court house including a steam heating system on Market St. About $500,000. Harry Barton, Greensboro, Archt

Fla., Fort Myers—Peter Schutt and associates, Bradford Hotel, are having plans prepared and will receive bids early in December for a 3 and 5 story hotel including steam heating and pumping plants on McGregor Blvd. Cost between $400,000 and $500,000. F. J. Kennard, American Bank Bldg., Tampa, Archt.

Fla., Jacksonville—The Wilson-Toomer Fertilizer Co., Viaduct, is having plans prepared for a new plant. About $1,000,000. N. M. G. Prange, Mgr

Ala., Tuscaloosa—D. O. Whilldin, Archt., Title Guaranty Bldg., Birmingham, will receive bids until Dec. 15 for a 107 x 235 ft. dormitory and the first units of a power house, laundry and other buildings for the Alabama Home for the Feeble Minded, here. About $163,000.

La., New Orleans—The American Can Co., 120 Bway, New York City, plans to build a factory including a steam heating system, here. About $250,000.

O., Ashtabula—The City voted on $1,000,000 bonds for a new electric light and power plant.

O., Cincinnati—The Business Men's Club, 9th and Race Sts., is having plans prepared for a 9 story, 150 x 200 ft. club house at 8th and Race Sts. About $1,000,000 Samuel Hannaford & Sons, 6th and 9th Sts., Archts.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ., c/o E. K. Bryan, Lee Rd., will receive bids until Nov. 24, for a 2 story, 50 x 67 ft. power plant. F. C. Warren, Hippodrome Bldg., Cleveland, Archt., L. A. Quayle, 1455 West 98th St., Engr. Noted June 8.

O., Huron—The City voted on $42,000 bonds for improvements to the electric light plant

O., Kent—The Bd. Educ. is having plans prepared for a 2 story, 160 x 200 ft. high school. About $275,000. Mills & Millspaugh, 67 East Long St., Columbus, Archts.

O., Lakewood (Cleveland P. O.)—Bd. Educ., G. Grill, Clk., Warren Rd., plans to build a 2 story school including a steam heating system. About $250,000. C. W. Hopkinson, 900 Rose Bldg., Cleveland, Archt

O., West Park—The Bd Educ plans to build a 3 story high school including a steam heating system. About $1,000,000. E. W. Featherstone, Clk.

Ind., Elkhart—The Wawasee Tire & Rubber Co. is receiving bids for a 4 story 175 x 175 ft factory including a steam heating plant. About $500,000. E. E. Simmons, Archt.

Mich., Detroit—The Detroit Art Museum, Jefferson Ave. and Hastings St., plans to build a 1 and 2 story 160 x 300 ft art museum including a steam heating system at Woodward, Kirby, Farnsworth and John Sts. About $2,000,000.

Mich., Detroit—The Central Christian Church c/o John De Tarr, Putnam Ave., plans to build a 2 story church including a steam heating plant on Second Blvd. About $500,000. Archt not yet selected.

Mich., Detroit—The Bd Educ 50 Bway Ave. has asked for an appropriation for plans for a 20 story 100 x 100 ft. office building including a steam heating system, at Gratiot and Library Aves. About $1,000,000.

Mich., Detroit—The Bd Fire Comrs., Wayne and Larned Sts., will receive bids until Nov. 22, for a 2 story, 90 x 90 ft. pumping station at Randolph St. and Detroit River. Bids will be received later for 2 motor-generator sets, 6 high-pressure pumps, vacuum pumps, etc. Smith Hinchman & Grylls, 710 Washington Arcade, Engrs.

Ill., Chicago—The B'nai Abraham Zion Congregation c/o Levy & Klein, Archts., 111 West Washington St., will soon award the contract for a 1 story, 126 x 165 ft. synagogue including a steam heating system, on Washington Blvd. and Karlov Ave. About $250,000.

Ill., Chicago—Cohan & Harris, 226 W. 42d St., New York City, are having preliminary plans prepared for a 4 story 100 x 135 ft theater at 121 North Clark St., here, including a steam heating system. About $400,000. A. N. Rebori, 410 South Michigan Ave., Chicago, Archt.

Ill., Chicago—The Stearns Bros. & Co., 619 South La Salle St., will soon award the contract for a 3 story, 100 x 160 ft. printing plant including a steam heating system at East Huron St. and Fairbanks Court. About $200,000. Berlin, Swern & Randall, 19 South La Salle St., Archts.

Wis., Marshfield—The Bd Pub Wks c/o John Seubert, City Clk., is having plans prepared for a 1 story, 36 x 40 ft. addition to power house. About $25,000. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Waukesha—The U. S. Public Health Service Hospital is in the market for one 125-hp. boiler. Lester McQuilkin, Supt.

Wis., West Bend—The West Bend Aluminum Co. is having preliminary plans prepared for a 2 story boiler and power house on Main St. About $75,000. Federal Engr. Co., Stephenson Bldg., Milwaukee, Engr.

Wis., West Bend—The Miller Spouting Co., Inc., P. O. Box 425, is receiving bids for twelve 220-volt, 60-cycle, three-phase motors, switchboard, air compressors, etc.

Iowa, Council Bluffs—The Women's Christian Assn., Mrs. E. Lucas, Chn., is having plans prepared for a 3 story addition to the Jennie Edmundson Hospital including a steam heating system. About $350,000. J. Chris Jensen, 305 West Bway., Archt.

Iowa, Mason City—The North Iowa Lutheran Hospital Assn. plans to build a 4 story addition to the hospital including a steam heating system, at 3rd St and Georgia Ave. N. E. About $300,000. Rev Richard Vordale, Secy.

Iowa, Pocahontas—C. Gilchrist, Co Aud., will receive bids until Nov. 23 for a 3 story 80 x 125 ft court house including a steam heating system. About $400,000. Proudfoot, Bird & Rawson, 810 Hubbell Bldg., Des Moines, Archts. (Incorrectly noted Nov. 9.)

Minn., Minneapolis—The State Bd. of Control, D. F. Mullen, Secy., Capitol, St Paul, received bids for a steam heating system in the proposed 3 story music building at the State University campus, here, from H Kelly Co., 925 Plymouth Bldg., $42,000; Archambo Htg. & Plbg. Co., 315 5th Ave. S., $42,540, and M. J. O'Neil, 608 Exchange Bank Bldg., St. Paul, $43,075. Noted June 15.

N. D., Fargo—The Young Men's Christian Assn. plans to build a Y. M. C. A. building including a steam heating system. About $275,000.

Wyo., Douglas—Prince, Nixon & Co., Engrs., Omaha, Neb., will soon receive bids for the installation of a water system, here, including a pump house, engines to be driven by fuel oil, etc. About $75,000.

Ark., Cotter—The Dixie Power Co., Title Guaranty Bldg., St. Louis, Mo., is having plans prepared for a hydro-electric dam on the White River, here. Col. Henry A. Allen, 23 Metropolitan Block, Chicago, Ill., Engr.

Tex., Dallas—Ben Ablon, Cadiz and Santa Fe Sts., will receive bids until Jan. 1, for an ice and cold storage plant consisting of a 4 story, 100 x 150 ft building and four 1 and 2 story buildings, 40 x 100 ft each. About $500,000.

Tex., Terrell—The City Commission will receive new bids for two 5-in. two-stage centrifugal pumps, 500 to 800 gal per minute against a 200-ft. head, direct-connected to two- or three-phase, 60-cycle, 2,200-volt electric motor, adequate to operate pumps at full capacity; installation to be made complete with all wiring, etc. Also as counter proposal, two 5-in., three-stage centrifugal pumps, 500 to 800 gal. capacity, belted to two or three 75 hp. oil engines of high compression type. Former bids were rejected. Noted Oct. 19.

Tex., Waco—The Methodist Orphanage, Herring Ave., is having plans prepared for a dairy barn and a steam or hot water heating plant for the orphanage. About $45,000. Address Ed. McCullough, 1108 North 18th St.

Okla., Big Heart—The Big Heart Light & Power Co., recently incorporated, plans to install two units and is in the market for meters, transformers, etc. P. J. Minck, Secy.

Colo., Greeley—The Colorado Milling & Elevator Co., 1441 7th St., Denver, is having plans prepared for a flour mill, here. About $350,000. Supt of company, Archt.

Wash., Tacoma—The Olympic Ice & Machine Co., 612 East 25th St., plans to build a 4 story, 100 x 130 ft ice plant. About $125,000.

Cal., San Diego—The San Diego Consolidated Gas & Electric Co. has applied to the State Water Commission for permission to utilize waters of the west fork of the San Luis Rey River for the development of 775 hp. Plans include dam and conduit. About $235,000.

Ont., London—J. C. Nichols, R.R. 2, Wilton Grove, will have plans prepared for a new dairy, creamery and milk plant on East London St., here. About $250,000.

Que., Westmount—The City Engr. will receive bids until Dec. 1 for 4,000 ft. of cable and a power house switchboard.

CONTRACTS AWARDED

Mass., Brookline (Boston P. O.)—The Commonwealth of Mass., Met. Dist. Comm., 1 Ashburton Pl., Boston, has awarded the contract for a pumping engine at the Chestnut Hill pumping station, here, to the Worthington Pump & Mach. Corp., 201 Devonshire St., Boston, at $75,900.

Mass., Hyde Park (Boston P. O.)—The Edison Electric Illuminating Co., 39 Boylston St., Boston, has awarded the contract for a 1 story, 25 x 50 ft electric substation on Hyde Park Ave., here, to F. F. Jonsberg Co., 15 Ashburton Pl., Boston, at $12,000.

Conn., Bridgeport—The City Engr. c/o Bd. of Bldg. Comnrs., has awarded the contract for a 1 story, 25 x 30 ft pumping station to be known as the Black Rock pumping station to the Bridgeport Constr Co., 983 Broad St., at $32,000.

Conn., Hartford—The Travelers' Insurance Co., 700 Main St., has awarded the contract for a printing plant on Albany Ave., to Marc Eidlitz, 30 East 42nd St., New York City, at $1,000,000.

N. Y., New York—The Liberty Nat'l Bank, 120 Bway., has awarded the contract for alteration to bank including a steam heating system at 100 Bway., to the Thompson-Starrett Co., 49 Wall St., at $400,000.

N. Y., Staten Island—The Bd of Welfare, Municipal Bldg., New York City, has awarded the contract for the installation of boilers in the proposed addition to present boiler house at the Sea View Hospital, here, to the Almerall & Co., 1 Dominick St., New York City, at $79,789.

Pa., Philadelphia — The Harbison's Dairies, Front and Diamond Sts., has awarded the contract for a 2 story, 80 x 196 ft dairy plant and boiler room to Barclay-White & Co., 1713 Sansom St., at $240,000.

Mich., Detroit—The Bank of Detroit, Fort St., has awarded the contract for a 3 story, 50 x 140 ft. bank including a steam heating system to Hazelton & Clark, Book Bldg., at $300,000.

Wis., Janesville—The City has awarded the contract for a pumping engine to the Murray Iron Wks., 880 Washington St., Burlington, Ia., at $46,538. Noted Sept. 14.

Minn., Fridley—The Walsh Tie Co., H. S. Gilkey, Secy. and Treas., 954 McKnight Bldg., Minneapolis, has awarded contract for a creosoting plant here, including a steam heating plant, to C. F. Haglin & Sons, 226 Lumber Exchange, Minneapolis. About $300,000.

Kas., Wagstaff—E. A. Hadley, Chief Engr. for the Missouri Pacific R.R. Co., Railway Exchange Bldg., St. Louis, Mo., has awarded the contract for a water works system including pump house, dam, etc., here, to E. Nelson & Sons, 3240 South Michigan Ave., Chicago, Ill. About $90,000.

Tex., Dallas—The City has awarded the contract for furnishing and installing an electrically driven centrifugal pump with daily capacity of 25,000,000 gal., to Jones & Allinger, at $82,000.

Tex., Denison—The Missouri, Kansas & Texas Ry. Employees' Assn. has awarded the contract for a 3 story hospital to the Munn Constr. Co., at $300,000.

Colo., Denver—The City has awarded the contract for a 2 story, 125 x 350 ft junior high school at South Washington and South Pearl Sts., Beard and Cedar Aves. to Simpson & Sullivan, Interstate Trust Bldg., at $400,000. A steam heating system will be installed in same.

Wash., Seattle — The Seattle School Board, Central Bldg., has awarded the contract for a 3 story, 126 x 250 ft. warehouse and shop to the Puget Sound Bridge & Dredging Co., at $247,380. A steam heating plant will be installed in same.

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POWER

Volume 52 New York, November 23, 1920 *Number 21*

HAVING GIVEN THANKS TO THE MASTER ENGINEER

Diesel Engines in a Modern Flour Mill

IN 1912 the Stanard-Tilton Milling Co. erected a 1,200-barrel flour mill in Dallas, Tex., the mill being one of the most modern in the Southwest. To secure maximum efficiency in the power plant, Diesel oil engines were chosen. Several manufacturers were experimenting with this type of engine, but only one firm, the Busch-Sulzer Co., was in a position to furnish engines backed by a number of years of actual field work. Although the mill required not over 400 brake horsepower, a reserve capacity was deemed desirable; consequently a 450-hp. type A Busch-Sulzer Diesel was installed.

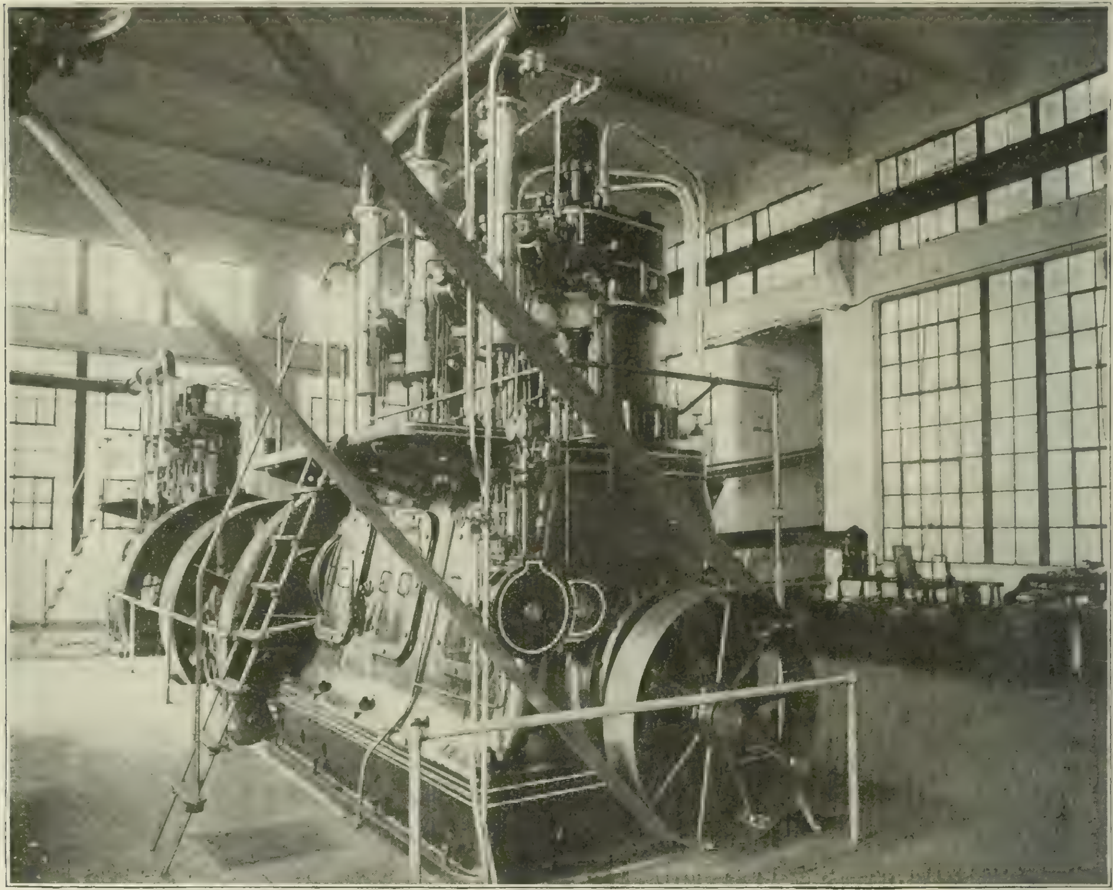


FIG. 1. 450-HP. BUSCH-SULZER TYPE "A" DIESELS

This unit is not a single engine, but is made up of two separate three-cylinder machines each controlled by its individual governor. The two crankshafts are belted to a common drive pulley placed on a stub shaft between the two engines. The flywheel effect is obtained from two flywheels, one being mounted on each engine shaft. The crank throws are so set that the cylinders of the two engines fire by pairs; the unit is then a double three-cylinder engine. It has been found that the regulation is better than when the cylinders are set to fire in rotation as a six-cylinder single engine. On the other hand the latter arrangement gives a greater brake horsepower. The two Busch-Sulzer Diesels appear in Fig. 1. The rope drive from the driving pulley to the mill is shown to the right of the engines; the rope is practically horizontal and has a horizontal tension carriage.

To give light and power to the grain elevator, a 50-kva. generator is driven off the flywheel of the rear engine in Fig. 1. The air compressor for the unit is belt-driven from the rear engine, the drive appearing in Fig. 2, which shows the switchboard as well. The exhaust lines run horizontally through the building wall with vertical exhaust pipes outside. From an examination of Fig. 1 it will be noticed that the exhaust pots are provided with a water drip. It is usual to find the pots eaten out by the sulphur and water, but in this plant no trouble of this kind has occurred.

The cooling water is carried in a rectangular overhead tank just outside the building. The cooling water from the engines flows into a sump, is picked up and discharged over the cooling racks in the overhead tank.

The water flows through the engines by gravity. The circulating pump and motor, both of Allis-Chalmers make, appear in Fig. 3, which also shows the heating boiler and auxiliary engine.

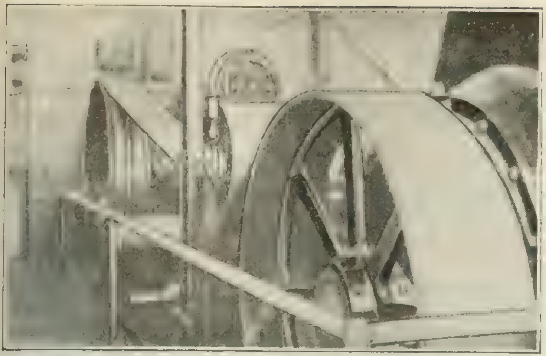


FIG. 2. TYPE "A" AIR-COMPRESSOR DRIVE

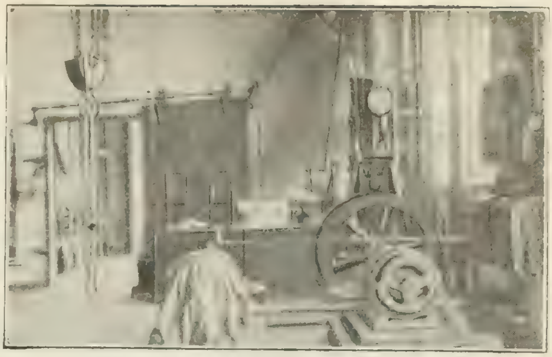


FIG. 3. CIRCULATING-WATER PUMPS

In 1919 the milling company erected a duplicate mill adjoining the one under discussion. This mill is completely equipped with roller bearings, thereby reducing the friction loss by 50 per cent. To drive this mill a 585-hp. Fulton-Tosi Diesel was purchased. This unit is shown in Fig. 4 and is set behind the two type A engines.

The new engine has four working cylinders; the cylinder liners are pressed into A-frames. A 192-kva. G. E. three phase 60 cycle generator is direct-connected to the extended shaft and has a built-in exciter. The engine-shaft extension also carries a friction clutch and rope-drive pulley. The engine is always started with the clutch disengaged. To prevent damage to the rope, a Dodge electric telltale operates a solenoid, which in turn allows a weight to unclutch the pulley.

At present the new mill is not in operation and the Fulton engine is used to drive the old mill, while the type A engines are held in reserve.

This Diesel station is a revelation to a steam engineer accustomed to a plant where the available space is filled with machinery such as pumps, fans, condensers, etc. The oil engine, with the exception of the circulating pump, is self-contained. The engine room, as a

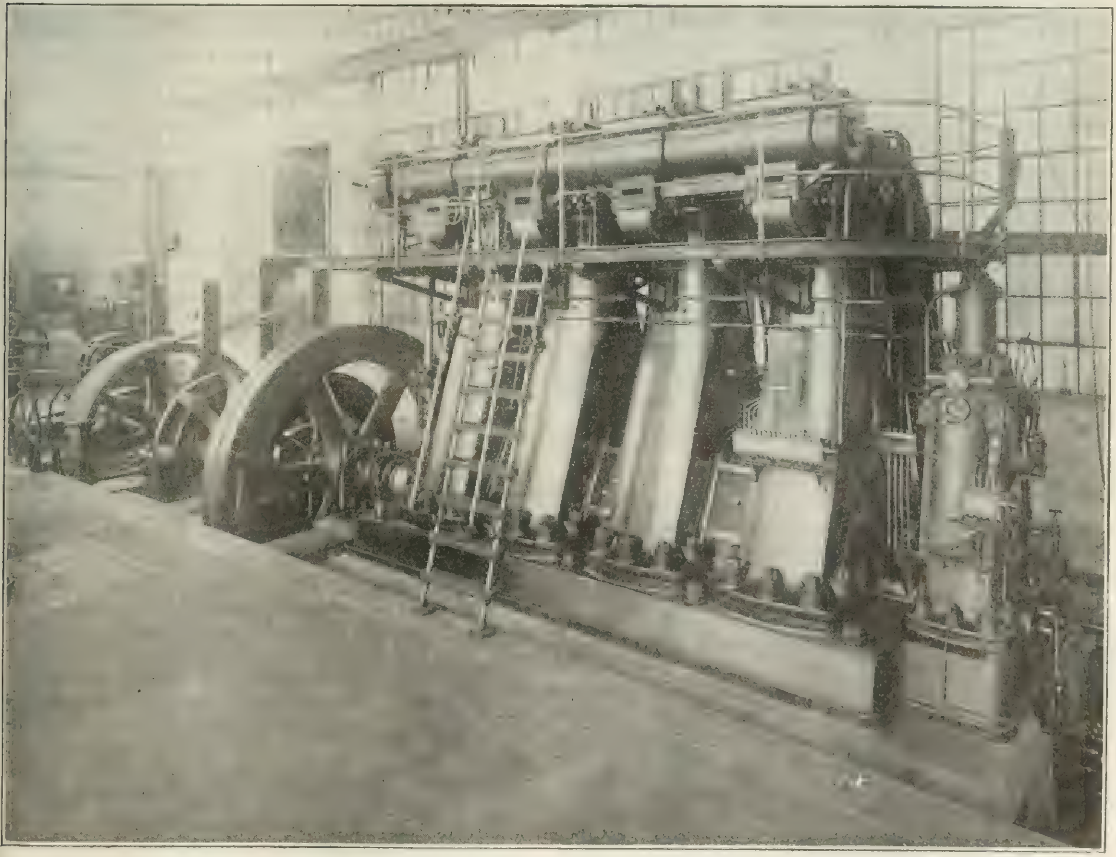


FIG. 4. 585-HP. FULTON-TOSI DIESEL

result, is light and airy, with every inducement to the operators to keep the place clean.

The Stanard-Tilton plant has had an exceptionally fine history. No serious accidents or breakdowns have occurred. This, in a great measure, is due to the high class of engineers that have operated the plant since it first started. It is one of the few plants where indicator cards are taken regularly. Fig. 5 is a diagram from the Fulton engine while carrying approximately full load.

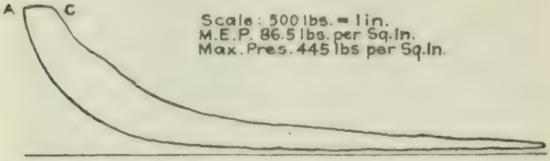


FIG 5 FULTON-TOSI INDICATOR DIAGRAM

Chain-Grate Stoker Operation

By W. M. McNiell

The selection and preparation of the coal is of first importance in the successful and economical operation of a chain-grate stoker. With the fuel situation as it is at present, the engineer has very little choice in the kind of coal he burns, as he is glad to get anything that even resembles coal, but he can at least see that the fuel is properly prepared before it is passed to the stoker. When it can be obtained, a non-caking bituminous coal should be used. It should contain as small a percentage of ash as possible and the fusing temperature of the ash should be high in order to eliminate the clinker nuisance as far as possible. Of course the greater the number of heat units the coal contains the more desirable it is, provided that the heat units are available for producing steam. If the coal contains a large percentage of ash and the ash fuses at a low temperature, forming clinkers, thus preventing a sufficient amount of air passing through the fuel bed and retarding combustion, even though the coal contains a great number of heat units, only a small percentage may be available for the production of steam, and it would not be as desirable as a fuel that contained less heat units, but more of which were available for useful work.

As stated at the outset, a non-caking bituminous coal will give better results on a chain grate than a coking coal. The latter will, of course, run together, forming one solid mass of coked coal through which it is next to impossible to get sufficient air to secure complete combustion. There are a great many other reasons why a non-caking coal is more desirable than a coking coal, which will not be discussed in this article.

Next in importance to the selection is the preparation of the fuel. In plants not prepared to crush the coal it is best to secure a good grade of screenings of as near uniform sizes as possible. It will be found that these give fairly satisfactory results on this type of stoker. In supplying screenings from an overhead bunker through a spout to the hopper of the stoker, the lumps and the fine coal have a tendency to separate, the larger sizes coming out on each side of the hopper and the fines accumulating in the center of the hopper. This of course distributes the larger sizes on each side of the chain, while the fine coal will be in the center. The large sizes along each side will burn off first, leaving the grate bare and allowing excess air to enter the furnace at these points, with insufficient air entering through the center of the grate, where the coal is not burned and where it is most needed.

This can be overcome by providing means for thoroughly mixing the coal as it is delivered to the stoker. Large lumps of coal or other objects should never be allowed to reach the stoker hopper, as they are sure to break out the brick in the grate and give trouble in numerous ways. I was once forced to use some run-of-mine coal on a chain grate very much to my sorrow. The coal was broken up as much as was possible with hammers, but the large chunks soon ruined a perfectly good grate and forced the plant out of service.

In the larger-sized plants crushers are usually installed for reducing the coal to the proper dimensions, and such plants may purchase a run-of-mine or even the domestic sizes, if they are not too expensive, and prepare them for use on the chain grate. These plants have an advantage over the smaller ones which are not fortunate enough to be equipped with coal-crushers, as they may purchase the coal that is best adapted to their needs.

It is also essential to keep the ignition arches and other brickwork in connection with the stoker in good condition. Given the very best of coal, well adapted to the stoker and the conditions under which the coal is to be used, and assuming that it has been properly prepared, results cannot be expected unless the stoker and all its accessories are kept in the very best of condition. The arch should be watched closely to see that it is kept in good order, especially if it happens to be a flat suspended arch, for as soon as one or two bricks have spalled off to a great extent, the fire will begin to reach the supporting ironwork and will cause it to fail in a very short time. Even if the arch does not fail entirely, it functions very poorly in its duties toward promoting combustion.

The stoker should be watched closely also, as a broken link means a hole in the fuel bed for excess air to enter, as well as an increased amount of unburned coal under the grate to be raked out and returned to the hopper. Frequently the coal under the grate is allowed to take fire and burn for a considerable time. This overheats the chain as well as other parts of the stoker and will surely cause serious trouble. It should never be permitted.

The efficiency of a chain-grate stoker will, of course, depend to a great extent on the design of the stoker and the manner in which it is installed. If an engineer has to accept the stoker his employer feels like furnishing him, he has nothing to say about the design, but he can have something to say about the way in which it is installed. He should see that observation holes are properly placed in the setting, so that the condition of the fires and the furnace may be readily observed. He should have clean-out doors so located that clinkers and other objects may be easily removed from the furnace. In case of extremely wide furnaces, a clean-out door as well as observation holes should be placed on each side of the setting.

The stoker should be set so that it may be rolled out of the setting for examination and repairs. In a certain plant, a chain-grate stoker was installed under a Stirling boiler. The stoker was fifteen feet in length, but the distance from the front end was only six feet from the boiler-room wall, making it impossible to draw the stoker from under the boiler. Whenever repairs were to be made it was necessary to go inside the furnace to do the work, which of course made it inconvenient. This same setting has a clean-out door on each side, but the boiler-room wall is only three feet from one of the doors on one side and a set of boiler feed pumps are directly in front of the other door. The doors in any setting should be so arranged that the fireman may hook the clinkers out of his fires, for he will surely have to keep them out if he would get economical results.

If the fuel bed is carried too thick and the chain is driven too fast, the fuel will have a tendency to pile up at the water back or bridge wall. When this happens, either the fuel bed must be thinned down or the speed of the chain slowed up. At times it is well to compromise by thinning the fuel bed a small amount and at the same time slowing down the speed of the chain.

Under ordinary conditions the proper speed for a chain is about eight inches per minute. With very light loads it may be less and with heavy loads a little more. However, it is better to thicken or thin the fuel bed to suit the conditions than to change the speed very much.

The Philo Multigage

The Philo Multigage is the result of a demand for an instrument that will tell at a glance a complete story of the existing draft and pressure conditions. It is a combination draft and pressure indicator, and it gives either reading or both simultaneously.

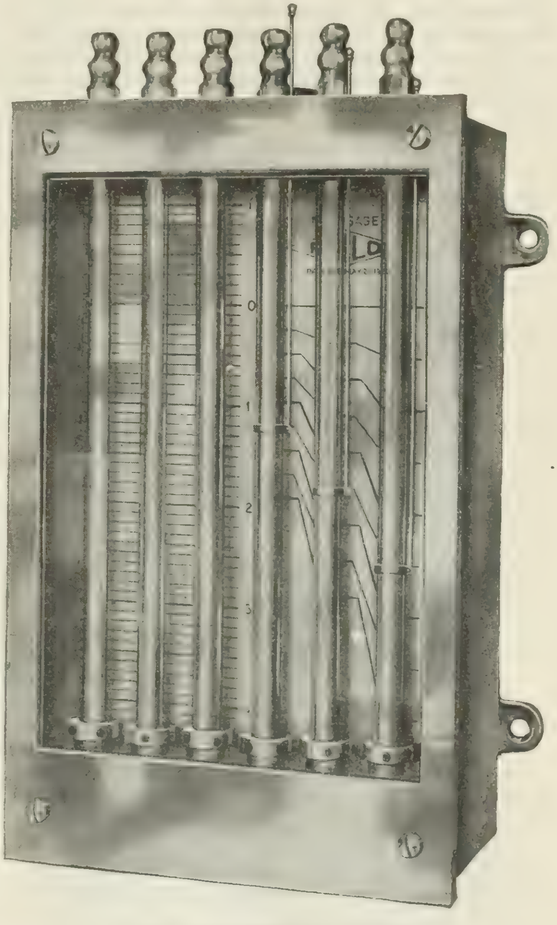
The gage is a nickel-plated brass casting and weighs approximately 10 lb. The six tubes into which the liquid flows connect with a common storage tank, which is filled to the zero mark on the scale with special gage oil having a specific gravity of 0.89. The tubes are in such proximity that a careful comparison of each reading with any other may be obtained. With conditions running along normally, the height of the liquid in the various tubes forms a certain curve. Any variation in the characteristic of this curve, caused by too heavy fire on some point of the grate or by blowholes, will tell the fireman what he should do and where he should do it, to adjust conditions.

There is nothing mechanical to get out of order. Gravity is the sole adjuster in this instrument. To insure a tight oil seal at the bottom of each tube, a stuffing gland and oilproof packing are used.

This gage, which is manufactured by the Schumacher-Santry Co., 141 Milk St., Boston, Mass., is designed not only to indicate graphically the pressure conditions at various points in the blast system, but also to instruct and guide the engineer as to the proper relative pressures at the different indicated points in the system.

The gate is made in two sizes. Type C, indicating the draft up to 1.3 in. and pressure up to 4 in., is supplied with a special proportional chart for use in connection with the Coxe type of traveling-grate stoker. This chart consists of a series of zigzag lines each showing the comparative air pressures desirable under a given set of operating conditions in the first, second and third air compartments, when burning anthracite buckwheat. For example, the outside tube of the gage is connected to the first compartment. If this shows, say, 3 in. pressure, the liquid will stand at the horizontal part of one of the zigzag lines 3 in. below 0. By following this same zigzag line upward and over to the second tube, it will be seen that the next horizontal part of this line is about 2.1 in. below 0, at or near which point the liquid should stand. Farther upward and over on this same line to the other tubes, a pressure of 1.4 in. will be indicated.

When other fuel is used on this stoker or when the gage itself is applied to other kinds of stokers, the adjustable sliding clips shown in the cut may be used in place of the chart.



PHILO SIX-TUBE MULTIGAGE

The Type E gage indicates a draft up to 1.3 in. and a pressure up to 6 in., and is for use in connection with other kinds of mechanical stokers.

A Correction

In the editorial, "Power Development of the Future," on page 753 Lazarovich-Hrebelianovich is referred to as being a "well-known Czecho-Slovakian engineer and economist." Instead, he is of Serbian nationality, and is well known as such in engineering, banking and diplomatic circles in this country.

Application of Induction Motors—III

Location of Motors — Connections Between the Motor and Driven Machines — Nature of Load and Power Demand—Underwriters' Requirements for Motor and Controllers—Protection of Motors—Other Types of Motors.

By FRASER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

IN THE first article of this series, published in the issue of Oct. 26, sixteen points to be considered in application of induction motors were outlined and five of them discussed. In the second installment, Nov. 9, five more of these features were treated and in this, the last article of the series, the remaining six are considered.

11. LOCATION OF MOTOR, ETC.

A great deal of trouble with motors has been experienced due to improper foundations. Epecially is this true of motors suspended from ceilings of poorly constructed buildings, when the ceilings tend to sag and the pulling up of the foundation bolts throws the motor out of alignment. The same is more or less true also for floor or wall mounting, and proper motor operation cannot be expected unless rigid foundations are used. Motors are frequently required to operate indoors or outdoors and under conditions where they are subject to steam vapors, acid fumes, extreme dust, extreme heat, explosive gases, etc. In order to meet these different requirements, the American Institute of Electrical Engineers has realized that oftentimes standard apparatus is unsuited to meet special conditions and has therefore recognized the following types of machines: (1) Open; (2) protected; (3) semi-inclosed; (4) inclosed; (5) separately ventilated; (6) water-cooled; (7) self-ventilated; (8) drip-proof; (9) moisture-resisting; (10) submersible; (11) explosion-proof; (12) explosion-proof slip-ring inclosure.

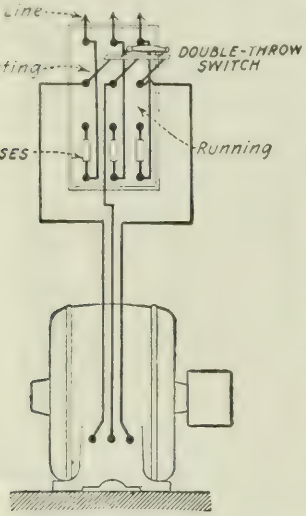


FIG. 1. SQUIRREL-CAGE MOTOR CONNECTED DIRECTLY TO LINE

Standard commercial machines may be classified under 1, 7 and 9, and are defined as follows:

1. An "open" machine is of either the pedestal-bearing or end-bracket type where there is no restriction to ventilation other than that required by good mechanical construction.

7. A "self-ventilated" machine differs from a separately ventilated machine only in having its ventilating air circulated by a fan, blower or centrifugal device integral with the machine.

9. A "moisture-resisting" machine is one in which all parts are treated with moisture-resisting material. Such a machine shall be capable of operating continuously or intermittently in a very humid atmosphere such as in mines, evaporating rooms, etc.

As altitude directly affects temperature, it is recommended by the American Institute of Electrical Engineers that for machines intended for operation in altitudes higher than 3,300 ft. above sea level, the permissible rise in temperature at sea level shall be reduced by 1 per cent for each 330 ft. by which the altitude exceeds 3,300 ft.

It is therefore seen that due consideration must be given the location and conditions under which motors have to operate, otherwise correct applications cannot intelligently be made.

12. WILL THE MOTOR BE DIRECT-CONNECTED OR BELTED, ETC.?

As has already been indicated (in the second article, Nov. 9 issue) it is desirable for motors direct-connected to their loads to have some form of flexible coupling between the two members. There are, of course, exceptions such as may be found in small units or vertical outfits, but in general it is advisable that the drive be so arranged that any chance for vibration, thrusts, misalignments, etc., of the driven load be contained therein and not be transmitted to the motor. Incorrect belting arrangements are often the cause of considerable bearing trouble and are seldom given the necessary thought to insure good operation. Belt speeds to insure the best results should not exceed from 3,700 to 4,500 ft. per min. and in the most extreme cases the limit should not exceed 5,500 to 5,700 ft. per minute.

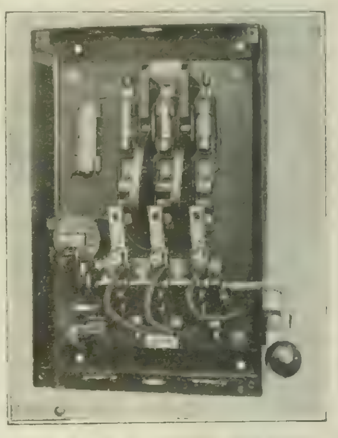


FIG. 2. A.-C. FUSED STARTER, COVER REMOVED

It is desirable that the angle of the belt with the floor should not exceed 45 deg. and the direction of the belt motion should always be such that the loose side or sag is on top. This increases the arc of contact, which in correct practice probably averages in the neighborhood of 180 degrees.

Vertical belt drives should be avoided wherever possible inasmuch as the belt must be kept very tight to do the work. In addition to this, it should be noted that in cases where the belt drive is downward, such as in ceiling-suspended motors driving to the floor, the whole weight of the belt is a factor contributing to increasing the pressure on the motor bearings.

For standard horizontal drives the belt centers should be such as to allow a slight sag to the belt when in motion, and for the usual small drive for belts not wider than 4 in. 10 to 15 ft. is the lowest limit recommended. For larger drives 30 to 45 ft. or even more is the limit used, depending on the power transmitted, the pulley sizes, etc.

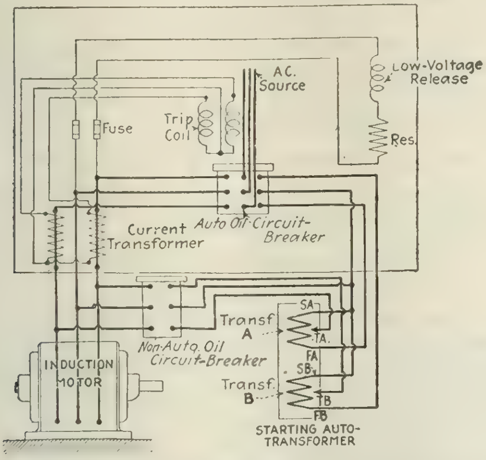


FIG. 3. CONTROL CONNECTIONS FOR LARGE SQUIRREL-CAGE MOTORS

As the pressure on the bearing on the pulley end of the motor is directly dependent on the belt pull, which in turn is dependent on the belt speed set by the pulley diameter, any change to pulley diameters smaller than given as standard or a minimum, by the motor manufacturer, reduces the factor of safety on the bearing beyond that deemed safe for good operation.

13. If Power Is To Be Bought, Will the Power Demand Meet the Local Power Company's Requirements?

In cases where power is to be bought, the nature of the load and the power demand is not often fully understood. For instance, many power companies, in addition to a flat rate, have a maximum-peak rate and also penalize for power factors lower than 80 or 85 per cent. Frequently, the nature of the load is such that a flywheel can be used to reduce the peaks and in this manner insure lower power bills. Again, high-speed motors, having better power-factor characteristics than slow-speed motors, may be advantageously used by a change in the method of drive. This might involve higher first costs which will be more than offset by savings ultimately made in the cost of power. Furthermore, some power companies might be able to carry a certain true power load at 80 per cent to 85 per cent power factor, but be unable to carry it at 65 per cent to 70 per cent power factor owing to the limitations of their generating equipment. While this latter applies more to units of fairly large capacity, still a large number of smaller units will produce the same effects. It simply goes to show that due consideration must be given the power apparatus back of the motors.

14. Will the Motors and Control Meet the Local Underwriters' Requirements?

All electrical apparatus must be installed in accordance with the rules and requirements of the local underwriters as well as the National Board of Fire Underwriters or any other board holding jurisdiction in the particular district in which the apparatus is to be installed. Unfortunately, districts and states are governed by rules differing from other districts and states. A large difference in requirements is apparent, from a perusal of the different rules, for motor-driven fire-pump apparatus, both motors and control, and, while differing widely for different districts, is usually covered by special regulations made by the particular city or town in which the installation is to be made, in addition to the requirements of the National Fire Protection Association. Apparatus for use in flour mills and grain elevators is generally governed by the Millers mutual fire insurance companies, so that standard or commercial machines frequently cannot be used for special and particular applications. A study of all the underwriters' requirements for the districts in which the apparatus will ultimately be installed may reveal the fact that special motor construction, pump construction, and even control construction is sometimes involved.

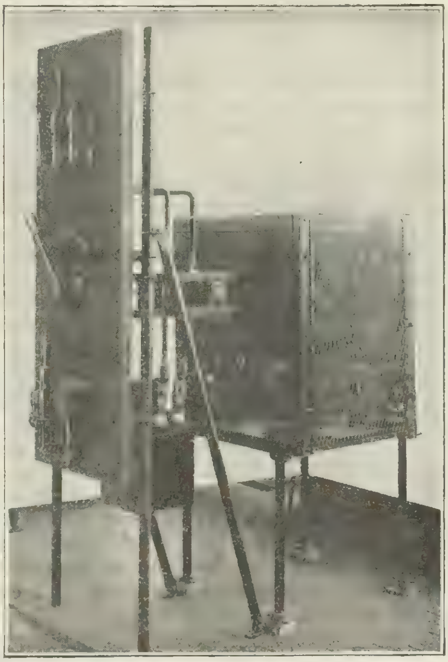


FIG. 4. STARTING PANEL WITH FACEPLATE STARTER FOR SLIP-RING MOTORS

15. Will the Motors Be Supplied with Adequate Protection Such as Overload, Low-voltage and the Necessary Interlocking Devices?

All motors should be protected against overload. For small squirrel-cage motors, 5 hp. and under, a fuse, as in Figs. 1 and 2, is often deemed sufficient, while for the larger motors a relay, Fig. 3, used in combination with a no-voltage release, is to be advocated. The method shown in Figs. 1 and 2 for starting the small motors provides protection for the running condition only and makes no provision for protection during the starting period. Full overload protection during starting and running and no-voltage release may also be had by the use of starters made especially for these small types of machines, but their first cost is naturally greater than the simple knife switch and fuses.

For slip-ring motors the foregoing protection is also needed, but some form of interlock, either electrical or mechanical, and between the primary switch and the secondary starter and control, is recommended, especially for motors in capacities of 50 hp. and above. This prevents throwing the stator windings across the line with all secondary resistance out of the circuit.

With multiple-switch starters the no-voltage release takes the place of the interlock, but with the drum-type starter auxiliary contacts on the drum, acting in conjunction with the relay, prevent the reclosing of the primary switch until the starter is brought to the off position. A mechanical lock functioning in the same manner and used in connection with primary oilswitches and face-plate starters is shown by Fig. 4. The use of this type of lock is limited, however, to the back of board type of oil switch and hence a panel for mounting is required.

16. WOULD SOME TYPE OF MACHINE OTHER THAN AN INDUCTION MOTOR BE PREFERABLE TO MEET THE EXISTING CONDITIONS?

Applications requiring extremely slow-speed induction motors involve the question of extremely low power factor. As a conservation measure, an efficiency measure, or from an engineering standpoint alone, the use of induction motors in these cases is not especially good. For such drives the synchronous motor has of late been supplanting the induction motor at practically no greater first cost. As the starting and pull-in torques of this type of machine are not comparable to those of the slip-ring induction motor, and where the starting-torque requirements are large, a form of magnetic clutch between the motor and its load has been successfully used. This allows the motor to be brought up to speed without load, after which the magnetic clutch, having a certain element of slippage, is brought into play. Such installations have been used in rubber mills, flour mills, cement mills, etc. (see Fig. 5).

A study of details sometimes reveals conditions that at first thought do not seem logical or even correct. Take, for instance, a centrifugal pump that has to operate against a varying head and deliver a constant quantity of water. It does not seem logical and correct to say that more efficient operation can be had under such conditions by the use of a slip-ring type induction motor running at reduced speed by means of energy dissipated in an external resistance unit than could be obtained by the use of a squirrel-cage type induction motor driving the pump at constant speed, the variations in head being taken care of by throttling the discharge line. But such is the case provided a reasonable amount of running has to be done at the lower speed and the volume of water delivered has to remain constant.

Assume the condition where the slip-ring motor has to run at a reduced speed all the time. Suppose that the pump requires a 250-hp. motor which operates at a speed of 1,760 r.p.m. when the full amount of water is being delivered. If the full-load efficiency of the motor equals 92 per cent and the full-load power factor equals 92 per cent, then if the pump is run at 1,490 r.p.m., the power required will be

$$\textit{h.p. output of motor} = \frac{(1,490)^3 \times 250}{(1,760)^3} = 152.$$

and the efficiency will, for practical purposes, fall off directly as the speed and be

$$\frac{1,490}{1,760} \times 92 = 78 \textit{ per cent at } 1490 \textit{ r.p.m.}$$

(Assuming a flat efficiency curve)

At this load of 152 hp. the power factor will drop from 92 per cent to 90 per cent. (This would be considerably lower if a slow-speed motor were being considered.) The input and the basis on which the cost of power will be based is therefore

$$\textit{Hp. input of motor} = \frac{152}{0.78} = 195 \textit{ horsepower.}$$

Consider now the case of the constant-speed squirrel-cage-type induction motor operating at the same full-load speed of 1,760 r.p.m. as the slip-ring motor. If the full-load efficiency is 92 per cent and the full-load power factor is 93 per cent, then when the pump is delivering the same amount of water (by throttling) as when driven by the slip-ring motor at 1,490 r.p.m., the load on the motor remains constant and the efficiency and power factor do not alter. On this basis the power input to the motor will be

$$\textit{hp. input of motor} = \frac{250}{0.92} = 272.$$

which, when compared to the 195-hp. input, shows that a much larger expenditure for power is required in the latter case if power is bought on the basis of so much per kilowatt-hour. It has the advantage, however, of a better operating power factor.

The importance of correct application is being realized more and more every day. It is becoming more or less of a science, and men are beginning to make a study of it and to devote more time to it. The old hit-or-miss method is being done away with because of the fact that it is recognized as being not only wasteful, but also inefficient. Looking at the proposition broadly, it can be asserted that correct application is a means ultimately conserving the natural resources of the country.

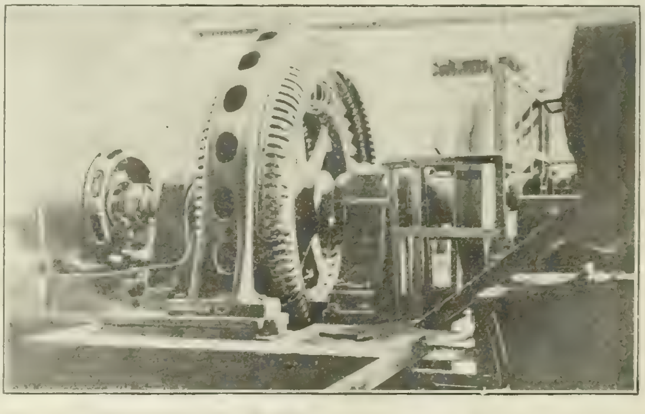


FIG. 5. SYNCHRONOUS MOTOR DRIVING A CEMENT-GRINDING MILL THROUGH A MAGNETIC CLUTCH

Piling Storage Coal to Prevent Fire

By W. D. Langtry
President Commercial Testing and Engineering Co., Chicago, Ill.

In the storage of coal more care must be given to selection as to origin and size, the choosing of a suitable place, avoidance of breakage in unloading, segregation of different sizes, outside sources of heat and the mixing of combustible matter with the coal. Do not pyramid the coal, but pile in layers and as shallow as the available space will permit.

THE storing of coal is a national necessity. Storing during the summer months will act more or less as a governor, tending to even up the load factor on the mines. If the railroads of the country can be relieved of at least a part of the coal hauling during the winter months, it will help them also. The consumer will have been materially benefited as well as the railroads and a more even running time given the mines. It is entirely possible and likely that when "a normal" is reached in the coal industry, there will be a summer and winter price similar to the hard-coal arrangement, where there is a drop in price April 1 and then a raise of ten cents per ton each month to Sept. 1. If thirty to fifty cents a ton can be saved, it is an item well worth considering. The railroads have realized this and have stored thousands and thousands of tons annually when coal could be bought cheapest and transported the easiest. They have been great offenders in the past when it came to successfully storing coal, but they have realized the importance of storing and, by studying the causes of fires, are far more successful than heretofore.

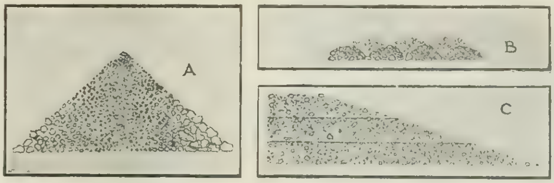


FIG. 1. METHODS OF PILING COAL. A, INCORRECT METHOD; B AND C, CORRECT METHODS

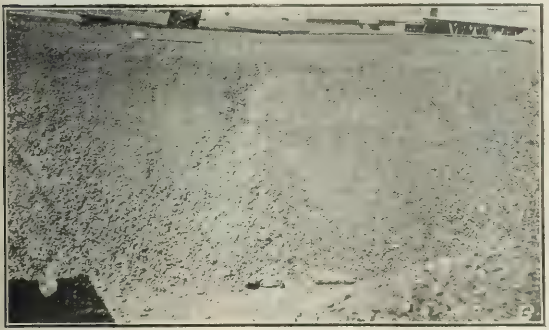


FIG. 2. PILE FORMED BY CONTINUOUS DUMPING FROM TOP EDGE

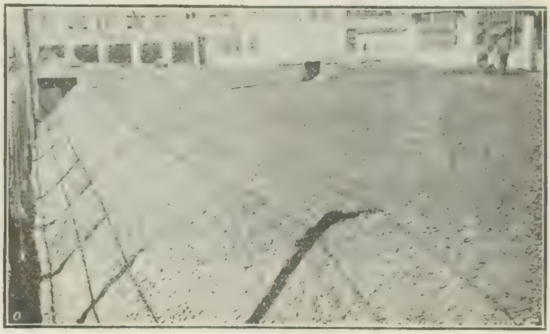


FIG. 3. PILE FORMED BY LAYER METHOD GAVE NO TROUBLE

When the average plant buys coal for storage, the management tells the engineer it is on the way and to see that it is unloaded. Coal will never be stored successfully in this way. Some one person should be made responsible. There are some general principles that hold true for every storage pile. No matter where the coal comes from, no oily waste, rags, paper, shavings, nor in fact anything foreign of a combustible nature, should be left under or in the coal.

Some coals are more susceptible to spontaneous combustion than others. If the purchaser has his choice, naturally the kind best suited for storing should be purchased. There are few bituminous coals that have not at some time given trouble, and again some that have the worst reputations for firing have been stored successfully.

It is known that coal will absorb heat very easily. It is for this reason that storing of coal in summer is more hazardous than during the winter, so that far more care and attention should be exercised. In fact, summer storage should be surrounded with all known precautions. Steel railroad cars that were saturated with heat have been known to transmit the heat to the coal. This may be a source of trouble unless the coal is given a chance to cool off. Likewise, hot steam pipes, the top of sewer manholes or hot furnace walls, when in close proximity to the coal, may be the means of adding heat and accelerating the process of combustion.

The surface of coal is oxidized by the air. This being the case, it would seem judicious to go on the principle of "locking out" the air, as it were, from a pile. This is accomplished when coal is stored under water—the most successful system of storage known.

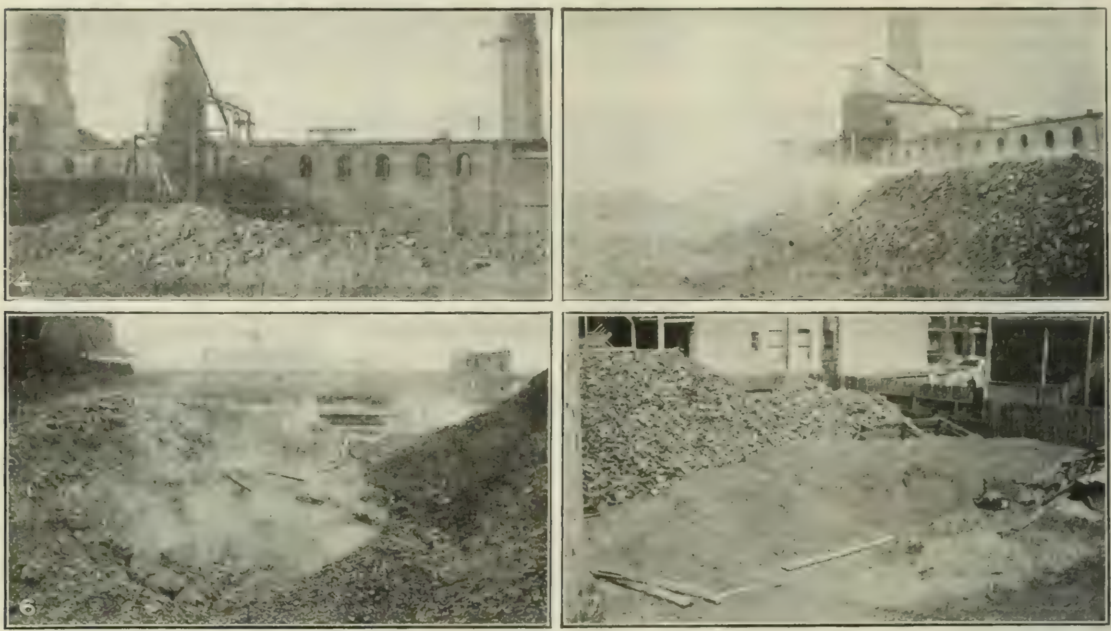
Mine-run coal has all the different sizes that come from the mine. It is the one kind of coal in which the segregation of the different sizes is most likely to take place if care is not taken when it is unloaded. If clamshell after clamshell, or shovelful after shovelful of this coal are dropped on top of each other, it will be found that the lump coal rolls to the bottom and to the outside of the pile. This causes the fine to pyramid in the center. As the large lumps will not lie close together, it is possible for the air to pass on through to the interior of the pile, where the finer coal is located with more of its surface exposed to the oxidizing element.

Experience seems to indicate that if this segregation is not permitted to take place and the coal piled in layers and not allowed to pyramid, the chances for spontaneous combustion are reduced to a minimum provided some other outside agent is not contributary to the heating of the coal. Pile *A* in Fig. 1, gives an idea of the pyramiding effect from clamshell unloading. Pile *B* to the right shows individual dumps side by side. Then if it is possible to level off the coal so that each layer is approximately two feet thick, the fine will fill in between the lumps and act as a seal; the pile thus formed appears at *C*.

A striking example was photographed at a plant in Chicago. Screenings from two different mines were delivered mixed for storage. As shown in Fig. 2, the coal was unloaded onto the pile by wheelbarrows dumping one load on top of another until the pile reached the height shown in the picture. It was then extended back from the railroad switch by continually dumping the coal at the top edge, this causing it to roll to the bottom. The coarser coal will be seen at the bottom and in streaks up the sides. This pile was placed in one part of the yard and gave an immense amount of trouble from spontaneous combustion and had to be moved and used up.

The coal in Fig. 3 from the same mines was unloaded by dumping one wheelbarrow alongside of another and leveling off so that a layer of coal was formed on the entire available space for the storage pile. The first layer put down was about two feet deep. The second layer was put on top of the first by wheeling over it. This had the effect of packing down the first layer, thus helping to keep out the air. In this way a pile eight to nine feet deep was built up layer by layer. The more or less even distribution of the fine and large pieces throughout the pile will be seen in the picture. This coal gave no trouble whatever from spontaneous combustion. At a plant in Indianapolis the same plan was adopted and the coal was carried through for two years, until it was necessary to use it during the strike.

To many plants placing coal in storage the depth of the pile seems to be a perplexing question. A good plan to follow is to go on the principle of piling the coal as shallow as possible and in layers over the entire space that is available for this purpose. The item of expense always enters into this method both for unloading and reclaiming. Safety first is a good motto to follow.



FIGS. 4 TO 7. FIRE PREVENTIVE METHODS

Fig. 4—Sprinkler line on top of mine run. Fig. 5—Sprinkler line in action. Fig. 6—Unsuccessful attempt at "cooling off" with line of hose. Fig. 7—Hot coal that was cooled off by repiling in layers.

Figs. 4. and 5 show a pile of coal over the top of which has been placed a sprinkler system. The coal in this pile started to heat and the engineer knew if he could get enough water to the seat of the fire it would be quenched. Fig. 5 shows the spray in action. The water was sprinkled 24 hours a day for a stretch of about thirty consecutive days. This method successfully kept the heating under control and finally cooled off the pile so that no more spraying was necessary.

It is a well-known fact that unless enough water is used, it is poor policy to try this method for cooling-off purposes. Where a hose and nozzle are used, it will be found more effective to bury the nozzle in the pile, directing the stream toward the seat of trouble. More harm than good takes place unless the pile is thoroughly soaked and completely cooled off. Unless the stream actually reaches the hot spot, it may have the tendency to temporarily seal up the heat and cause the fire to break out afresh a little later on.

It is almost impossible to combat successfully a fire that has spread all over a pile with a line of hose, as in Fig. 6. A better way is to move it. In some cases where coal has heated, it is good policy to burn it up at once, as it saves rehandling and any further danger from fire. When storing coal, it would be well to keep in mind the following suggestions:

1. Some one person should be appointed to supervise the storage of coal and be held responsible for its success.
2. A suitable place for storage should be selected.
3. The coal should be carefully selected as to origin and size.
4. The breakage in unloading should be kept at a minimum.
5. Segregation of the different sizes should be avoided.
6. The coal should not be piled where outside sources could be contributing agents for transmission of heat.
7. The principle of "packing" the coal so as to lock out the air should be followed.
8. Interior temperature readings should be taken every ten days to two weeks.
9. If the pile has heated to 150 or 160 deg. F., it should be moved.
10. If water is to be used, soak the coal, break through the coke that is sometimes formed over and around the heated part.

Norwalk Iron Works Refrigerating Machine

The Norwalk Iron Works, of South Norwalk, Conn., well-known builders of air compressors, have entered the refrigeration field. For the present, at least, this company will confine itself to small machines from one-quarter ton up. The illustrations show clearly the construction. The long pistons are actuated by connecting rods which get their motion from eccentrics on the shaft (see Fig. 1). The suction gas enters through ports in the piston, which uncover on the suction stroke. The gas fills the space in the piston and compresses until the pressure overcomes the condenser pressure and weight of the valve. The valve area is large.

The ring on the base of the connecting-rod slips over a loose ring which in turn fits over the body or disc of the eccentric, the middle ring, as a bearing, being of babbitt metal. This bearing is retained by a lip on the inner edge of the eccentric-shaft ring and a similar lip on the outer edge of the connecting-rod ring.

Lubricant is supplied through holes in the inner and outer rings. The crankshaft journals have bearings of the same loose-ring type. On the inside of the housing, where the crankshaft passes through, there is a babbitt ring floating on the shaft which is forced by the pressure of the gas within the housing, against the stuffing box. The pressure put on the stuffing box in packing it is limited by a spring between the stuffing-box outside cap and the packing. The crankshaft bearings are of the loose ring or shell type. Fig. 2 shows a complete small motor-driven refrigerating plant.

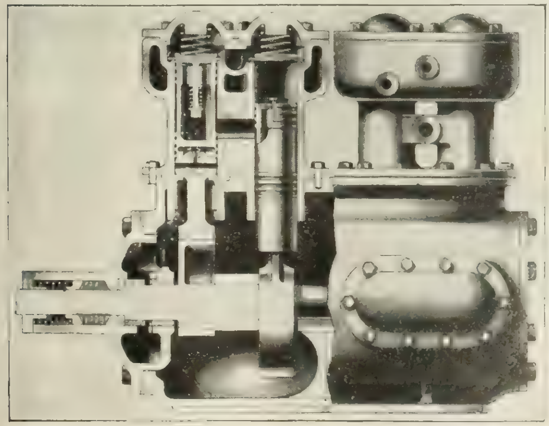


FIG. 1. SHOWING SECTION OF THE COMPRESSOR

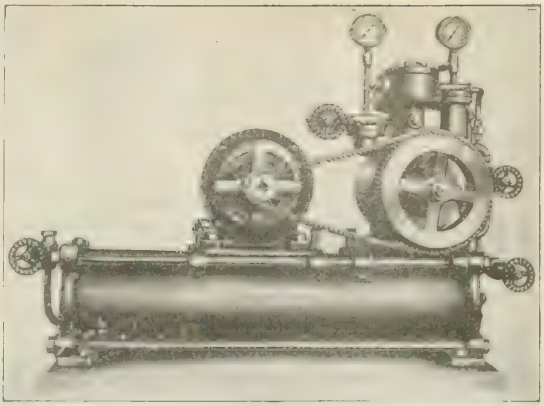


FIG. 2. COMPLETE SMALL REFRIGERATING PLANT

For lubrication a graphite mixture is used instead of oil. The aim is, of course, to avoid carrying oil into the ammonia system, also to avoid volatilization of the lubricant. The housing is packed with graphite which, the builders claim, will last for many months.

Ice-freezing tanks and complete small self-contained plants are built by this company.

Diesel-Engine Pointers

The main-bearing oil grooves should be examined at frequent intervals. Small carbon particles often choke up the passages.

The bearing cap studs should always be locknutted and cotterpinned.

In cutting grooves in rebabbitted bearings, never extend them to the edges of the bearing. This will prevent a too free escape of the oil.

Each time the crankpin bearing is taken out, caliper the bearing to see if it has belled. If the bearing is larger at the ends than at the middle, it will likely begin to run hot. What causes belling is unknown—probably the result of the crank and piston-pin bearings being cut of line, or side shifting of the mainshaft.

The Diesel engineer should remember that as the crankpin and piston-pin bearings wear, the connecting rod is shortened. This wear increases the clearance in the cylinder, decreasing the compression. Each time the wear is taken up, the rod end should be shimmed back to its original length.

In tightening up the big end bearing bolts, a heavy hammer can be used on the wrench. The locknuts must be drawn tight and cotter pins used. Washers can be placed between the nuts and cotter pin to fill the space.

The crank bearing should have but little play. A clearance of 0.006 in. is ample. If a slight movement can be detected when jumping with a bar, the clearance is sufficient.

The Air Lift

By A. H. BLAISDELL
Assistant Professor Mechanical Engineering, Carnegie Institute of Technology

It is the aim of the following discussion to give in as simple a manner as possible a brief explanation of how the air lift works, and to indicate in a general way how to carry out calculations in connection with this apparatus.

As a means of pumping liquids from deep bore-holes or wells the air-lift system is excellent. Not economy but expediency appears to be the governing factor in the use of air-lift apparatus. Thousands of installations scattered over the globe testify to the great success of this method of pumping water, oil, liquid sulphur, etc. In spite of its extensive use there has been little investigation of the air lift and there are few engineers that claim to know much about this method of pumping.

OPERATING PRINCIPLE

Referring to *A*, Fig. 1, this represents a well of great depth as compared to diameter, the diameter of such holes ranging from 6 to 12 in. and the depth from 500 to 1,500 ft. or more; *B* is a pipe of large diameter which projects down into the well to any desired extent; *C* is a pipe of smaller diameter than *B* and not quite so long; its lower end may project into pipe *B* as shown or into a chamber which connects with *B* by means of a number of small holes (see diagram to left of *A*). At *mm* is the water level in the well when no water is being pumped, the water standing to the same level on the inside of pipes *B* and *C* as on the outside.

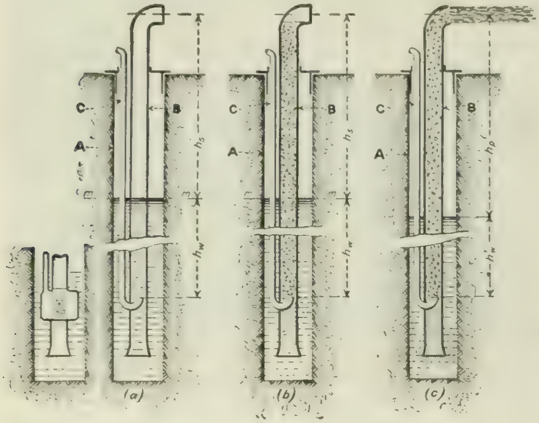


FIG. 1. SECTIONS OF THE AIR LIFT

Now suppose that air under pressure is supplied to the pipe line *C*: as the pressure of the air in *C* is gradually increased, the water level in this pipe is lowered until finally it reaches the end of the pipe. It is quite evident that the air pressure at this instant must be equal to the pressure due to the head of water h_w. Any further increase of air pressure will now cause the air to push the remainder of the water out of *C* and the air will start to ascend in pipe *B* in the form of bubbles. The effect of this action will be to lengthen out the fluid column in *B*, although the water level outside of *B* remains unchanged. The level of the aërated column of water finally reaches the top of pipe *B* and at this point we have then a column of water h_w feet in length supporting a column of air and water ($h_s + h_w$) feet in length. The instant that overflow occurs at the discharge end of *B* the pressure is relieved on the upper portion of the fluid column in *B*, the air bubbles rapidly expand and water is blown out from the upper end of *B* followed by a vigorous and continued discharge of aërated water *C*, Fig. 1, which is maintained as long as air is supplied to the system.

With the beginning of flow the level of the water in the well on the outside of *B* will drop from 15 to 20 or more feet, depending on the geologic formation of the strata which supplies water to the well and to the rate at which water is being removed from the well. The distance from the new level of the water to the center line of the jet is known as the pumping-head or lift (h_p); see *C*. It will always be greater than the static head (h_s). The distance (h'_w) is called the submerged head and is customarily given in terms of a percentage.

Before flow begins, the air serves only to lighten the column of water in *B*, but with the commencement of flow it really performs two functions—to maintain a fluid density for the air and water mixture less than that of the water, and at the same time to furnish a portion of the motive force required to keep up a continuous discharge of water from the discharge pipe *B*. Some authorities have argued that the motive force is due entirely to the difference in density of the fluid columns within and without the pipe *B*, while others have claimed that it is the buoyancy of the air bubbles which supplies this motive force. It seems resonable to suppose that both these effects occur simultaneously, although the former predominates over the latter to a greater or lesser extent, depending on circumstances.

To secure as much lifting effect as possible from the buoyancy of the bubbles, it is desirable to reduce the slippage of the latter as they move upward through the water in *B*. The larger the slip or relative velocity of the air with respect to the water, the greater the loss of energy. The slip increases with the size of the air bubbles, and for that reason it seems best to supply the air to the water in the lower end of the discharge-pipe, in a finely dispersed state.

SUBMERGENCE VARIES WITH THE LIFT

It is quite evident that the greater the lift (h_p) the larger the submergence must be, since it is due to the difference in weight of the aërated column of water inside of pipe *B* and the solid water on the outside of this pipe that flow from the discharge pipe *B* is sustained. What the submerged head (h'_w) should be, for a given well, can be ascertained only by actual test. Apparently, it is influenced by the quantity and rate at which water is taken from the well and the volume furnished to the well by the water-bearing strata. The difference in head ($h_w - h'_w$) is approximately equal to the drop in the air pressure at the instant that pumping begins and is different for each well. Formula

(1) can be used to estimate this drop when the change in air pressure is known or assumed.

$$h_w - h'_w = 144 \times \left(\frac{p_2 - p_1}{d}\right) + \frac{v^2}{2g} \qquad (1)$$

h_w = Head of water in feet on end of air pipe before pumping begins;
h'_w = Head of water in feet on end of air pipe after pumping beings;
v = Velocity of fluid mixture at point where air enters discharge pipe (feet per second);
d = Air density in pounds per cubic feet (see table);
p_2 & p_1 = Pressures of air before and after delivery begins in pounds per square inch absolute respectively.
g = 32.2

The fact that the air pressure necessary to keep the air lift in operation is less than that required to start the apparatus is because energy is consumed in overcoming the initial inertia of the water in the discharge pipe and setting it into motion. After flow has once been established, this additional energy is no longer required and hence a lessening of the air pressure results. Of course the drop in pressure will also be influenced by the resistances which the water may have to overcome when entering the lower end of the discharge pipe, such as strainers, etc. It is this change in h_w that makes air-lift estimates so uncertain, and for that reason experience is necessary before one can expect to design or install such pumping outfits with reasonable expectation of success.

In making preliminary calculations, the submerged head (h'_w) can be assumed as ranging from 0.5 to 0.6 times $h'_w + h_p$. In this connection the submergence curve of Fig. 2 can be used to advantage. This is a composite curve based upon results of various tests made by E. M. Ivens on different types of air lifts, and represents in a general way how the percentage of submergence should vary with the lift. It can be taken for granted that the higher the lift the greater will be h'_w, but the smaller will be the percentage of submergence.

SIZE OF DISCHARGE PIPE

The size of the discharge pipe will be governed by several factors—the diameter of well, rate of water delivery, and allowable velocities of fluid mixture in the discharge pipe.

The size of the well-bore is fixed, but the rate of delivery and the velocities admit of some variation. When deciding upon what velocity value shall be assumed for the discharge pipe, it must be borne in mind that a large area of pipe means a low water velocity with small friction loss in so far as the water is concerned; but this gain is offset by the greatly increased slip of the air bubbles, this slippage increasing as the discharge pipe is enlarged.

The velocity of the air and water mixture at the upper end of the discharge pipe will be from three to four times that in the lower portion of the same pipe (if the pipe is of constant diameter throughout) due to the expansion of the air bubbles as they ascend in the discharge pipe and reduce the effective area for the flow of water. It will serve for most purposes to assume a velocity of from 6 to 8 ft. per sec. for the lower end of this pipe and 18 to 26 ft. per sec. for the upper end. A gradual increase of velocity can be secured by making the discharge pipe taper from bottom to top.

The quantity of water and air in cubic feet passing by the lower end of the air pipe is given by

$$Q = Q_w\left(7.48\, q\, \frac{p_1}{p_2} + 1\right) \qquad (2)$$

where
Q = Cubic feet per second of water and air;
Q_w = Cubic feet per second of water pumped;
q = Cubic feet of free air per gallon of water pumped;
p_1 = Atmospheric pressure in lb. per sq.in. abs.;
p_2 = Pressure at lower end of air pipe in lb. per sq.in. abs.

Formula 2 applies to but one section of the discharge pipe; for any section of this pipe located y feet from the lower end of the air pipe, the density of the fluid mass is less than it was lower down in the pipe and Q becomes greater although the weight of fluid discharging from the pipe per second remains constant.

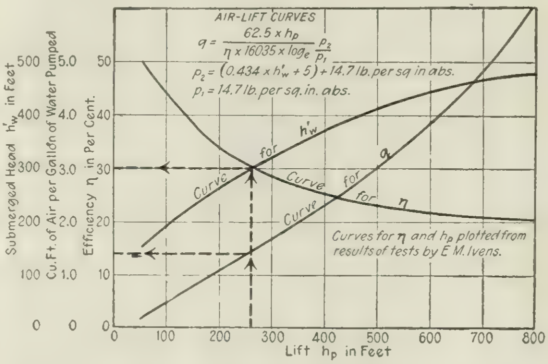


FIG. 2. CURVES TO ASSIST IN DESIGNING AIR LIFT FOR WATER

The diameter of the discharge pipe is given by

$$D = 0.62 \sqrt{\frac{G\left(7.48\, q\, \frac{p_1}{p_2} + 1\right)}{V}} \qquad (3)$$

where
D = Diameter of discharge pipe in inches;
V = Velocity of fluid mixture in lower end of discharge pipe in feet per second;
G = Gallons of water pumped per minute.

The value of D given by this formula must be less than that of the well by 3 to 5 in. A suitable value of V for the lower end of the discharge pipe can be assumed as already mentioned, but should never exceed 10 ft. per sec. As a rough estimate one can allow about one square inch of free cross-sectional area for discharge pipe for every 12 to 18 gal. of water pumped.

CUBIC FEET OF FREE AIR PER GALLON OF WATER PUMPED

An uncertain item in air-lift calculations is the quantity of free air required per gallon of water pumped from the well. It will be influenced by the capacity of the installation, the submergence, the sizes of the air and discharge pipes, etc. It is practically impossible to deduce a theoretical relationship between the air supplied and the water pumped that can be at all reliable, and for that reason it is customary to use empirical formulas which check fairly well with tests of actual installation. One of the best known is that originated by Edward Rix and T. H. Abrams. In this case, however, I shall utilize the following expression which relies for its accuracy on the relation between (h'_w) and the efficiency (η) as determined from tests on air lifts. The formula is

$$q = \frac{62.5\,h_p}{\eta \times 16{,}035 \times \log_e \frac{p}{p_1}} \qquad (4)$$

where q = cubic feet air per gal. water pumped; h_p = lift in feet; $p_2 = (0.434\,h'_w + 5) + 14.7$ lb. per sq.in. abs.; p' = atmospheric pressure in lb. per sq.in. abs. Values of q as calculated from this formula compare favorably with those secured from empirical formulas in use at present. The curves of Fig. 2 show the variation of η q and h'_w and h_p. The data for the h'_w and η curves were taken from tests made by E. M. Ivens. The η curve is of a composite nature and gives average values covering several different types of air-lift installations. It will be observed from these curves that as h_p increases, the submergence h'_w gradually grows, while the efficiency drops off rather abruptly at first and then quite slowly. The cubic feet of free air required per gallon of water pumped is least for low lifts and a maximum for high lifts.

As the curve for q is based on test results, it is not necessary to increase q in figuring the required air compressor capacity, since this curve includes the effect of volumetric efficiency of the average compressor.

The air pipe must be of such size that the velocity of air flow shall not exceed about 3,000 ft. per min. Velocities in excess of this cause a considerable drop in the air pressure between the compressor and the end of the air pipe, particularly for long pipes. It is customary, in practice, to make the area of the air pipe about one-sixth that of the discharge pipe, but if the former is very long it is well to calculate the probable drop in pressure.

AIR-LIFT EFFICIENCY

The efficiency of an air lift is usually stated as the ratio of the work done in lifting W lb. of water through the height h_p and the expansion work of the air while passing up through the discharge pipe. Expressed mathematically, it is

$$\eta = \frac{212 \times h_p}{q \times d \times T \times \log_{10} \frac{p_2}{p_1}} \qquad (5)$$

where η = efficiency in per cent; h_p = pumping head in feet; d = density of air taken in by compressor, in lb. per cu.ft. (see Table I); p_2 = air pressure at base of air-pipe in lb. per sq.in. abs. ($= 0.434\,h'_w + 5 + 14.7$); p_1 = atmospheric pressure in lb. per sq.in. abs.; T = temperature of water in well in deg. F. abs.; q = cu.ft. of free air per gal. of water pumped.

This formula is based upon the assumption that the air expands isothermally while rising up through the discharge pipe. A more exact expression for the efficiency would be one that considered the compression work done by the air compressor rather than the expansion work of the air in the discharge pipe.

An examination of the efficiency curve of Fig. 2 shows that the efficiency of an air lift will vary between 50 and 20 per cent, the higher values accompanying the lower lifts. The low average efficiency is offset by the great advantage of having an outfit which does not require constant tinkering. An air lift can handle dirty, gritty or acid water with equal facility. As a matter of fact its over-all efficiency is as good as, if indeed not greater than, that of any pumping apparatus that could be used for the purpose of raising fluids from great depths.

Suppose that a well, 10-in. bore, is to be equipped with an air-lift system. If the distance to the water level from the ground surface is 242 ft., what will be the probable total length of the discharge pipe and air pipe, air-compressor capacity in cubic feet per minute, sizes of both pipes, and efficiency of installation? Well capacity to be 200 gal. of water per min.

The effective length of the discharge pipe equals the lift plus the submergence. The lift or pumping head (h_p) will be greater than h_s, but just how much it is impossible to say. We will assume a drop in the water level of the well of about 20 ft. when pumping begins. In that case the pumping head can be estimated as about 242 + 20 = 262 ft. Referring to the (h'_w) curve of Fig. 2, we find that for h_p = 262 ft. h'_w = 300 ft. Hence the effective or working length of this pipe must be at least 262 + 300 = 562 ft., and since the lower end of the pipe will be anywhere from 5 to 20 ft. below the air-pipe connection to the discharge pipe, we can estimate the total or over-all length of this pipe as being 562 + 10 = 572 ft., from which fact it is evident that the well must have a depth of from 575 to 580 ft.

The air-pipe length will be exclusive of that portion above the ground surface, 562 ft.

From the q curve of Fig. 2 we observe that for h_p = 262 ft. q or the free air required per gallon of water pumped, is 1.33 cu.ft., or a total of 200 × 1.33 = 266 cu.ft. per min., and this must be the air-compressor capacity.

For (h'_w) equal to 300 ft. p_2 is

$p_2 = 300 \times 0.434 + 5 + 14.7 = 150$ *lb. per sq.in. abs.* and the diameter of the discharge pipe must be from formula (3)

$$D = 0.62 \sqrt{\frac{200\left(7.48 \times 1.33 \times \frac{1}{10} + 1\right)}{6}} = 5.07 \textit{ in.}$$

That is, allowing for friction, etc., about a 6-in. pipe would undoubtedly fill the bill provided the velocity in the upper portion of the pipe does not exceed 30 ft. per sec. To check this, let $p_2 = p_1$. Then if D = 6 in. we find, on re-arranging formula (3) and solving for V, that

$$V = \frac{0.384 \times G\left(7.48 \times q \times \frac{p_1}{p_2} + I\right)}{D^2} =$$

$$\frac{0.384 \times 200\left(7.48 \times 1.33\,\frac{1}{10} + I\right)}{36} = 23.4 \textit{ ft. per sec.}$$

Evidently, with a 6-in. pipe the velocity in the upper portion of the discharge pipe will be considerably less than 30 ft. per sec., and we may consider this size of pipe as satisfactory.

If the area of the air pipe is taken as one-sixth that of the discharge-pipe, then

$$D_a = \frac{D}{\sqrt{6}} = \frac{6}{2.45} = 2.45 \textit{ in.}$$

That is, a standard 2½-in. pipe is required.

The efficiency η will be, from efficiency curve of Fig. 2, about 30 per cent.

Temp., Deg. F.	Weight of One Cu. Ft. of Dry Air (at 14 Lb. per Sq.In. or 28.5 In. of Hg.), Lb.	Increase or Decrease of Weight for Each 0.1 Lb. Change in Pressure, Lb.
32	0.07688	0.000549
35	0.07642	0.000546
40	0.07565	0.000540
45	0.07490	0.000535
50	0.07417	0.000530
55	0.07340	0.000525
60	0.07272	0.000520

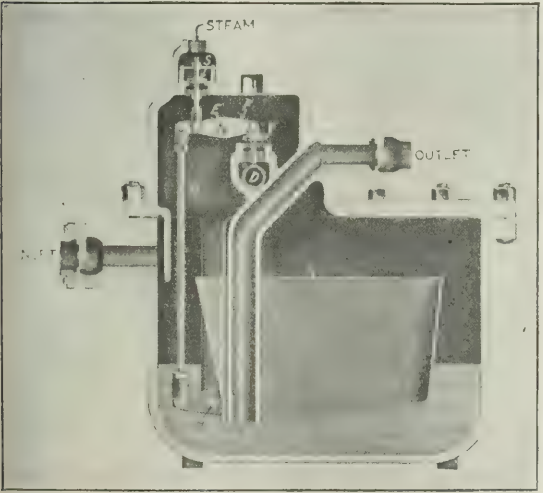
Strong Vacuum and Pumping Trap

This trap, "Type M," is designed for draining exhaust lines to condensers or for draining any system under any degree of vacuum, such as the receiver of a compound engine or the receiver between an engine and exhaust or low-pressure turbine, whether the receiver is under pressure or under vacuum. It will also drain vacuum oil separators and deliver the water to any distance or any height, limited only by the steam pressure available.

This trap, designed by L. A. H. Merrihew and manufactured by the Strong, Carlisle & Hammond Co., Boston, can also be used as a pumping trap, as it will take the water from low-pressure or gravity-heating returns and pump it anywhere, limited only by the available steam pressure. It will also serve as a sump pump.

The principal parts of the trap are the body, cover with valve chamber, open float bucket, vacuum or equalizer valve, steam valve and valve-operating connections. The steam and equalizer valves are both connected to the valve rocker arm *F*, which swings on a bearing at *E*. The bucket is hinged at *H* to an extension from the trap cover and is connected to the valve rocker arm by the valve-operating rod *G*.

The illustration shows the trap in the filling position. The bucket is up and afloat. The steam valve *S* is on its seat, and the equalizer valve *V* is open. Water comes into the trap, fills the bucket, which sinks and pushes up the rod *G*, closing valve *V* and opening valve *S*. The valve *V*, in closing, cuts off the trap from equalizer pipe; valve *S*, opening, admits live-steam pressure to the trap and discharges it from inside the bucket, through the outlet pipe. The bucket, becoming empty, floats and reverses the valves to the filling position. When live steam is admitted to the trap, it cannot go out through the inlet because of the check valve. After the trap has discharged and the steam is cut off by the rising of the bucket, the steam pressure in the trap equalizes back into the system or exhausts through the equalizer port, as the case may be. The trap then functions in this manner continually. A check valve in the discharge cuts off any air or back flow from the discharge line.



SECTION THROUGH VACUUM AND PUMPING TRAP

Hydraulic Turbines in the Rural Districts About 1830

As illustrating the "state of the art" some eighty or ninety years ago in backwoods New England, the following true story may be worth recording. It was told to the writer by Z. Coffin, founder of the Coffin Valve Co., of Neponset, Mass., many years ago.

There were two men in his town, an old conservative and an enterprising young man, who owned a sawmill in common and operated it in alternate weeks. The output of the mill did not satisfy the younger man, so he proposed to his colleague that they should put in a better turbine wheel, which he thought could be bought in the market. But the old man would not agree to this proposition.

"THAT IS BECAUSE YOU WERE SO GOL-DURNED MEAN TO ME ABOUT PUTTING IN A NEW WHEEL"

"You can put in a new wheel, if yer want to," said he, "but you must put it in, in your week. And you must keep the old wheel in good shape and put it back again, if the new wheel is no better than the old one, in your week."

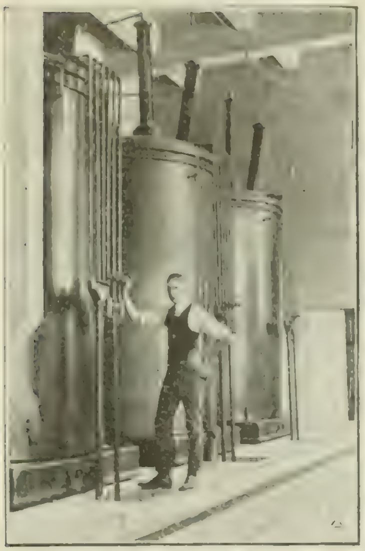
That was not very encouraging, so the young man did the next best thing and, experimenting, soon found that the efficiency of the whole plant was improved when he smoothly plugged up some quarter part of the guides; or perhaps it was of the buckets, "undergating" and "overgating" being common defects at the time. But he said nothing about it to anybody, and at the end of his week took the plugs out again. The result was that the old man soon noticed that there was something mysterious about the output of that sawmill which he couldn't account for.

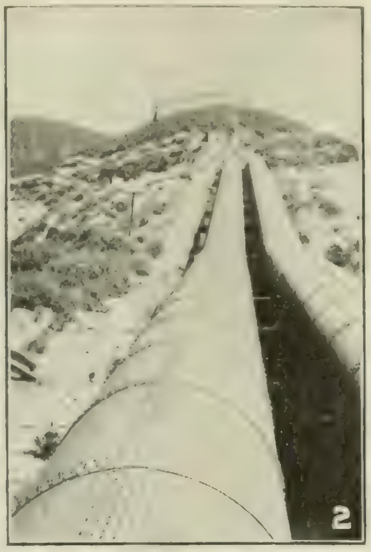
"How is it," he said to his fellow-owner, "that in your week the saw seems to buzz faster and that you always turn out more sawed stuff in a week than I am able to turn out?"

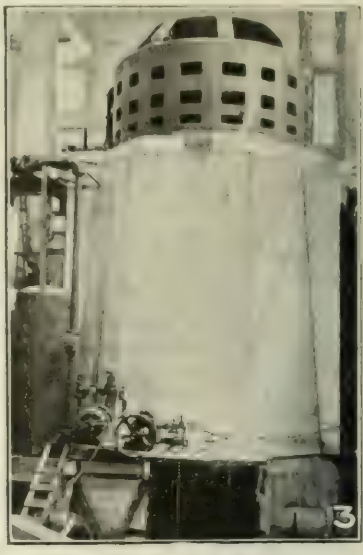
"Don't you know why that is?" asked the younger. "That is because you were so gol-durned mean to me about putting in a new wheel. It is a punishment from God Almighty."

This did not seem rational to the older man, but when it continued week after week, it at last brought him around. The old wheel was taken out at the close of one man's week, and a new one installed in the beginning of the other man's week; the weekly output of sawed stuff was permanently increased, and presumably they lived happily ever after.

Views of Power Equipment Along the Los Angeles Aqueduct System







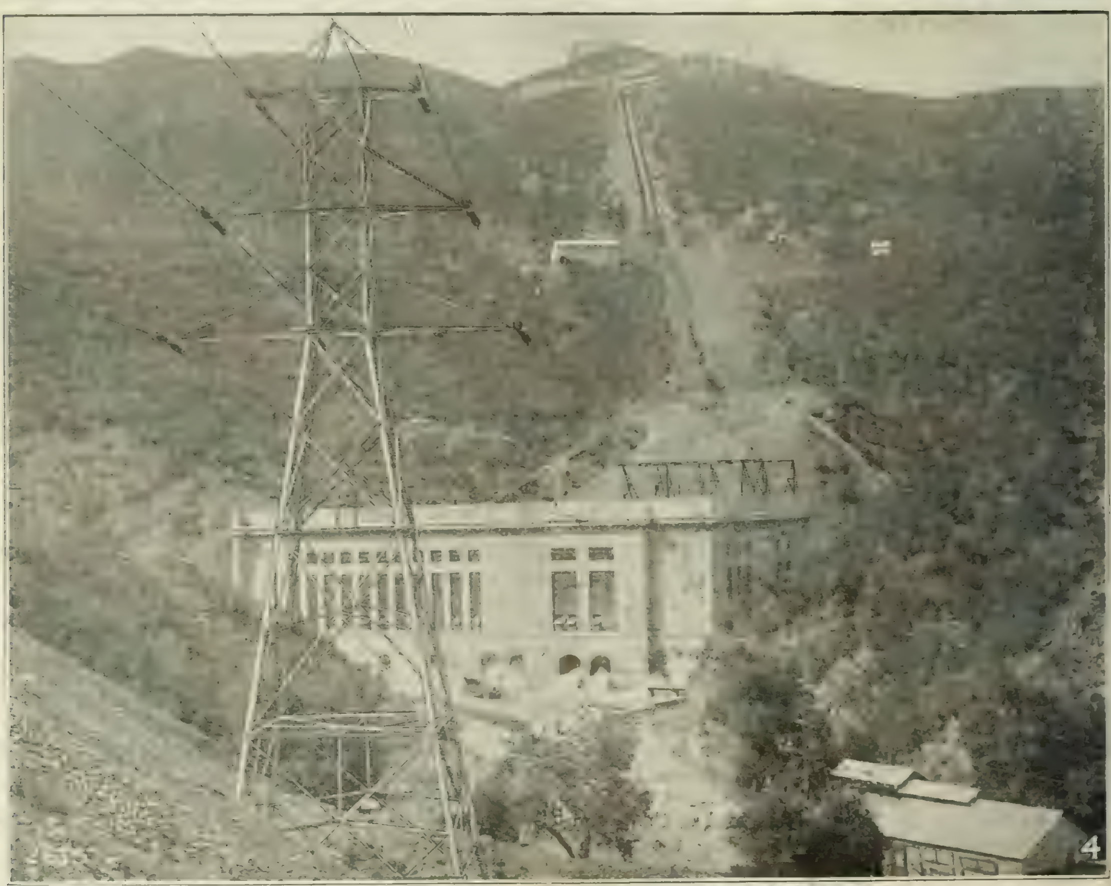


FIG. 1. THREE 110,000-VOLT TRANSFORMERS. FIG. 2. PART OF PENSTOCKS AND SURGE CHAMBER AT NO. 1 PLANT.
FIG. 3. TURBINE INCASED IN CONCRETE WITH STATOR FOR 15,000-KVA. GENERATOR IN PLACE.
FIG. 4. SAN FRANCISQUITO (LITTLE ST. FRANCIS) POWER HOUSE NO. 1

Ice Tank of New Design Gives Remarkable Results

By C. WILKIE

Engineer, Finney Avenue Plant, Merchants Ice and Coal Company, St. Louis

This ice tank is 114 feet long, holding 856 cans, freezing 400-pound blocks. Direct-expansion coils are in one end, flooded coils with horizontal accumulator in the other end. Seven inches of agitation is produced by one propeller, 36 inches in diameter, at the center of the tank. Special floor design, cans four inches higher than usual and means for holding cans vertical permitted this rapid circulation. Other features are eighteen-can pneumatic crane and spring-bottom dumps. New tank shows heat transfer of 40 B.t.u., a remarkable performance.

DURING the season of 1919 it was decided to increase the capacity of the ice-freezing tanks in the Finney Avenue Plant of the Merchants Ice and Coal Company, St. Louis, Mo., the location of the new tank being the first question to be determined. In the June 22, 1920, issue of *Power* a general description of the plant was published. The reader may remember that there were three freezing tanks, each 79 ft. long and wide enough to hold eighteen 400-lb. cans in a row. To build a new tank by the side of the old ones it would have been necessary to extend the building on that particular side, and to locate the new tank under one of the old ones would have deprived the plant of an ice-storage house having a volume of 58,000 cu.ft. At one end of the older tanks was an unoccupied room which would give ample space for extending the old tanks 35 ft. and at the same time provide the necessary space for ice conveyors to carry the ice to the storage rooms below.

Extending the old tanks was much the cheaper plan, although it would make an excessively long tank, calling for a coil 1,500 ft. long, provided the coil ran the full length of the tank. During the winter of 1919-20 one of the tanks was extended and the coils, propellers and pipe connections were rearranged. The results obtained from the new tank during last season were so much above expectations that the other two tanks are being rebuilt along the same lines. After removing the old coils, the tank was raised 3½ ft. by means of 1⅛-in. continuous threaded rods, which were put through timbers above and passed through 6 x 6 x ⅝-in. angles 10 in. long, bolted to the side of the tank, with a takeup nut on the bottom side of the angle, as shown in Fig. 2. With a man at each rod the tank was raised to the proper height and blocked up in a short time. The addition was made and the coils arranged as in Figs. 3, 4 and 5. To preserve the efficiency in a freezing tank of such length, it was considered necessary to make one end of the tank direct-extension, with double coils, and to expand 100 per cent excess liquid through them. This end of the tank was practically flooded and really better than a regular flooded coil, as it would have higher internal velocity. The opposite end of the tank was arranged to operate on the flooded system, as it made possible the use of a short coil in which each foot of pipe had a decided pitch. This coil will be used to evaporate the 100 per cent excess liquid fed to the opposite end of the tank. With the arrangement outlined it was possible to use a horizontal accumulator in the place of headers, and it was made of large capacity to insure delivery of dry saturated gas to the machine. Inlet headers and check valves are used on practically

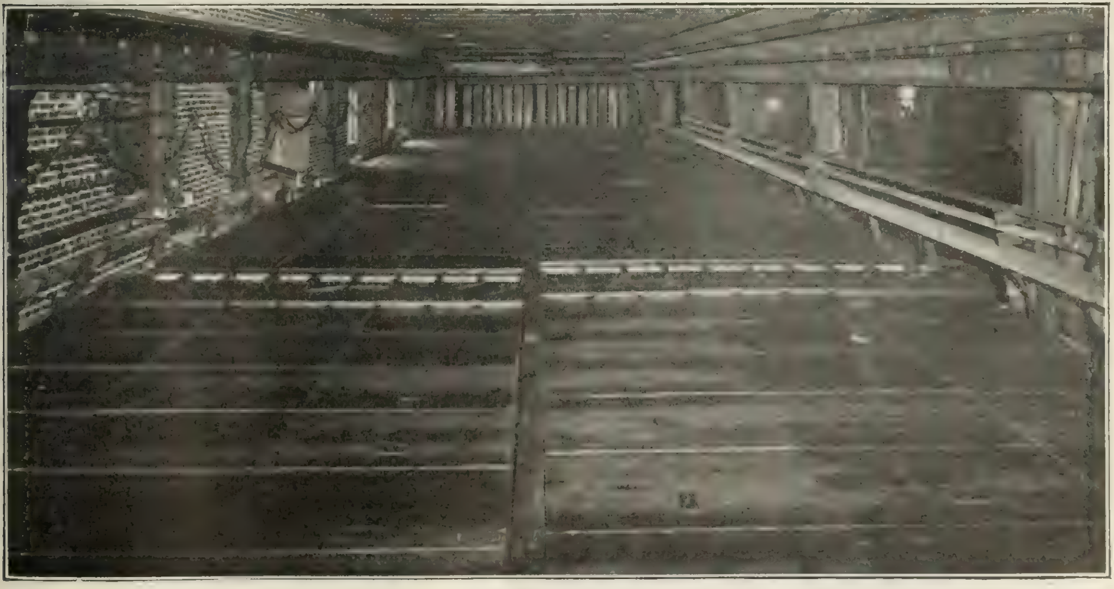


FIG. 1. NEW ICE TANK FOR FINNEY AVENUE PLANT 114 FT. LONG

all flooded systems, as it has been proved by tests that there is a periodic kick-back in the circulation of ammonia. The ammonia evaporates in the coils faster than it can flow steadily forward. Thus the closing of the check valve against its return accelerates the forward circulation. In the present case the check valves and headers were not installed because it would have been necessary to shorten the tanks two or three rows of cans to get the necessary alley. The difficulty was overcome by using short and steep flooded coils, on the ground that if the coils were short enough and had sufficient pitch there would be no kick-back and no necessity for check valves. This arrangement also reduced materially the cost of construction.

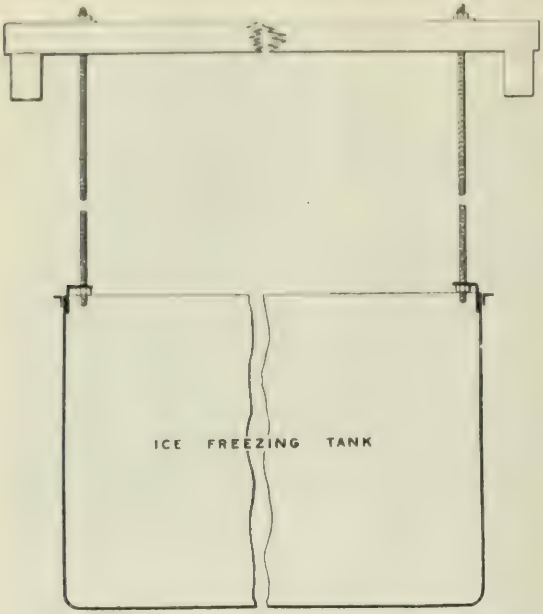


FIG. 2. METHOD OF RAISING ICE-FREEZING TANK

While these tanks were being designed, the idea was conceived that the cause of most of the flooded-system failures was due to excessively long coils and to small accumulator capacity. The latter difficulty was solved by building an unreasonably large accumulator and placing it horizontal so that its separating area would be as large as possible. It was expected that even with this arrangement the machine would get wet gas and that possibly a drier or superheating accumulator would have to be installed in the main suction line. Results obtained so far have proved that such a precaution is unnecessary.

The expansion header is made of 5-in. single-strength pipe, drilled and tapped for 1¼-in. nipples, 7¼-in. centers, to receive the two connections from each double coil. Ninety degrees from the coil connections and six feet from either end, 1¼-in. nipples have been inserted for expansion-line connections. The nipples were screwed into the header and welded, and ⅜-in. firebox steel plates were welded to each end. The header lies in the bottom of the tank and feeds the two bottom pipes of each double coil. This gives an even ammonia feed for each coil as the header is half full of liquid before any of the coils can receive any of the fluid. The suction header for the direct-expansion coils is made up of 7-in. single-strength pipe drilled and tapped for 1¼-in. nipples, which are made up and welded. The continuation of this header connects with the accumulator.

In the direct-expansion end of the tank the coils are double; that is, two coils in one, each 376 ft. long. U-bends of 5- and 13-in. radius were used to make up the coils. The latter are welded throughout except where they are connected to the expansion header, steel flanges being used here.

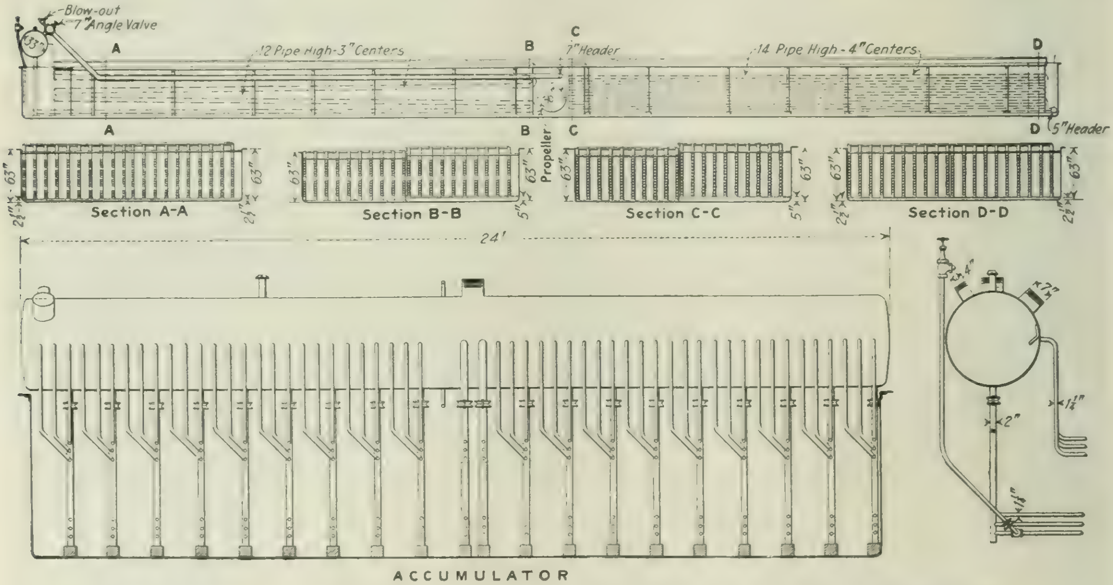


FIG. 3 GENERAL LAYOUT OF ICE TANK AND CONNECTIONS TO HORIZONTAL ACCUMULATOR

In the flooded end of the tank triple, or three-in-one, coils are used, each 220 ft. long. The liquid ammonia for the flooded end passes through the direct-expansion coils, then through the 7-in. line to the accumulator. From this point it is gravity-fed into the bottom of the flooded coils, and the gas passes from the coils back into the side of the accumulator above the liquid level. These coils have a gradual incline of about $\frac{3}{32}$ in. to the foot. Fig. 3 shows the accumulator, which was made of ½-in. marine steel plate with welded seams. The 2-in. liquid feeds, which are welded to the bottom of the triple coils, are insulated and made waterproof so as to prevent any of the liquid ammonia from evaporating before it enters the coils. A 10-in. dry pipe was placed inside of the accumulator with a 7-in suction connection leading from it. The dry pipe has a slot one inch wide for its full length through which the gas must pass before it can enter the suction line. To get liquid to the compressor would require that the accumulator be practically full of liquid ammonia. A 1¼-in. blowoff connection was made to the bottom pipe of the triple coils. The main suction header and line to the compressor room is 12 in. in diameter and passes above the accumulators. The connections between the accumulators and the header are 7 in. in diameter. The suction does not pass through any forecooler, and yet with this arrangement it is difficult to freeze back to the compressor.

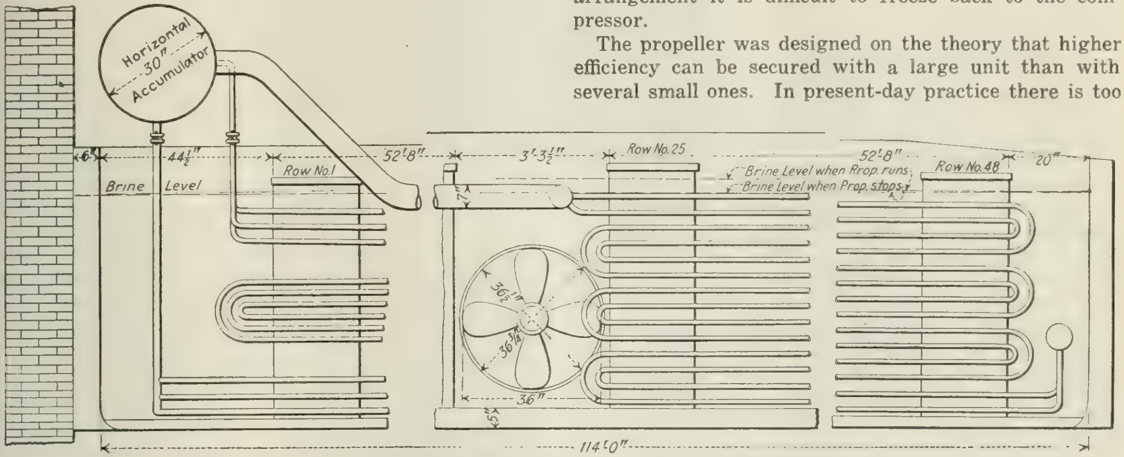


FIG. 4. CONNECTION OF FLOODED COILS TO ACCUMULATOR

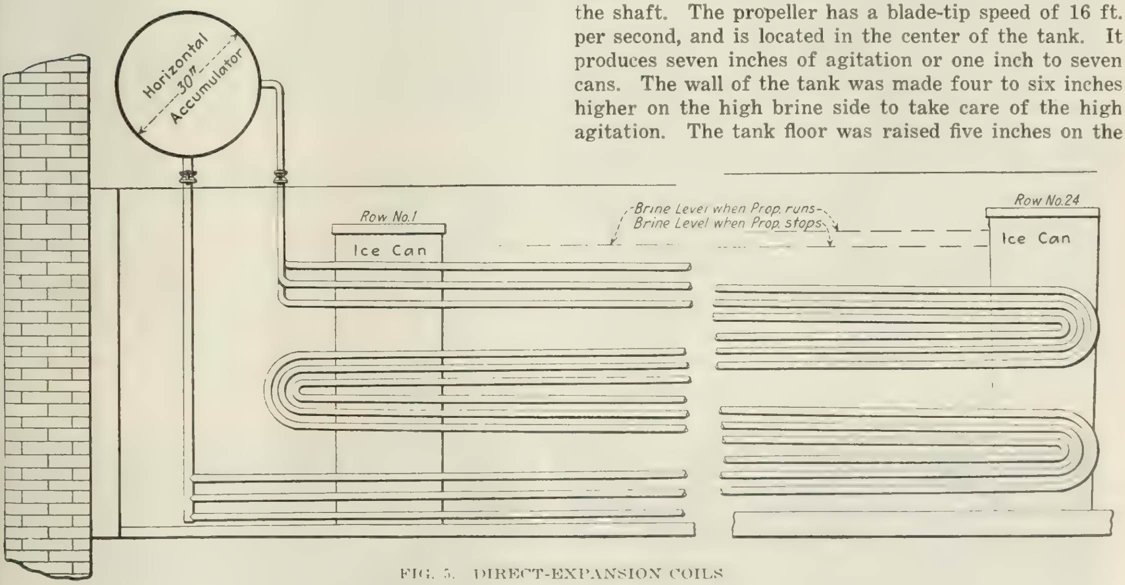


FIG. 5. DIRECT-EXPANSION COILS

The propeller was designed on the theory that higher efficiency can be secured with a large unit than with several small ones. In present-day practice there is too much room for slippage between blades and the blade tip speed is so high as to cause cavitation.

Fig. 6 shows the propeller. It is 36 in. in diameter and has three blades made of ¼-in. steel plate welded to a piece of 8-in. pipe, 18 in. long, which has solid heads in either end and is bored for a 2$\frac{11}{16}$-in. shaft. This completes the hub, which is keyed on the shaft and held against a shoulder by means of a jam nut on the end of the shaft. The propeller has a blade-tip speed of 16 ft. per second, and is located in the center of the tank. It produces seven inches of agitation or one inch to seven cans. The wall of the tank was made four to six inches higher on the high brine side to take care of the high agitation. The tank floor was raised five inches on the high-brine side immediately in front of the propeller, with a fall of 2½ in. from the center to each end of the tank and also a 2½-in. fall from each end to the center of the tank immediately behind the propeller on the low-brine side. The floor on the high-brine side was made of concrete, that on the low-brine side of yellow pine.

New cans four inches longer than the old ones were ordered, the extra length costing but little more. This seemed to be the best method to meet the high-brine circulation. With cakes of ice 53 in. long, cans 62 in. deep and special tank-floor design, it was easy to get from seven to nine inches of agitation and keep the brine above the ice without flooding over the top of the cans, whether the propeller was running or standing. The propeller is motor driven and takes about 7¾ hp. motor input.

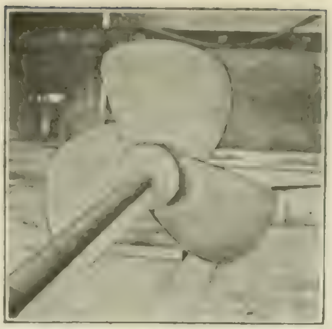


FIG. 6. SINGLE 36-IN. PROPELLER USED TO CIRCULATE BRINE

It was necessary to provide in the freezing tanks some means of holding the cans in a vertical position against the rapid circulation. This was accomplished by the use of tapered blocks bolted to the sills for holding to tops of the cans, a 1⅝ x 3¼ x 3½-in. yellow-pine strip located on the tank floor between the cans to prevent the bottoms from moving, and guide rod ⅝ in. in diameter bolted to the tapered block. The lower end of the rod is forked and is fastened to the 1⅝-in. strip by drive screws. The rod and coils serve as guides while the cans are being filled.

A crane designed to handle eighteen 400-lb. blocks of ice at one time is one of the outstanding features of the installation. It is of the pneumatic type and motor-propelled. Two 12-in. x 8-ft. cylinders are located, one on either side of the channel-iron frame, each cylinder handling nine cans, as shown in Fig. 7. The round rings between the clevises on the can dog and the clevis on the tee-bar were desiged to hold the cans straight for entering the dumps and at the same time allow the can dog free movement so that it could be connected easily to the can.

In the past 16- and 18-block cranes have failed owing to the fact that, when a whole row of ice was pulled, the brine would be lowered below the water in the cans. This would seriously affect the freezing rate and leave a large cup in the top of the block. In the present case the special floor design and the extra-long cans solve this problem, as three rows, or 54 blocks, can be pulled out without lowering the brine below the water level in the cans.

As shown in Fig. 8, the ice dumps, eighteen in number, are located at one end of the tank. The sides are made of ¼-in. sheet iron with a 2-in. oak-wood back. The most interesting feature of these dumps is the spring bottoms used to protect the cans from shock, the springs serving as cushions when lowering the cans into the dumps.

The ice is transferred to a conveyor directly in front of the dumps, carried across the tankroom and automatically transferred to a retarding conveyor which delivers the ice to the storage rooms below. The two conveyors are timed so that the ice on the cross conveyor is transferred first behind a shoe on the retarding conveyor, which in turn holds the cake of ice back until it is delivered to the storage room.

Table I gives a fair indication of the performance of the new tank, and these data may be compared to the results obtained with the older tanks, reproduced in Table II. In the latter a heat transfer per degree temperature difference per square foot per hour of 25.8 was considered excellent, as it was above results usually obtained. The 40-B.t.u. heat transfer of the new tank is nearly 60 per cent better and must be taken as a remarkable performance.

TABLE I. PERFORMANCE OF THE NEW TANK

Number of 400-lb. cans	856
Tons of ice per day	110
Average can allowance per ton	7.7
Lineal feet of 1¼-in. pipe	28,370
Lineal feet of 1¼-in. pipe per ton of ice	257
Average suction pressure, lb	23.5
Average brine temperature, deg. F	13.5
Temperature corresponding to suction pressure, deg. F	10
Temperature difference, deg. F	3.5
Surface external pipe, sq.ft	12,331
Tons refrigeration in 24 hours	144
B.t.u. water cooling and freezing	38,720,000
B.t u. losses tank covers, sidewalls, air for agitation	2,744,000
Total B.t.u	41 464,000
B.t.u. per square feet external pipe surface per hour	140
K-heat transmitted per degree temperature differencr per square feet per hour	40

TABLE II. PERFORMANCE OF OLDER TANKS

Number of cans, 400 lb	1,818
Tons of ice pr day	238
Average can allowance per ton	7.6
Lineal feet of 1¼-in. pipe	57,000
Lineal feet of 1¼-in. pipe per ton of ice	239
Average suction pressure, lb	20.5
Average brine temperature, deg. F	12
Temperature corresponding to suction pressure, deg. F	7
Temperature difference, deg. F	5
Surface external pipe, sq.ft	24,800
Tons refrigeration in 24 hours	266.9
B.t.u. per 24 hours ice cooling and freezing	76,892,000
B.t.u. per square foot per hour	129
K-heat transmitted per deg. temperature difference per square foot per hour	25.8

The design throughout was by company engineers, Messrs. Ormsby and Gass being responsible. R. H. Tait, of the consulting engineering firm of Tait, Nordmeyer Engineering Co., was retained as an expert to pass upon the design of the flooded coils, accumulator, etc., since many features were included that were not of current practice in refrigerating work.

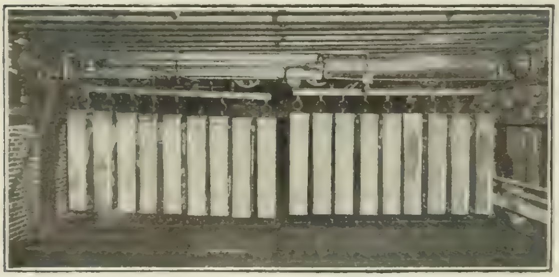


FIG. 7. MOTOR-PROPELLED PNEUMATIC CRANE CARRYING EIGHTEEN 400-LB. BLOCKS

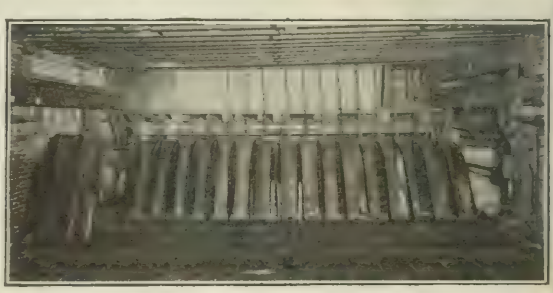


FIG. 8. EIGHTEEN-CAN ICE DUMPS WITH SPRING BOTTOMS

Eliminating Waste To Reduce Power-Plant Costs

By Paul R. Duffey

One of a number of power plants under my supervision was showing month by month a gradual increase in operating costs. When these increases were analyzed, it was found that additional load on the plant was partly responsible. Not being satisfied that this was the entire cause, a further check showed that the plant in general was so run down and badly located that unless it was changed and necessary repairs made, nothing could be expected but a continuation in the rising costs each month.

Relocating the Boilers

In order to keep the plant in operation while relocating the boilers, it was decided to put in a continuous ashpit to accommodate four locomotive-type boilers spaced four feet apart, allowing sufficient room between the boilers to make repairs to staybolts, etc. The pit completed, a new 125-hp. boiler was set and temporarily connected to the steam main. This boiler, after being fired up, permitted cutting two of the old boilers out of service and relocating them over the new pit. A fourth unit was installed, and after this work was completed and all boilers temporarily connected to the old steam header, the boiler room was built up around the boilers and over the old boiler room, which was later torn down.

The new boiler room is of wooden construction, the framing being covered with corrugated galvanized iron siding. The ends are provided with windows extending across the entire length; windows are placed in the side next to the coal bunker and firing aisle, thus affording plenty of natural light and a cheerful place in which to work. The roof is made up of three-ply roofing and slag finish. A space four feet square was provided around each stack where it comes through the roof of the building. These openings are covered with steel plates securely held to place, thus giving protection to the roof and building against fire and weather. A concrete floor and steel plate along the firing aisle add to the cleanliness of the plant as well as to the convenience of the operator.

Special attention was given to locating the boilers in relation to the fuel supply, and it has been so arranged that the fireman does not have to take any unnecessary steps to reach the fuel, which is unloaded from the cars in quantity against the coal gates six feet from the firedoors of the boilers. The coal bunker has a capacity of 200 tons, which can be readily replenished with the clamshell crane used in other parts of the plant.

Feed-Water Heater and Feed Pump Installed

Previous to relocating the boilers the feed water was obtained directly from the general service tank and handled to the boilers through injectors at a temperature of 70 deg. F. In the new location an old abandoned closed feed-water heater was put in good condition and a suitable feed pump secured from another plant where it had become obsolete. These were installed and the water, instead of being pumped directly from the supply tank, is taken from a new concrete sump basin into which is run the overflow from the water jackets of three air compressors and coolers; this water was formerly wasted. It has been found that no makeup water is needed, as there is still a slight excess on warm days, when it is necessary to have a good supply of jacket and cooling water. Exhaust steam for the heater has been secured by piping the exhausts from the supply pump, mill engines and air compressors into a common header discharging through the heater to the atmosphere. There has also been provided the usual bypass arrangement for cutting the heater out at any time for repairs. The temperature of the feed water under the new arrangement shows an average of 180 deg., or a rise of 115 deg., making an effective fuel saving of more than 10 per cent. Besides hot feed water, there is also a supply of hot water for filling dead boilers which can be brought up to the steaming point with very little fuel waste. Sufficient exhaust steam is available for heating the wood mill and offices, live steam being used formerly in this service.

A new and substantial steam header has been run to all boilers and plant machinery served from it. Steam and hot-water lines, including exhaust-steam line, feed-water heater and boilers, have been properly insulated with sectional covering and lagging, making an additional saving in fuel of 10 per cent.

Engines and Compressors Overhauled

All engines and air compressors have been thoroughly overhauled and put in first-class running condition. A concrete floor, well drained, was laid around all such equipment, which can be kept in a clean condition, and the man in charge has already shown that he is interested in doing better work under good working conditions. All air lines were gone over for leaks, the valves and cocks repaired, and a new discharge line common for all compressors has been provided to the main storage reservoirs which has suitable oversize valves from each compressor discharge to the main. All drains, traps and miscellaneous equipment have been put in good condition, with the results shown in the table. A master gage-board containing gages showing steam pressure, air pressure and feed-water pressure, as well as a duplex recording gage for air and steam pressures, has been added as a further incentive for the operator to produce good results.

MONTHLY OPERATING DATA

	Last—Under Old Arrangement		Present New Arrangement	
Fireman......	4@ $137.84	$551.36	3@ $137.84	$413.52
Ash man..........	1@ 115.20	115.20	None	....
Coal pans..........	2@ 115.20	230.40	None	....
Fuel..........	300 tons @ 5.15	1,545 00	170 tons @ 5.15	$875.50
Water........	estimated	35 00	No charge	....
Oils, etc............		50.00		30.00
		2,526 96		$1,319.02
		1,319.02		
Saving per month...........		$1,207.94		

Saving, year, $14,495.28. The cost of the project was $3,500.00 and it paid for itself in three months.

Semi-Diesel and Hot-Bulb Engine Suggestions

On starting the engine, do not inject too much fuel oil. Two strokes of the hand lever should be sufficient. If an excessive amount of oil is used, there is great danger of blowing the cylinder-head joint.

In old engines where the usual copper gasket fails to keep the head joint tight, try using asbestos wicking braided into a rope. This should be soaked in salt water and then covered with graphite and oil before using.

In installations where the starting torch is fitted with a heating coil, small carbon particles will choke the coil; a spare torch should be always on hand. The coil can be cleaned in lye water and then blown out with air.

The World's Largest Boilers

THE eight enormous boilers that are being installed at the Ford Plant at River Rouge, Mich., are the largest of their kind and are part of the first really large power plants in the United States to use pulverized fuel. One of these boilers is already in successful operation.

An idea of the great size of the installation may be gained from the picture, which shows eight Ford cars lined up inside one of the furnaces. There is plenty of room, as the furnace measures 23 x 25 ft. and is 55 ft. in height. The boilers, which are being made by George T. Ladd Co., Pittsburgh, Pa., are of the water-tube type and have an effective heating surface of 26,470 sq. ft. Each one has two lower drums, two upper drums and one steam drum. Connecting the upper and lower drums are 1,467 tubes, 3¼ in. in diameter and having an average length of 20 ft. 6 in. Placed end to end they would extend a distance of six miles.

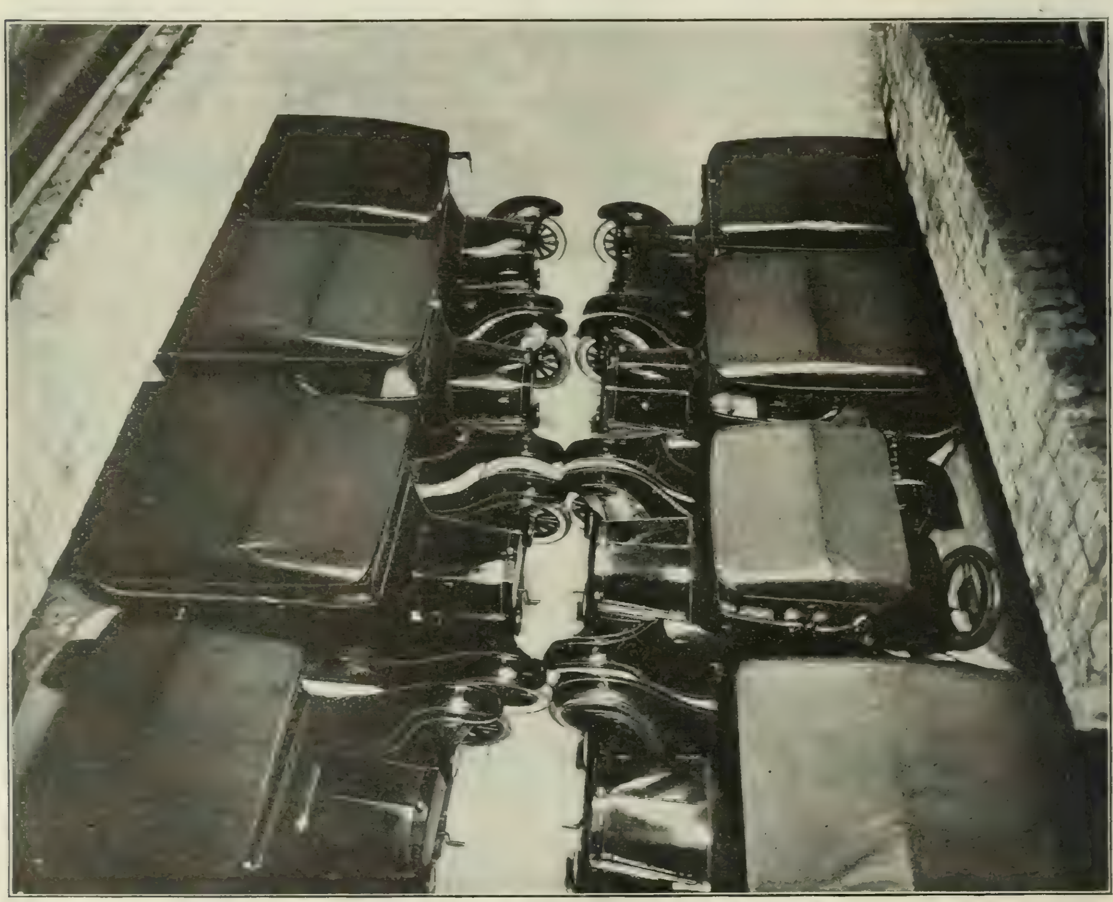
Pulverized coal and blast-furnace gas will be burned at the same time by firing the coal vertically from the top and injecting the gas horizontally through the side. The coal flame and the gas flame will unite at the proper point to give the greatest efficiency. It is planned to operate the boilers in the day-time at about 250 per cent of the rated capacity, although continuous operation at about 400 per cent will be possible.

It is estimated that 1,000 tons of coal will be consumed daily. From the time this coal leaves the Ford mines in West Virginia and Kentucky until it is carried away as ashes, it never is handled manually. All the operations are done mechanically—dumping, pulverizing, carrying to the bins, stoking, even to carrying the ashes away in small dummy cars.

Economizers will not be installed until some time in the future when it may be deemed advisable, but considerable attention has been paid to the superheater units. These are located in the first pass of the boiler, where they are protected by the boiler tubes.

There are many other interesting features about this plant; it is in almost every way a bold departure from established practice. It will be the first combined blast furnace, steel mill and foundry in the world, and will cover about 23 acres. It is designed so as to make possible the pouring of castings with uncooled metal which has come directly from the blast furnaces, a step never before attempted.

Power plans to publish at an early date a description of the power plant of this new works and will include more details of these boilers.



EIGHT FORD CARS INSIDE THE FURNACE

EDITORIALS

The Boiler Code and Cheap Boilers

THERE has recently developed a wave of agitation against the A. S. M. E. Boiler Code by builders and users of boilers, usually of the portable type, which do not comply with its requirements.

In order to judge the conditions intelligently, one should understand that the Boiler Code is a collection of rules for the design, construction and equipment of boilers, and of specifications for the material of which they should be composed in order that they may be safe.

These rules and specifications are not unnecessarily restrictive, designed to produce a boiler of superlative quality which only specially equipped shops can produce. The specifications are almost word for word those of the American Society for Testing Materials, the highest authority upon the qualities which materials should possess for given purposes. The rules for design represent the best thought of the world's best experts who have made the construction and failure of boilers a study in foreign countries as well as in our own. In the process of its formulation exhaustive hearings were held in which boiler users, insurance companies, manufacturers of materials and accessories, boiler manufacturers and in fact every interested party appeared and discussed the bearing of the proposed rulings upon their interests. The Boiler Code Committee itself comprises representatives of most of these classes. The result is a formula for a boiler of high grade but without any frills, which does not exclude any boiler that is reasonably safe nor condemn types or practices that are not admittedly bad. The American Society of Mechanical Engineers offers it as a standard, a boiler built to which will be free from defects that have been found to be productive of explosion.

Having done this, the society concerns itself only with the interpretation and betterment of the Code. It has no power to impress the Code upon industry, no right to insist that new boilers be built to its standard, and especially no concern with boilers already built.

True, the Code has a short section relating to existing installations, but it is a dead letter. It consists for the most part of a reiteration of the rules of the main section and for the rest of provisions which had better be left to the judgment of the authorities of the states or municipalities adopting the Code. In its inclusion of this feature it follows the Massachusetts Boiler Rules upon which the code was largely modeled, which feature, while pertinent and necessary in the rules governing the administration of a state boiler department, is out of place in the code of a society competent to define what a boiler ought to be, but which is not called upon to decide what ought to be done with a lot of boilers already in use which are not up to its standard.

Gradually, the legislatures of the several states are awakening to the importance of industrial accidents and are establishing industrial commissions, departments of safety, factory-inspection bureaus, etcetera. Some of the states have made a separate case of the steam boiler and under some of their safety commissions have instituted divisions of boiler inspection. In fifteen of the states and in a number of cities the boards or other bodies having the regulation of boilers in charge have adopted the A. S. M. E. Code boiler as their standard, and in the interest of uniformity it is hoped that the others will do so. Usually, this standard is applied only to new installations, existing boilers being so dealt with as to allow them to serve out their term of usefulness without becoming too much of a menace to the public safety.

If all the states would thus adopt and enforce the Code for new installations, all would be simple. The old and inferior boilers would be gradually worked out, boiler practice would be standardized, the boilermaker would simply have to build a boiler to the Code to have it universally acceptable, the customer would know what he was getting, and the danger of explosion would be confined to faulty operation. But there are those who insist upon building a cheap and inferior grade of boiler, claiming that it is good enough for the purposes for which it is designed. These are mostly of the portable type for use out in the open country, and if they blow up will, it is claimed, kill only a few farmers, lumbermen or oil-well drillers anyway. The curious thing is that the users of these boilers are as persistent and aggressive in their insistence upon their right to use them as are the builders in their insistence upon their right to make them, and between them they have enough influence with the legislators of the majority of the states to prevent them from adopting measures for regulating the construction and use of boilers or, if such measures are adopted, to get themselves, as a class, exempted from their provisions.

Such pressure and such tactics will delay for a time the nation-wide adoption of the Boiler Code, but gradually the law makers will recognize that the use of steam boilers must be regulated, and when legislation providing for such regulation is passed, the inspectors appointed under it will be increasingly likely to adopt the A. S. M. E. Code boiler as the standard to which they will require new boilers to conform before they can be operated, at least in factories and centers of population.

The treatment of existing installations must not be so drastic as to put out of commission a lot of boilers which, while not so immune from explosion as the Code boiler, have a fair chance, with good supervision, to put in yet a few years of usefulness. This treatment will require tact on the part of the Board and vigilance and skill on the part of the inspectors. These old boilers will work themselves off in a generation. As a matter of expediency, legislators, in adopting boiler-inspection laws and inspectors in enforcing them may have to tolerate for a time the risk of murder and suicide upon the part of the adherents of the cheap boiler for use in sparsely settled districts in order to secure protection for the public in more congested parts. But the matter will eventually work itself out. If the cheaper boilers do not explode, if the provisions of the Code by which they are disqualified are proven to be uncalled for and unnecessary to safety, the Code will have to be modified in these respects. If, on the other hand, they do continue to explode and it can be shown that their explosion is due to the failure of their makers or users to comply with the requirements of a safe boiler as defined by this board of recognized authorities, any court will ascribe their explosion to willful negligence, and the damages and opprobrium may be more onerous than compliance with approved practice.

Power-Plant Accounting

IN TOO many manufacturing plants the power and heating requirements are considered "non-productive" departments and insufficient attention is given to either economical operation or betterments. Coal is purchased and stored with only the most cursory record of the tally and expenditure. In a modern plant or machine shop a tenpenny nail could not be obtained without the proper requisition passing through the accounting channels, notwithstanding that the cost of this particular record may be greater than the article involved.

Contrast this with the methods of handling fuel. In many cases thousands of tons of coal are purchased, piled in the yard and used for heating and power generation with no check except the invoice and car weights from the coal or railroad company. No record of its distribution or accounting is attempted. A truck could be loaded and large amounts diverted to personal uses with no fear of discovery unless the theft was actually observed, and such instances are not unknown.

This is one of the inherent causes of power-plant wastes and also the reason why so many suggested improvements in operation are received with skepticism. As the management has not the faintest idea where the fuel is being used or how economically, there is no basis by which to judge changes or to ascertain whether a saving is possible. This lack of accounting in large manufacturing plants is more widespread than is generally realized.

Plant operators having no records or methods of demonstrating facts are sadly handicapped when trying to improve conditions. It is a function of the executive to probe the suggestions offered and determine the facts. Complete records in the power plant and a little money spent for proper accounting would not only solve his difficulty, but automatically bring about economy in operation by showing up shortages and departure from standard conditions. In operating results the executive would have a basis of comparison—he would know what to demand when an addition or new plant was to be built and after installation he would be able to check what had been received.

With initial investment averaging from one hundred to one hundred and fifty dollars per kilowatt of generating capacity and coal and labor bills running to extremes, it would seem that the comparatively few dollars required for power-plant accounting would be warranted many times over. If every department received monthly bills for power and heat the same as for raw products and labor, it would create a demand for accurate accounting and in doing so insure more economical results.

The introduction of a few miscellaneous meters, even if they are read regularly, and the compilation of fuel costs monthly or yearly are of little use. Such practice may be likened to maintaining a ledger and neglecting part of the entries on one side or the other. Accounting records should be kept so that at any time the manufactured products, such as steam for heating and processing, hot water and power, can be exactly balanced against all loss and expense, including the cost and quantity of the particular fuel purchased and used.

In charging departments a profit should be added to cover upkeep and betterments. In other words, the power plant should be on a separate basis of its own and made to stand on its own feet. Each finished manufactured product and each department should bear its portion of the expense. Unnecessary use of power by overmotoring and other wastes would be reflected in the costs of the offending departments.

Compiling Useful Data

WHERE can the information be found to solve such and such a problem? Where did I see this information in some technical paper or book? These are questions that most of us frequently have occasion to ponder over, and we spend much time in searching, all because our memory fails us at an inopportune time. The amount of valuable data published in technical books and magazines for engineers is beyond comprehension, but that there is still a great void that has not been filled, is clearly evident from the many inquiries we receive each week. The majority of these questions are not on subjects on which there is a lack of reliable data, but on the very questions discussed from week to week in *Power*. Frequently, the answers to the questions are given by sending those asking for information pages taken from a previous issue containing an article dealing comprehensively with the subject.

All this leads to the suggestion, which has frequently been made before, that *Power* readers should have some system of making available, when needed, the information published each week pertinent to their particular problems. One of the simplest and easiest ways of doing this is to file the copies away and at the end of each six months file the index, which is supplied gratis, either with the copies or in a binder. Then, when any question arises on which information is desired, it can be easily determined what has been published in *Power* on this subject. Another method is to keep a clipping file or scrapbook and file each week the articles which the reader thinks may be of service to him, under subject heads. Some of the best handbooks, so far as the individual owner is concerned, are of the home-made variety and have been compiled by arranging useful data in available form, as it comes to hand. It makes little difference how much useful information may be stored in books and magazines, so long as the possessor of these does not know when and how to call it to his assistance when needed. Information, to be of real service, must be in one of two places—either in the individual head or in such published form as to be readily accessible when needed.

The Standard Oil Company of Indiana, with an outstanding capital of thirty million dollars, has a surplus of one hundred and five million dollars and has declared a stock dividend of one hundred and fifty per cent.

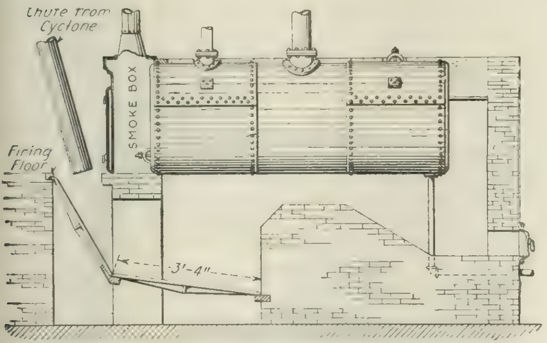
Gasoline today thirty-five cents!

CORRESPONDENCE

How Can Shavings Be Burned With Coal?

In a plant with which I am acquainted enough shavings and wood cuttings are produced to supply four 16-ft. x 72-in. return-tubular boilers. There are other boilers using coal. The furnaces by some stretch of the imagination have been called dutch ovens, but how nearly they resemble the dutch oven may be judged from the accompanying sketch. The opening through which fuel is fed is about 4 ft. 6 in. by 8 in. The shavings are fed direct from the cyclone shavings collector, and the wood cuttings, which measure up to four feet in length, are dumped from barrows into the opening and then shoved back by pokers.

Formerly, the custom was to let the opening fill up with shavings, then shove them back with the poker.



FURNACE FOR BURNING SHAVINGS AND COAL

The result was that carbon monoxide was formed, which invariably caught fire in the smoke-box from in-leakage of air. It is said that flame has been seen at the top of the chimney.

The remedy for this kind of combustion was to keep an opening at each end of the furnace for the admission of air. With cuttings this was not necessary, as sufficient air could enter through the voids unless these were filled with shavings. The horizontal grates are 40 in. long with 30 per cent air space, the spaces being $\frac{3}{8}$ in. wide. The result with this width of air space is not satisfactory as the grates choke too easily with ashes. Last summer one of the furnaces was fitted with grates 48 in. long and over 38.5 per cent air space, the spaces being $\frac{5}{8}$ in. wide. The result was a great improvement. The plant is equipped with an automatic damper, and the smoke is decidedly worse when it is closed to the limit for which it is set.

On account of lack of floor space the coal is burned under certain boilers and the wood and shavings under others, but I believe it is better to keep the fuels separate anyway.

In regard to leaking tubes, the present engineer's place of worship from Sunday morning to Sunday evening was in the combustion chambers of the wood-burning boilers rolling and beading tubes, but as the boilers were exceedingly dirty the leaking cannot with certainty be said to have been due to the fuel because the tubes of the coal burners leaked also.

The compound used was a well-known water treatment. By careful attention to the compound and the use of a tube cleaner, the boilers reached a condition described as "very good." But there was still too much tube trouble. Early last summer a so-called metal treatment was used and leakage was greatly reduced but whether as a coincidence or as a result it is as yet impossible to say.

Next spring we expect to begin alterations that will include a real dutch-oven furnace and a type of boiler that will give sufficient floor space for it, and my intention is to feed the shavings through the roof of the furnace and the cuttings, some of which are heavy, at the front end onto inclined grates considerably flatter than they are at present so as to give them a slide into the furnace, and also to have an adjustable shutter to regulate the air admitted to the furnace.

Toronto, Ont., Canada. R. McLaren.

Boiler Drum Pitted

In the Oct. 26 issue of *Power*, page 675, Charles W. Carter, Jr., asks for the opinions of readers regarding the pressure on the different drums of a water-tube boiler.

I believe that the pressure on the six drums is equal so far as steam pressure is concerned, but that there must be more pressure on the lower drums due to the water in the boiler. This extra pressure will be approximately one pound per square inch for each twenty-eight inches in height of the body of water.

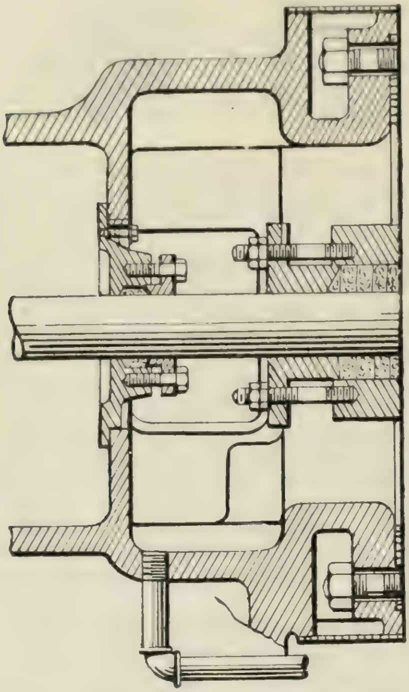
Therefore, if it is seven feet from the bottom of the lowest drum to the water line in the boiler, there must be about three pounds per square inch more pressure on the bottom of the lower drum than at the water line. There is no other reason why there should be a difference in pressure on any part of a water-tube boiler.

I think Mr. Carter's theory as to the cause of pitting is correct. L. M. Reed.

Webster, Mass.

Prevented Water Getting Into Crank Case

A self-oiling engine gave trouble from water getting into the crankcase from the stuffing box and causing the oil to emulsify. Almost every kind of oil was used without results. At the end of the frame was a cast-iron partition with a 5-in. hole through it. This was covered with a sheet-brass plate through which the rod ran. A drain hole in the cast-iron partition let the water, which dripped out of the stuffing box, run into the crankcase. A stuffing box and gland was made and bolted to the partition, as shown in the illustration, and the drain was stopped up with a metal cement. A ½-in. pipe connection was made through the side of the frame into the space between the stuffing boxes to drain out the water. Since this has been done the oil remains perfectly clear.



LOCATION OF AUXILIARY STUFFING BOX

Canton, Miss. JOHN T. SHARP.

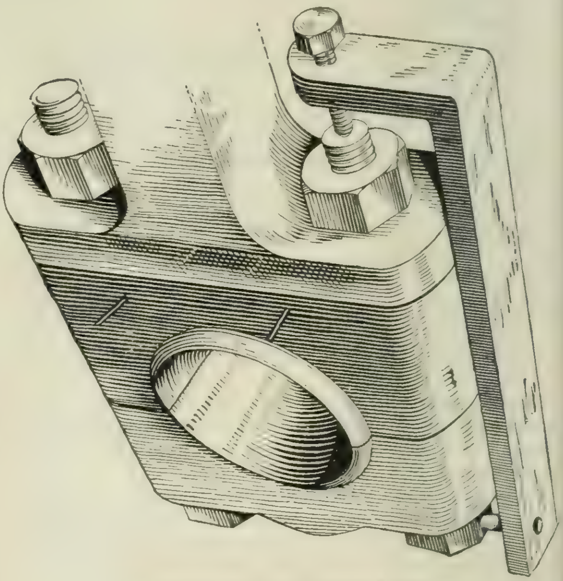
Detecting Elongation of Connecting-Rod Bolts

Seemingly, very little attention is paid by operators of Diesel and semi-Diesel engines to the question of elongation of the connecting-rod bearing bolts. In tightening up the nuts, often the bolts are severely stressed before the engine is put in service. Frequently the cranking bearing is allowed to run entirely too slack. The inertia of the pistons as the crank passes dead center is sufficient, in view of the play in the bearing, to stretch the bolt beyond its elastic limit. The bolt then fails. This puts all the stress on the remaining bolt, which either bends, opening up the brass, or breaks. When such an accident occurs, the connecting rod and piston come loose, wrecking the engine.

Several such wrecks have occurred during the last few months. Undoubtedly, one or more have been due to excessive slackness in the crank-pin bearing. The engineer has no reasonable excuse to offer for this class of accidents. The pounding of the bearing should indicate to a trained ear that the engine requires immediate adjustment. The fractured bolts resulting from elongation occurring when the nuts were being tightened are hardly blameable to the operator, although he should use judgment as to the manner of tightening. Elongation of bolts resulting from loose bearing or undue tightening does not take place immediately; it is gradual, and for that reason some device for detecting the elongation before it reaches the danger point should be provided.

The little contrivance illustrated, which might well be called an extensometer, was made by a Diesel engineer and will detect alterations of less than one-half of a thousandth of an inch. On the two Diesel engines in the plant, a hole was drilled in the side of the connecting-rod bolt heads and reamed to size. A tool-steel bar was bent as shown, and was threaded at one end for an adjustment screw. The other end was also fitted with a pin that fitted the hole in the bolt head. The ends of the bolts were ground until all were of equal length, the variation in length being less than 0.001 in. The adjusting screw was then set to barely touch a 0.01 brass plate when placed on the end of the bolt. In tightening up, a wrench and heavy hammer were used, but the bolt was never drawn up enough to elongate.

Each time the inspection doors on the crankcase were opened, the bolts were measured. If the clearance between bolt and gage was less than 0.008, it was assumed that the bolt had stretched and it was removed. Only one defective bolt was ever detected. This particular one, however, showed a decided lengthening, and on investigation a fracture which extended half through the bolt was discovered.



CONNECTING-ROD BOLT GAGE

E. LONG.

Dallas, Tex.

Does a License Law Help?

In an article in the issue of Oct. 12, page 591, "Does a License Law Help?" the author severely criticises license laws and is of the opinion that such are practically of no use or benefit to anyone. If it were not for license laws one can imagine the undesirables that would be found running engines, not knowing one part from another, and being obliged, when a breakdown occurred, to call up a near-by machine shop and get a mechanic to do the necessary repairs.

If we had a uniform graded license law, there would be more chance for advancement and engineers would make it a point to study and get the first-class grade, as that position would undoubtedly pay the most wages.

I do not say that an engineer must have a college education, although he would be better off if he had, but I do maintain that he should thoroughly understand the mechanism of every machine under his supervision.

I say, pass laws requiring licenses and make non-licensed engineers get in line and show whether they are capable or not; do not let every Tom, Dick and Harry come along and be promoted to engineers in two days' time. CHARLES W. CARTER, JR.

Olean, N. Y.

Regarding Mr. Shaw's communication "Does a License Law Help?" there are two sides to every question and I would like to have the readers of *Power* hear the other side of this one.

I am glad that Mr. Shaw is not opposed to license laws. Neither am I. In fact, I am strongly in favor of them. I will not attempt to defend the license laws of other states or cities, but will take up the question from the viewpoint of a licensed engineer in Massachusetts.

I know that the license laws here do help the engineer, increasing his pay and enlarging his knowledge of the proper operation of the steam plant. As a matter of fact the operating engineers in this state receive considerably higher wages than those in adjoining states where there are no license laws. As to increased knowledge there is no greater incentive for a fireman or an engineer to increase his knowledge than for him to tackle the steam-power plant game in this state. This I state as a result of my own experience. I do not doubt what Mr. Shaw says in regard to the vast number of engineers who carry different forms of licenses and operate in other states, but I believe that the percentage of those who operate on stolen licenses, etc., is but a small fraction of one per cent of the whole number of engineers employed, therefore I do not think that part of the argument amounts to very much.

I believe that the Alabama engineer of whom Mr. Shaw speaks is an exception the rule. I have met and worked with quite a number of engineers whose education was about as limited as this one, and I have found that, in the operation of their own plants, they were pretty good, but when it came to the knowledge of the underlying principles that govern the care and operation of any steam plant their ideas were very limited, which is a natural consequence.

I do not claim that the possession of a license indicates that a man is infallible as an engineer, but I do claim that one who has obtained a first-class Massachusetts engineer's license within the last five years has proved himself to be a practical man and to be possessed of a sufficient knowledge of the construction of steam boilers and of the vital facts and principles that govern the care and operation of a steam plant to make him a pretty safe man to place in charge of one.

As to the case cited by R. G. Summers, in the Sept. 14 issue, it is my candid opinion that a real engineer, whether licensed or not, would have been able to show his employer where he was in error.

The engineers of the country—the real engineers—want a license law and they are going to get it; perhaps not all in the same form as those of this state, some not so good, some perhaps better. As to a Federal license law, no such thing can exist owing to the sovereignty of the individual states, but if 55 per cent of the engineers in the different states knew the actual benefit to be derived through the enactment of sound license laws and were not afraid that if such laws were enacted their knowledge would not measure up to the standard required, there would be license laws passed in the various states as soon as their legislatures convened.

It is true that the holder of a license may be no better as an engineer than the one who does not hold one, but the average engineer who holds a license is certainly more capable of approaching his employer with suggestions owing to the very fact that he had to study, to dig down to the very bottom of things to obtain enough knowledge to pass his examination, and in so doing he acquired more confidence and is better able to talk with his employer upon the subjects which arise.

Mr. Shaw states that a man's competency to operate a plant could easily be found out as soon as the man began work if his employer knew anything about it at all. I take it from that he means if his employer knew anything about steam plants. I would like to ask what he considers a fair percentage of the employers of engineers throughout the country who know even the simplest rudiments of the care and maintenance of a steam plant? The average employer is not to be compared with the average official who sits on the examining board of engineers in this state. Every one of these men, I think, has been a practical operating engineer and has had to pass a rigid examination to obtain the position he holds and is possessed of a considerable amount of very useful knowledge of technical things.

Then, where does the average employer fit when it comes to determining a man's ability as an engineer as compared with the judgment of three such men as comprise a board of examiners for a second or first-class engineer's license in Massachusetts? Not only do they judge a man's ability by what he can show them during his examination, but a man begins with them as a rule as an applicant for a second-class fireman's license, and they follow him along as he obtains a higher-grade license, in his plant, in his daily work. They visit those plants which are in their particular territory, and if a man in a certain plant has applied for a license they look him up, see what his reputation is as a fireman or as an engineer and talk with him on the job.

Things have changed since Brother Shaw obtained his first-class license 25 years ago. By no means do I intend to infer by this that he is not in reality a first-class engineer, but I fear he is out of step with the times as regards Massachusetts license laws. Twenty-five years ago we were examined by but one man, today by three men. A man who had sufficient knowledge to obtain a first-class license in 1895 would do mighty well now to obtain a second, and the laws are getting more strict each year; and as they become so there can be but one effect—it must raise the standard of the licensed engineer.

I can see that the engineers of the country would be better off with a license law than they are at the present time, and I also can see that the employers would be benefited; if this were not so, the claim that education is beneficial would be without foundation, and if it pleases one any better to call our license law a compulsory-education law, so be it, for that is just what it is.

They are learning more and more to appreciate an engineer who is educated along his line, and are getting to realize that while the steam plant may be a necessary evil, it is something that does need skilled attention. Things are shaping themselves very fast in favor of license laws in every state where there is at least a normal amount of industry, and the high price of coal is not the least factor which tends to help, by any means. Let us have license laws; if each engineer helps himself, a license law will help him.

We realize that there will be a small percentage of men who are unable, due to limited education, to acquire a high-grade license, and it is to be regretted, for in many cases it is not their fault; but a few sacrifices must be made for the good of the whole.

Webster, Mass. L. M. REED.

The license-law question should be dealt with from all sides. It is admitted that a license is of little value as regards a man's ability, as there are men operating who are not licensed and are receiving salaries equal to that of the licensed man who has spent years in study and work to obtain a license. The licensed engineer is entitled to and should receive a much higher rating than the non-license man.

The license should be graded into three classes. The first-class man should be capable of assuming the chief duties of operating which, in the general run of the plants, are left to the watch engineer.

The second-class man should be capable of performing the duties of assistant chief operator, and in the course of time he can advance to chief engineer. He would have plenty of time to study the plant and to pick up what he could relating to combustion, an important factor in the engineering of today.

The watch engineer should hold not less than a third-class license, but there are watch engineers who have first- and second-class licenses.

A license does not help a fireman make steam, but it does incidentally protect both life and property. With a licensed fireman and water tender the manager knows that they are qualified to perform their duties. There should be two classes of firemen's license and there should be a fireman and a fireman's helper. The fireman should hold a first-class and the helper a second-class license. The water tender should be in a class by himself. He should be a man that has started as a fireman or fireman's helper and has worked his way up.

The water tender who cannot speak English should not be permitted to tend water in any plant. I recall an instance where the engineer placed a log board in the boiler room and instructed each man to fill in at various places when leaving his shift. When the engineer came back, there were no entries on the log sheet, and upon investigating he found that none of the men could read or write English. Would they be good men to have on the job in case of accident?

I was recently called upon by the manager of a mining plant to go over his plant with him. Each boiler was provided with a U-tube draft gage and they were being operated under natural draft. Upon investigating, only one gage was found to be in working order. Three were broken and the piping on four was clogged.

Had the plant been in charge of a licensed engineer, he would not have allowed the plant to get in this condition. I will admit, however, that I have visited plants where unlicensed men were in charge and found things in just as good condition as in the license-operated plant, but there are exceptions to all cases.

I trust that the time will soon come when we can have a universal license law and that every individual that is connected in any way with power-plant operation will be a licensed man. R. M. JENNINGS.

Latrobe, Pa.

Behavior of a Semi-Diesel Oil Engine

In *Power* of Oct. 26, page 674, some troubles of a semi-Diesel oil engine are described and a solution is asked. One of the most remarkable things about this type of engine is the extremely meager amount of information published or otherwise obtainable.

The seizing and sticking of the piston may occur from a faulty cooling system or poor bearing of piston on cylinder walls. The cooling system should be sufficient to cool the cylinders "stone cold" at the maximum load the engine will pull. For the volume of water passing through jackets must increase as the load increases; or in other words, the temperature must be lowered until the piston stops pounding from heat. The piston should show a full bearing at full load and no high spots or other distortions. This may be remedied thus: The engine should be run at its maximum load and the piston carefully watched for pounding or groan, and removed at first sign of it, and all high spots filed down. This process should be repeated until the engine pulls its maximum load without any sticking or seizing.

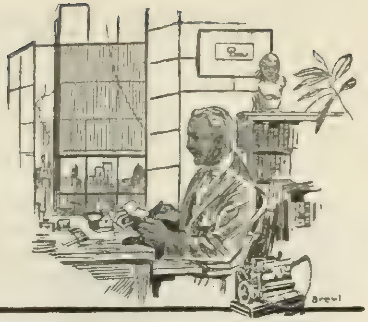
The cracking of exhaust and inlet port bridges is caused by unequal expansion when solid bridges are used between exhaust ports, and clogged circulation passages when water-cooled bridges are used. Solid inlet-port bridges do not break because they are not exposed to heat, but the exhaust-port bridges should be water-cooled to prevent cracking and the circulating water should pass these ports first before cooling elsewhere.

The fuel system requires careful attention, particularly the straining of the fuel of all grit and foreign matter. If this is neglected, all manner of annoyances will occur, for it breaks and misdirects the spray from the fuel nozzles. The fuel nozzles should be checked for spray at intervals. This is very important especially where the spray is directed against some special igniting surface.

If an engine is a four-stroke-cycle type, there are other freaks. I remember seeing such an engine tested. It pulled its rated power for one hour, the next hour only $\frac{3}{4}$ load, the next hour only $\frac{1}{2}$ or $\frac{1}{4}$ load, and finally stopped altogether. Nobody could locate the trouble, and design and engine were scrapped. Three years afterward in another factory, I ran across an exactly similar circumstance. We were all about to throw up our hands when one tester suggested we examine the valves, and here trouble was found—the seat had warped from heat. When this was remedied, the trouble disappeared. G. STROM.

Erie, Pa.

INQUIRIES OF GENERAL INTEREST



Carbonizing of Diesel-Engine Cylinder After Repairs—I find that the cylinders of my Diesel carbonize badly. What is the reason? I recently put in new crankpin bearing. Would this cause the trouble? J. M. C.

In putting in the new bearings, you probably failed to replace sufficient shims between box and rod end. Low compression resulted, which would produce soot or carbon.

Welding Fractured Crankshaft of Oil Engine—Can a fractured oil-engine crankshaft be welded successfully? C. B. H.

Electric welding of crankshafts has been uniformly successful. This does not mean that an inexperienced man can weld successfully. Such work should be turned over to firms who are experts in the work. If the weld is ground and polished, it is easy to determine if it is perfect.

Suspended Engine Foundation—How can a suitable foundation be provided for an engine placed on the second floor of a steel-frame building so the engine bed may be the usual height above the main floor-line? F. K.

The foundation recommended by the engine builder is for the purpose of absorbing vibrations as well as for supporting the engine, and if the building framing is strong enough to support the engine and foundation, a mass of concrete equal to that recommended by the engine builder may be suspended from the floor framing, with the upper surface of the foundation carried up to the desired level for receiving the engine.

Density of Steam—What is meant by the terms "specific volume" and "density" of steam? A. H.

The specific volume of saturated steam of any pressure is the volume in cubic feet of one pound of steam of that pressure. Density signifies heaviness or weight of a unit of volume. The density of steam usually signifies the weight in pounds per cubic foot and is the reciprocal of the specific volume. The density of dry saturated steam increases with the increase of its pressure. At atmospheric pressure or zero gage pressure, the density is 0.03732 lb. per cu.ft., and at a pressure of 100 lb. gage, or 114.7 lb. per sq.in. absolute, the density is 0.2571 lb. per cubic foot.

Electrical Input to Develop 15 Brake Horsepower—Will an electric-driven pump that requires 15 hp. when driven by a 20-hp. motor consume 20 hp. or will it only consume 15 hp.? C. D.

The actual, or brake, horsepower developed by the motor will be the number of horsepower required by the pump, regardless of the rated capacity of the motor. The amount of electric power absorbed by the motor would depend on the efficiency of the motor when developing 15 brake horsepower. A 20-hp. motor developing 15 brake horsepower would have an efficiency of about 80 per cent, requiring an electrical input of $15 \div 0.8 = 18.75$ electric horsepower, or $18.75 \times 746 = 13{,}987.5$ watts.

Use of Crude Oil as Fuel—Why is not crude petroleum used for boiler fuel? W. R. F.

Crude oil contains many highly volatile constituents that can be distilled off and have high market value in the forms of gasoline and allied distillates. The presence of these volatile constituents makes the oil more dangerous to store or handle, as combustible vapors are given off in large quantities at comparatively low temperatures and the mixtures formed with the atmosphere are highly explosive. Hence, the material generally marketed as fuel oil is a residuum left after the more volatile constituents of the crude oil have been distilled off, and it has nearly the same properties as the crude oil without giving off the dangerous vapors at so low a temperature.

Inches of Vacuum Not Determinable from Temperature—Cannot the number of inches of vacuum, or absolute pressure, of a condensing system be known from the pressure corresponding to the temperature of dry saturated steam as shown by the steam tables? J. H. C.

The temperature is not an index of the pressure because of the presence of an unknown quantity of "air." The exhaust of an engine is a mixture of water, vapor and gases, the gases being a mixture of those originally dissolved in the boiler-feed water and atmospheric air which leaks into those parts of a condensing system in which a partial vacuum is maintained. Hence, the absolute pressure within the condenser, as indicated by a vacuum gage, is that of water vapor at the pressure corresponding to the temperature, plus the pressure due to any gases present. As there always is more or less of the gases present, an actual vacuum-gage reading always shows higher absolute pressure than the pressure of saturated steam corresponding to the temperature as given in tables of properties of steam.

Computing Theoretical Mean Effective Pressure—What is the formula for obtaining the theoretical mean effective pressure of an engine, knowing the initial pressure and fraction of cutoff? D. R.

The mean forward absolute pressure per pound of initial absolute is given by the formula

$$P = (1 + \log_e R)\ (f + c) - c$$

in which

P = The mean forward pressure per pound absolute;
f = The fraction of stroke at which cutoff takes place;
c = Per cent. of clearance;
R = The actual ratio of expansion, that is $1 \div (f + c)$;
$\log_e R$ = Hyperbolic logarithm of R.

The mean forward absolute pressure per pound of the initial, multiplied by the initial absolute pressure, gives the mean absolute forward pressure. Subtracting from this the mean absolute back pressure gives the mean effective pressure.

In place of making tedious computations, values of P for different values of R, f and c may be obtained from tables, such as given on page 115 of of F. R. Low's work entitled "The Steam Engine Indicator."

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Steam Regenerators in Mine Plants Save One-Third the Coal*

By W. H. Schacht†

Installation of steam regenerators between mine hoisting engines and the heating load, permitting a large reduction in back pressure and utilizing the exhaust steam to better advantage, reduced coal consumption from 25,000 to 17,000 tons per year—a saving of one-third the fuel.

IN THE Lake Superior district the air indoors must be heated continuously during eight months of the year and occasionally during the remaining months. Incident with mining in this district, therefore, there is need for heating many of the buildings connected with these operations. In addition to the mine buildings—that is, shops, engine houses, offices, change houses, etc.—such public buildings as schools, library and theater, when close to the mines, are often supplied from the mine heating mains.

At the Copper Range Co.'s mines, Champion, Trimountain and Baltic, the heating surface thus supplied from the mine mains is over 50,000 sq.ft., which requires a steam consumption, at times, of 18,000 lb. per hour, or the equivalent of over fifty tons of coal per day were live steam used. This figure is based on a consumption of one-third pound per square foot of heating surface during the coldest weather, and provided the system is not wasting steam by blowing it to the atmosphere or into the return line on account of leaky traps, which so often is the case.

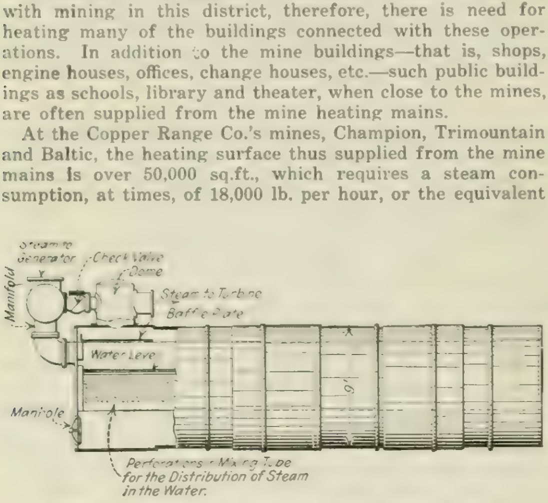


FIG. 1. TYPE OF REGENERATOR INSTALLED

At the stamp mills the use of the exhaust from the stamps to operate low-pressure turbines has reduced the former water rate per horsepower developed by more than 50 per cent. Electric motors have replaced the many small steam engines, so that this supply of exhaust steam has been practically eliminated. The larger engines are compound, triple or quadruple expansion, condensing. The hoists, however, in all cases are simple and noncondensing and of two sizes, 24 x 60 in. and 32 x 72 in. These hoists now offer the only available supply of exhaust steam; but as the flow is intermittent and varies from extreme violence to zero, the steam so discharged cannot be satisfactorily used without some means of storage, such as is offered by a regenerator that transforms the variable flow into a constant one.

Efforts were made to use this exhaust steam for heating, without using regenerators, by having it discharge directly into the heating system, using a back-pressure valve weighted so as to provide sufficient pressure to permit the circulation of the steam through the system. The greater portion of it, however, for lack of storage capacity, escaped through the back-pressure valve to the atmosphere. The supply so obtained was not sufficient and had to be supplemented with live steam, introduced by an automatic reducing valve at a pressure usually a few pounds under that at which the relief valve was set. This meant that the hoisting engine would exhaust against a back pressure, which in cold weather and on account of poor design or condition of the system sometimes was as high as ten pounds or more, thereby reducing the efficiency of the hoist, because of the reduction of the range through which the steam used by the engine could expand.

With this reduction in efficiency there was a greater steam consumption for the engine, and although some of this additional steam was used in the heating system, most of it was discharged to the atmosphere. As a result the operation was not as profitable as feeding live steam directly into the system without the imposed back pressure on the hoist.

The condensate and non-condensable vapors from the several buildings heated were returned to the boiler house and discharged from the system by using steam-driven wet-vacuum pumps. This condensate, on account of the oil contained therein, could not be used for boiler feed and had to be wasted.

A survey showed that the steam requirements for heating for more than half of the year were equal to or in excess of that required by the hoists; further, during the coldest weather, at most of the plants, live steam would have to be supplemented, and for the remainder of the year most of the exhaust would be required. Considerable steam is used in the summer months for heating the dry or change houses, water for buildings, and feed water for the boilers. To utilize as much of the exhaust steam as possible, steam regenerators of the Rateau design were placed between the hoisting engines and the heating system.

METHOD OF OPERATION

As is well known, the method of operation consists in passing an intermittent flow of steam through a closed vessel, or regenerator, in which the steam is condensed and re-evaporated. Condensation takes place when the steam is in excess of the quantity required to maintain a constant flow of outgoing steam, and re-evaporation takes place when the steam discharged into the regenerator is not sufficient to maintain this constant flow. The condensation and re-evaporation are due to interchanges of temperature between the flowing steam and a large mass of water. To keep this water in intimate contact with the steam flowing through the regenerator, the surface of contact must be as great as possible.

The regenerator is equipped with a suitable steam dome for the discharge of the regenerated steam to the heating system and with a special automatic water-level device which removes the water of condensation entrained with the exhaust steam. A relief valve controlling the maximum pressure permissible between the exhaust of the engine and the main inlet is located at a suitable point of the piping. The exhaust steam discharged into the regenerator always contains water. After passing through the water in the regenerator, the steam never contains more than a fraction of 1 per cent of moisture. This apparatus was found to be equally efficient as an oil separator. The condensate of the regenerated steam is practically free from oil and suitable, therefore, for boiler feed, which was not the case before regenerators were installed. A longitudinal section of the regenerator is shown in Fig. 1.

Some of the buildings to be heated are 2,300 ft. from the engine house and well above the elevation of the boiler house, thus offering ideal conditions for gravity return and good drainage. As a result the condensate is returned to the boiler house and discharged from the system (operating at 20 in. of vacuum) by means of a water seal.

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*Abstract of a paper presented before the Lake Superior meeting of the American Institute of Mining and Metallurgical Engineers, Inc.

†General manager, Copper Range Co., Painesdale, Mich.

In remodeling the several heating systems, estimates of the steam requirements were made and pipe sizes used that would give a pressure drop through the mains of approximately one pound. The return lines installed were also of ample size. Asbestos sponge felt one inch thick was used where the pipe lines are sheltered—that is, where they are suspended in concrete boxes—and 1½ in. thick where the pipe lines are exposed to the weather. The return lines are covered also so as to conserve the heat in the boiler feed. These coverings are protected from the weather by asphalted asbestos jackets which, when in place, are given a coat of asphalt paint.

No slip expansion joints were used, expansion being provided for by offsetting the lines 50 or 60 ft. at intervals of 500 ft. The piping is usually anchored midway between the offsets. One of the systems at the Champion mine, which has 2,300 ft. of mains in which all expansion is provided for in this manner, has not required the use of a wrench on it since it was installed, about three years ago.

These pipe lines are suspended in long slings suspended from a steel beam resting on concrete columns. The slings are free to swing from an eyebolt having a vertical thread adjustment for pipe alignment. A diagrammatic sketch of one of these installations is shown in Fig. 2. From the cylinders the exhaust is piped to the regenerator inlet, which is placed at least six feet below the cylinders to avoid drawing back water from the regenerator into the cylinders when the engine is idling or drifting, thus causing a vacuum sufficient to raise the water several feet above the level in the regenerator.

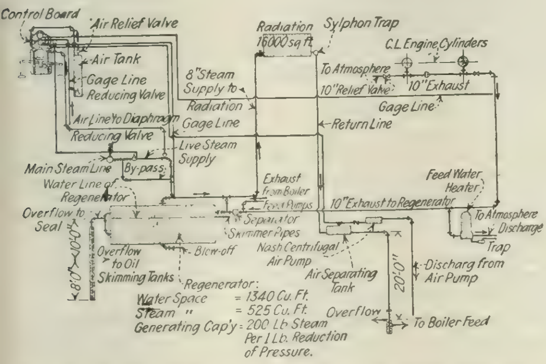


FIG. 2. DIAGRAMMATIC SKETCH OF PIPING SYSTEM

In some installations the regenerators are placed in the basement of the engine house; in others they are placed in the boiler room. An atmospheric relief valve in the exhaust line near the engine can be set to maintain any pressure desired, but it is usually set to relieve at one-half pound above atmosphere. The exhausts from the boiler-feed pumps, hoist auxiliaries and trap discharges from the hoist receivers are also piped to the regenerator. The feed-water heater is connected to the exhaust line between the engine and the regenerator, so that it gets its supply of steam from the engine or pump exhaust or draws from the regenerator when the other supply is insufficient. As the pressure in this line is below atmospheric, a power or steam operated steam trap is used to discharge the condensate from the heater. Considerable condensation or entrained water is carried with the exhaust steam into the regenerator, which must be discharged from it. As the working pressure carried is usually below atmospheric and as ample head can be obtained for a water seal to discharge under these conditions, this method of relief is used. The overflow of the seal is situated so as to operate either with vacuum or pressure, being able to discharge to the atmosphere with pressures of four or five pounds plus or minus.

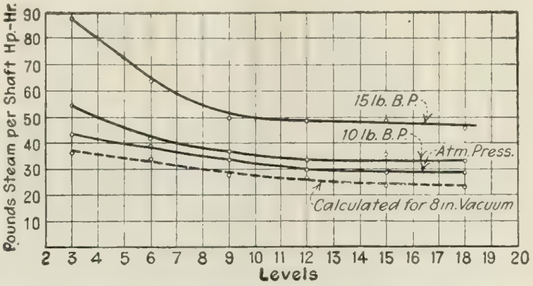


FIG. 3. STEAM CONSUMPTION OF 24 x 60-IN. HOISTING ENGINE AT DIFFERENT BACK PRESSURES

Provision is made to supply live steam to supplement the exhaust through two reducing valves in series. The reducing valve on the high-pressure side is of the ordinary type and reduces down to fifteen pounds. The other valve is of the diaphragm type, operated by auxiliary pressure introduced by means of a special control mechanism.

Steam from the regenerator is delivered to the buildings to be heated with a drop in pressure not to exceed two pounds at times of greatest demand and about one pound during average winter conditions. A two-pipe system is used. In the buildings the drainage of mains and return lines is in the direction of the flow, thus eliminating water hammer. Sylphon traps are used on all radiators, direct and indirect, and all headers and drips. The air and condensation are collected into and returned by a 3-in. line, the end of which is submerged, forming a water seal that is located in the boiler house. At a point about twenty feet above the overflow of this water seal is located an air-separating tank, from which the air and noncondensable vapors are drawn from the system by a vacuum pump, requiring for its operation about 1½ horsepower.

The pressure carried on the regenerator, being also the back pressure on the hoist, varies from 8 to 10 in. vacuum to one-half pound above the atmosphere; the colder the weather the lower is the average of the range maintained. The return-line vacuum is usually constant at about 18 in., making a working pressure available, therefore, of about eight pounds, which is more than sufficient in almost any emergency.

RESULTS OBTAINED BY INSTALLATION OF REGENERATORS

Shaft	Coal Consumption				Rock Hoisted				Radiation Involved
	Before Regenerator Installation		After Regenerator Installation		Before Regenerator Installation		After Regenerator Installation		
	Years	Tons	Years	Tons	Years	Tons	Years	Tons	Sq.Ft.
Nos. 2 and 3, Champion	1916	5,340	1917	2,076	1916	290,000	1917	240,000	18,000+
No. 4, Champion	1916	4,296	1917	2,256	1916	335,000	1917	292,000	11,000+
No 2 Trimountain	1918	4,235	1919	2,908	1918	303,650	1919	295,510	7,000+
Nos. 2, 3, and 4 Baltic	1918	11,410	1919	9,766	1918	373,150	1919	349,970	11,000+
		25,281		17,006		1,301,800		1,177,480	47,000

Of the several plants, the coal consumption before and after installing regenerators, the tons of rock hoisted during the same periods and the radiation involved in each plant are given in the accompanying table. There was a slight reduction in the tons hoisted in most plants during the year following the regenerator installations, but this did not affect the coal consumption materially, for in most cases some live steam was used for heating, there not being enough hoisting to supply the need. At Nos. 2 and 3 Champion, the live steam thus used would have been available for additional hoisting, so that only a few more tons of coal could have been used had the same tonnage of rock been hoisted. The results exceeded expectations, and in some instances the installation and remodeling costs were returned by the savings made during the first year's operation. In all cases at least one boiler was shut down, and in some, two were discontinued.

Relative steam requirements of the hoists before and after the regenerators were installed were determined from continuous indicator diagrams taken in a series of tests. The curves in Fig. 3 make a comparison of the steam consumption per shaft horsepower-hour for a 24 x 60-in. engine hoisting a 5-ton loaded skip when operating at various back pressures. The dotted line shows the calculated consumption were the hoist to operate at 8 in. vacuum, which is the back pressure obtainable when regenerators are used; this result has since been verified. The comparison shows why a saving of one-third of the coal is possible.

Figuring Generator Requirements

To show the method of figuring regenerator requirements, the large plants at Champion (Nos. 2 and 3) have been taken as an example. The radiation to be heated at that time totaled 16,000 sq.ft. Allowing ⅓ lb. of steam per square foot for coldest weather, the maximum requirements per hour would be 5,300 lb. and for average winter conditions, with a consumption of ¼ lb. per square foot, 4,000 lb. per hour. In addition to this about 600 lb. is required for heating boiler-feed water, and 10 per cent must be allowed for condensation in transmission, requiring, therefore, approximately 5,000 lb. per hour as the average consumption. The hoisting averaged about fifty-five trips during the eight-hour working period, and was from an average depth of 1,600 ft. The time to make the complete hoisting cycle was 110 sec. The idle period, or time during which no steam flows, was 6.9 min. and under actual conditions at that time did not often exceed 12 minutes.

Exhaust from two hoists is used to supply the regenerator. The average steam consumption of these engines per cycle when hoisting from the sixteenth level (this being the average hoisting depth) was found to be 275 lb., making available an average of 3,800 lb. per hour. To this must be added steam from the auxiliary cylinders of the hoists, which amounted to an additional 12 per cent, or about 400 lb.; also 200 lb. from boiler-feed pumps, making a total available of 4,400 lb. per hour.

For a twelve-minute idling period of both hoists, a steam storage of 1,200 lb. was required to provide for the heating requirements during the coldest weather. The amount of water required to store that amount of steam, when using a pressure range on the regenerator from 8 in. vacuum to zero, can be determined as follows:

Latent heat of steam at 4 in. of vacuum, or average of the working range = 975 B.t.u.; 975 × 1,200 lb. steam = 1,170,000 B.t.u. required.

Temperature of water in the presence of steam at atmospheric pressure, 212 deg.; temperature of water at 8 in. of vacuum, 197.7 deg.; difference 14.3 deg.

Pounds of water required to store this heat = 1,170,000 ÷ 14.3 = 81,818 lb.

Weight of water at the above temperature equals 60 lb. per cubic foot; amount of water required, 81,818 ÷ 60 = 1,363 cu.ft. The storage capacity of the regenerator installed, 1,190 cubic feet.

Hydro-electric power is beginning to be utilized by the tin and copper mines of Bolivia. The Guggenheims, of New York, have acquired rights to three tin mines in the department of La Paz, consisting of more than 4,000 hectares. Water and power rights to some six streams in the vicinity of the mines have been secured, and a hydro-electric power plant is to be built, but the site has not been decided on. The installation of a smelting plant run by electricity is under consideration. The company plans to found a town below the mines and construct an electric tramway to it.

The Diesel Engine and the Automobile

By Charles Day, M. Sc.

In a paper read before the Institution of Automobile Engineers, as reported in *The Practical Engineer*, Charles Day stated that as regards the application of the Diesel engine to automobile work the method of introducing the fuel into the cylinders and the conditions of combustion were the limiting factors at present.

In regard to the spraying of the fuel into the cylinder, it will be readily appreciated that time is a factor in forcing oil through an atomizer, and that as the viscosity of the oil increases the time required to force the oil through will increase, or the atomizer design must be changed. With free-flowing oil and with an air pressure of 1,000 lb. per sq.in., the author was of the opinion that atomizers of prevailing design could, with suitable oils, be arranged to deal with speeds up to 500 or 600 revolutions per minute. At 600 revolutions the time during which the fuel is sprayed into the cylinder is approximately 1/200 of a second. For higher speeds atomizer modifications will need to be developed.

The character of the fuel oil is a factor in the permissible engine speed, both from the point of atomization and that of combustion. Viscous oils are more difficult to atomize than the free-flowing oils and cannot be put through a atomizer so quickly.

Again, the combustion of heavy oils is not so rapid as that of refined oils such as paraffin or petrol, and if the engine speed is so high as not to allow sufficient time for the combustion of the fuels, difficulty will arise from sticky pistons, smoking exhaust, etc. From this it would seem that high-speed engines may need refined oils, in which event one of the great advantages of the Diesel engine will disappear.

Another factor that must be kept in mind for automobile work is range in speed. In the Diesel engine ignition depends on the temperature of the air at the end of the compression, but if the speed is reduced very much it may happen that the cooling effect on the slowly compressed air is enough to prevent the temperature from reaching the ignition point. There is thus a limiting factor to the slowness of speed, and the range of speed permissible with the Diesel engine is not so great as with petrol engines, in which the ignition is obtained by a spark.

Before Diesel engines are likely to be applied extensively to automobile work, development along the lines indicated will be necessary, so that higher rotative speeds can be adopted and reduction of space and weight thus secured.

The Electrical Review, London, states that the Italian Government has already granted concessions for the exploitation of water power of more than 2,000,000 hp., of which 1,500,000 hp. has already been developed. The fact that the concessions have not been utilized to their full extent is attributable to the high cost of construction and the lack of material. Italy's requirements in electric energy are very large; 500,000 hp. will be required for the manufacture of nitrogenous fertilizers and 4,000,000 hp. for the running of blast furnaces and the working up of spelter. Power requirements will be further increased by the electrification of the railways; projects already sanctioned provide for the electrification of 4,000 km. (2,500 miles). The electrification of the entire system would result in the saving of 1,800,000 tons of coal annually, which is equivalent to 800,000,000 or 900,000,000 lire ($160,000,000 or $180,000,000).

The A. A. E. schedule of salaries for engineers in municipal service was unanimously adopted recently by the American Society for Municipal Improvements at the convention of that body in St. Louis. The schedule was prepared by a subcommittee of the Committee of the American Association of Engineers on Salaries of Engineers in Public Service. Samuel C. Hadden, editor of *Municipal and County Engineering*, is chairman of the subcommittee. The schedule contains lists of fair salaries for engineers of various grades in cities of different populations.

Hazards of Power Plant Construction

BEFORE the National Safety Council Congress held recently in Milwaukee, W. H. Mulligan, of the Hydro-Electric Power Commission of Ontario, presented an interesting paper on the "Hazards of Power Plant Construction," omitting reference to accidents that are common to all industries and may be classified under handling tools, handling material, slipping, tripping and falling, stepping on nails, eye injuries, etc.

In all construction work good lighting is essential. The wiring must not be makeshift, but of good material, used and installed under proper supervision. Damp places require the best reinforced portable cords and weatherproof sockets, and it should be the specific duty of some one person to see that all electrical equipment is in first-class condition.

In all building work, ladders are in constant use, and as a rule all types may be found. It should be a rigid requirement that only ladders properly constructed by a competent workman should be allowed. No ladder reinforced longitudinally with metal should have a place in any work in which it will at some time be used for electrical operation. The ladder should be equipped with some form of non-slip footing. For outside use a spiked type has proved most satisfactory, and for the inside, any type that will not damage the floor or allow the ladder to slip on a smooth floor on which there may be oil can be used.

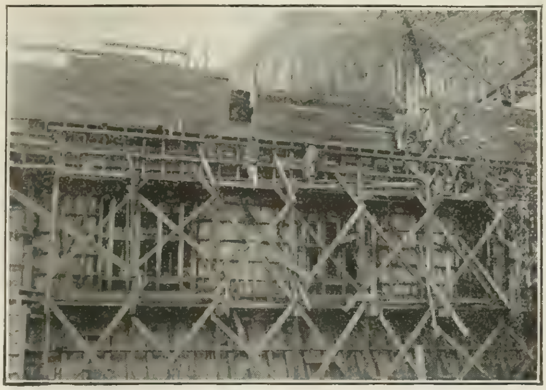


FIG. 1. SUBSTATION SCAFFOLDING WITH NO RAILINGS NOR TOEBOARDS

All scaffolds should be equipped with a railing 42 in. high and a toeboard. To the latter particular attention must be paid, especially where the scaffold passes over equipment that may be alive. Fig. 1 shows scaffolds that are substantially constructed but entirely lacking in safeguards. Neither railings nor toeboards have been provided, and the platform is obstructed with various materials. The conditions shown are exactly what must be guarded against.

Pure air must be supplied to the workmen even if it is necessary to install fans. Drills and hammer heads must be kept dressed, and when holding drills, tongs should be used and goggles worn. Care must be taken that the jaws of wrenches are in first-class condition. No defective tools should be used, as a failure or a slip will result not only in the ordinary hazard which would arise, but an extra hazard imparted should live electrical equipment be present.

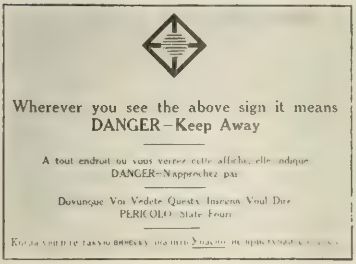
If the work is located below a cliff, scaling operations must be carefully and continually carried out, and cranes, hoists, elevators, permanent stairways and ladders should be constructed as soon as possible.

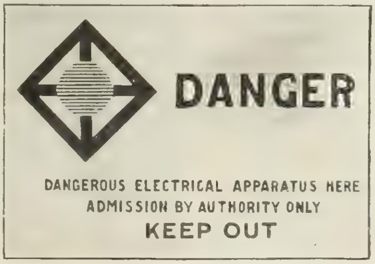
If it is necessary to operate a railway, a proper set of operating rules and signals should be placed in effect and all men who operate the trains should receive the standard eye and ear tests.

All work in a power house or substation that is in operation must be under the direct control of the man who has a definite set of construction rules for his guide. The operator in charge of the station should have the necessary authority to hold up any work which he feels is going to endanger life or apparatus and must work in close conjunction with the man in charge of the construction work.

For the protection and guidance of the workmen danger signs should be installed. A proper sign must display the universal danger emblem accompanied by such wording that the nature and location of the danger is apparent. In these signs the foreign element must be considered and the warning published in different languages. The sign shown in Fig. 2 meets these requirements. It is placed in all bunk houses and at tool wickets. For general electrical use the signals shown in Figs. 3 and 5 are employed. The lined portions indicate bright red as it is used in the signs.

During construction, in order that operation may not be unnecessarily interrupted, certain pieces of apparatus are alive one day and dead the next. To reduce the possibility of a mistake, the tag shown in Fig. 6 was placed in service. The foreman assumes the responsibility for this sign and attaches it to the apparatus which has just been turned over to the operating department, either for temporary or permanent use. He marks the voltage and a safe working distance. All equipment not yet turned over to the operating department or which has been released by them for construction purposes, should have one of these special tags, and when the equipment is so marked, it must be wholly under the control of the construction foreman. Safe working distances as laid down by the Hydro-Electric Power Commission of Ontario for their various operating voltages are as follows: 110,000-volt line or apparatus, 5 ft.; 46,000-volt line or apparatus, 4 ft.;


Wherever you see the above sign it means
DANGER—Keep Away
A tout endroit ou vous verrez cette affiche, elle indique
DANGER—N'approchez pas
Dovunque Voi Vedete Questa Insegna Vuol Dire
PERICOLO State Fuori
FIG. 2. UNIVERSAL DANGER EMBLEM AND PRINTED WARNING


DANGER
DANGEROUS ELECTRICAL APPARATUS HERE
ADMISSION BY AUTHORITY ONLY
KEEP OUT
FIG. 3. DANGER SIGNAL FOR GENERAL USE

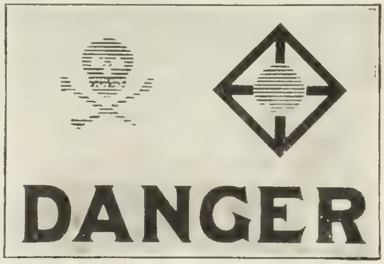


FIG. 4. UNIVERSAL DANGER EMBLEM

26,000 volt line or apparatus, 3 ft.; 13,000 volt line or apparatus, 2 ft.; 6,600-volt line or apparatus, 2 ft.; 2,200 volt line or apparatus, 2 ft.

These distances are only a minimum and should be considered as such. As much clearance as possible should be obtained in all cases.

For a universal danger emblem the sign shown in Fig. 4 has been of great assistance.

If general work is being carried on in the vicinity of live apparatus, it must be screened in such a way that it will be impossible to make accidental contact. There are times when it may be necessary to work within the foregoing minimum distances. No workman should be allowed to use his own judgment in this matter, but special permission must be obtained for each individual case and then granted only when it is impracticable to carry on the work in any other manner. At such a time two men must always be present. When work must be performed above live equipment, a scaffold should be built over the live section so that it will be impossible for falling tools or materials to cause an arc.

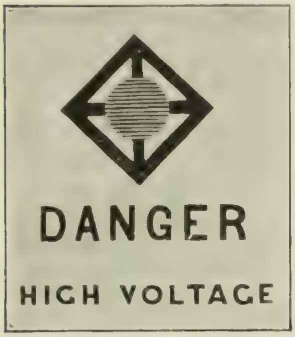


FIG. 5. HIGH-VOLTAGE DANGER SIGNAL

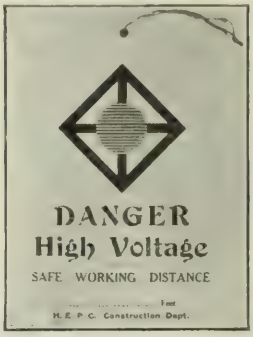


FIG. 6. DANGER SIGNAL GIVING DISTANCE

In all work of this nature the operating man must not be forgotten when the work for the day has been finished. Aisles should be left reasonably free from obstruction, any gallery rails that have been removed should be replaced or the openings protected, and if any extra-hazardous condition exists which might interfere with operation, it must be pointed out to the operator.

Relative to fire hazard care must be taken to leave no excelsior or packing around the switchroom, as such material is an added risk in case of an oil explosion. Gasoline should be stored in minimum quantities in safety cans. Fire equipment must not be removed nor access to it blocked. An adequate supply of extinguishers should be distributed over the works, in the camps, storehouses and offices.

In a large construction camp it would be impossible to get every man to practice resuscitation, but a certain few men in each group should be so trained, and in the electrical construction gang every man must know and must practice resuscitation.

According to William Clayton, vice president and managing director of the San Diego Electric Railway Company, the San Diego Consolidated Gas and Electric Co. has purchased the power house of the railway company for $1,000,000 and also the heating plant of the United Light, Fuel and Power Company, of San Diego, for $100,000. The sale is now subject to the approval of the State Railroad Commission. The San Diego Consolidated Gas and Electric Co. is to furnish the street-railway company with power to operate its cars.

The New York Chapter of the American Association of Engineers has voted to contribute a sum not to exceed $100 toward the promotion of the bill providing for a national department of public works.

Electrical Engineers Discuss Lightning Protection

On Nov. 12 the American Institute of Electrical Engineers met in Chicago under the joint auspices of the Chicago Section and the Protective Devices Committee of the society, with the electrical section of the Western Society of Engineers participating. In the afternoon the board of directors of the Institute and the various committees held their scheduled meetings and in the evening a reception and informal dinner at the City Club, followed by a technical session on "Lightning Protection" at which four papers were presented.

D. W. Roper's paper on "Studies in Lightning Protection on 4,000-Volt Circuits" was of exceptional interest. The author endeavored to list the several factors that affect lightning-arrester performance and to describe the methods of eliminating these several variables so as to permit the presentation of curves showing the relative merits of the arresters under investigation. The other three papers of the evening were: "Electrostatic Condensers," by V. E. Goodwin; "Lightning Arrester Spark Gaps," by Chester T. Allcutt, and "Life and Performance Tests of O F Lightning Arresters," by N. A. Lougee. The attendance was exceptionally good and the discussion brought out many interesting points on the subject of the evening.

Union Labor and A. A. E. Lock Horns

The Building Trades Council of Newark, N. J., is making an effort to unionize engineers, architects and draftsmen. The council has issued an ultimatum to the effect that after Nov. 1, 1920, union labor, as represented by its members in Newark, would do no work on new buildings or other structures for which the plans were not made by union draftsmen or engineers. The American Association of Engineers, which is vigorously opposing the idea, reports that draftsmen in the architect offices in Newark have been canvassed on the question of union affiliation, and that almost to a man they are opposed to any unionization of draftsmen, engineers or architects. The General Contractors' Association of Newark will continue to use plans made by non-union architects and draftsmen, and James O. Betelle, president of the New Jersey Chapter of the American Institute of Architects, is working in harmony with the A. A. E. on this matter.

Chile has vast hydro-electric resources, which have been but slightly developed, chiefly by German and British capital. The most definite development project in that country at the present time is that provided by a $35,000,000 loan by the Chilean government, $10,000,000 of which has been appropriated for the electrification of the railway from Santiago to Valparaiso, via Casablanca. The electric generating station is to be located on the Aconcagua River, about thirty miles from Llai-Llai. In fact, the Chilean government will electrify all the state railways, and plans are in charge of Senores Rafael Edwards, the electrical consulting engineer for the state railways, and Ricardo Solar, a civil and electrical engineer of prominence. Moreover, an internationally organized company (Anglo-Chileno-Americano) in Valparaiso plans to construct a 10,000-hp. plant for supplying electric lighting and power to that region.

The only time since 1911 that coal has been exploited in Armenia was in 1915, when some 50,000 tons were extracted for the use of the troops in the region of Olti. These coal fields are 27 miles from the town of Olti in the valley of the Kanli-Sou River, in the region of the villages of Bal-Kai, Souzous, Karatash and Gueliat. They were discovered and explored by one Dr. Gadomokin, and the deposits have been estimated at 12,000,000 tons. The nearest railway station to the Olti coal fields is Kars, which is only 76 miles from the Kars-Merdeneck mines.

The Development of Oil Specifications

BY W. F. PARISH†

FIVE years ago a prominent builder of Diesel engines, in an attempt to standardize the lubricating oil for his new type of engine, sent to twelve of the most prominent oil manufacturers in the country a full description of the engine with photographs and drawings, asking them to submit a gallon sample of the oil they would recommend. The result was that the best oil men in the country submitted 37 different oils, no two alike, varying all the way from 136 sec. Saybolt Universal viscosity at 100 deg. F. (and 41 sec. at 210 deg. F.) to about 3,500 sec. viscosity at 100 deg. F. (actually 178 sec. at 210 deg. F.). The engine referred to required, for the conditions under which it was to operate, an oil having a viscosity of from 450 sec. at 100 deg. F. for the paraffin oils to 750 sec. at 100 deg. F. for the asphaltic base oils.

The questions for engine builders to consider are: First, Why is there such a wide difference of opinion among oil men as to what is necessary to properly lubricate the same machine?

DIFFERENCE IN OPINION AS TO PROPER LUBRICANT

The difference in opinion as to the proper lubricant for a certain unit may have a vast effect upon the operation and results obtained from that unit. Taking the Diesel engine example as an instance, using the lightest oil submitted would allow the main bearings to operate at low temperature and would allow a low power consumption. The oil, however, would be entirely too thin for the power cylinders or air-compressor cylinders, and there would be the consequent danger of excessive scoring or wear. On the other hand, it would be impossible to use the heaviest oil recommended in the lubricating system of the engine; and further, this oil would be entirely too heavy for the power cylinders, would form excessive carbon which would prevent the free movement of the rings, would cause scoring of the cylinders and wear, and the same general condition would also prevail in the air-compressor cylinders. This very heavy oil, therefore, would be absolutely unsuited as a lubricant for any part of the engine in question.

Second, What system can be introduced that will make it possible for the engine builder, the oil industry and the users of the machines to co-operate for the purpose of bringing about the desired results?

Theoretically, the engine builder should be able to specify the classification and grade of oil that should be used on his machine; he should pass this information on to the operator who purchased his machine and the latter should be able to buy that particular kind of oil wherever most convenient. This preconceives a universal language in regard to oil that would be perfectly understood; and it also makes necessary the general establishment of some form of specification and nomenclature acceptable to both the oil industry and the manufacturers of engines.

HISTORICAL

Oil refiners have always been averse to specifications and attempts made at standardization of petroleum products. This position is easily explained. Specifications or laboratory readings as originally drawn by the refiners were developed for the purpose of allowing standardization of their own production, and the necessary instruments were patented and built by the large refiners for their own use; as these same instruments were not obtainable by the small refiners, several different methods of taking apparently the same reading resulted. This was especially true of the viscosimeter.

The type that is today generally in use was developed by one of the large refiners and for many years could not be purchased or made by the smaller refiners. Many consumers of large quantities of lubricating oil made their own pipettes and other instruments which were not used by the refiners, and while for many years the word "viscosity" has been used, its meaning in definite terms has been obscure, owing to the fact that it was often impossible to tell upon what instrument the test had been made; the temperatures used were not always the same and the method of operation was different. As a result of this disorganization the term conveyed little outside its interpretation by the individual oil companies.

Probably the first outside agencies to make use of refinery instruments were the various states, when it was found necessary to limit the volatile nature of burning oils. Nearly every state had a different instrument or had a different method of using the same instrument, so that for years there has been a controversy regarding the proper method and instruments to use in determining flash and fire tests.

Fifteen years ago practically all the lubricating oils came from the Pennsylvania fields and were, therefore, generally uniform. As a result of using one crude oil, the various refiners put out practically the same oils and regularly marketed brands, such as "25 Gravity Paraffine" or "885 Paraffine Oils," named for the Baumé and specific gravity of the two respective oils, became standard for the jobbing trade; and these oils, which in time were produced by various refiners under a general classification which was entirely the result of trade custom, were uniform to a degree.

FIRST SPECIFICATIONS ISSUED

Consumers, however, eventually came to the point of issuing specifications. These first specifications called for blends of a certain percentage of some particular local crude with other combinations generally impossible for the majority of refiners to secure or furnish, and it looked as if that specification had been issued on the advice of some one marketer who was manufacturing that particular combination, therefore making certain the fact that he would retain the business.

When the new oil fields were discovered in California, Texas and the Midwest, producing oils that had entirely different physical characteristics from the Pennsylvania crudes, the specifications established and used by various industries in purchasing their supplies very effectively barred the new oils. Combating Pennsylvania specifications was probably the hardest task that fell to the lot of the marketers of the newer oils, and it required constant and expert attention to change this situation. It was necessary to run many comparative tests to prove that oils not meeting the authorized specifications would meet the mechanical needs of the machinery, and in this way it was possible sometimes to have the specifications changed so as to admit the new oils. Many times the revised specifications, when finished, could have read simply "oil," as they were so broadly drawn as to be practically no specification.

On the other hand, specifications not broad enough to allow competition, or that require manufacturers to turn out a special oil when some stock product would meet the requirements, are practically useless.

These conditions from an economic standpoint were undesirable and the general acceptance of specifications as a policy by the industry was discouraged, the refiners generally taking the stand that writing specifications should be left to the discretion of the oil refiner for his own specific use and that the customer should simply ask for a product for a certain purpose, allowing the refiner or marketer to send his experienced operators into the customer's plant to designate which of the oils on his established list would do the best work.

Innumerable instances were also found where specifications, which were used to facilitate purchases, did not cover oils that were entirely suited for the machinery in the plants, and as a result of mechanical troubles other oils would be purchased entirely opposite to the specification,

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*Abstract of paper read before the National Gas Engine Association.

†Sinclair Oil Co.

resulting in many heated discussions between the purchasing agents, plant engineers and oil company representatives.

There is no question but that specifications that were properly drawn and that actually represented lubricants satisfactory for operating conditions would help the refiner and make his work more simple, and they would also be a help to the purchaser, as under such specifications he could be sure of purchasing oils of certain classifications which he had already determined by trial or builders' recommendation were suitable for the machinery in his plant.

There are many points to be taken into consideration in drawing up specifications. They must be simple and readily interpreted by the trade, and they must be broad enough to allow bids on suitable oils from all crudes. Further, they must be so worded as to call for low-, medium- and high-priced oils, according to the work to be done. For instance, oils that are intended for ordinary lubrication and oils for special requirements, such as turbines and internal-combustion engines, might have the same flash and fire, viscosity and cold test and yet the oil for the special work would have been so refined that it would handle the severe conditions; and as a consequence of this special refining the manufacturing cost of this oil would be increased and it therefore would come into the high- or medium-priced classification as compared to the oil for ordinary lubrication.

GOVERNMENT SPECIFICATIONS

That specifications can be so written that they describe the oil required and yet allow wide competition is shown by those of the War Department. When the first specifications were drawn up during the war, it was necessary to have a minimum number of grades and each oil was made to cover as wide a range as possible. Where it was possible to use the more expensive oils for purposes where, ordinarily, cheap oils would be used, this was done; it was considered that the increased cost in using the expensive oil was more than offset by the cost of handling additional brands under war conditions. This was especially true of the specification covering motor oil, which was used as widely as possible in substitution of the numerous cheaper oils for various uses; and as the greatest gallonage was to be used for the motor transport units, the oil necessary for that equipment was considered more or less as standard and used for many purposes. The Navy Department also follows this practice of using the high-class oils for less important lubrication; for instance, turbine oil will probably be used for machine-shop lubrication because it simplifies the storage and makes impossible the danger of getting an ordinary machine-shop oil in the turbines, as one such performance would more than offset a year's savings on purchases of the cheaper oil.

The specifications at present used by the War Department have been drawn up to cover three classes of oils, which will fall under grade or price classification. This is covered practically as follows:

Class A states that the oil is required for general lubrication of engines and machines where a highly refined oil is not required, which would mean that a cheap, red oil of the viscosity mentioned would be suitable.

Class B states that the oil is to be better than Class A oil. This specification also includes an emulsion test which would necessitate a better oil than furnished under Class A.

Class C covers oils suitable for lubrication of air compressors and internal-combustion engines and is also suitable for turbines, dynamos, high-speed engines, forced-feed systems, etc., where a better lubricant than Class B is required. In addition to the tests required under Class A and Class B is included a carbon test which will insure the oil furnished being a highly refined, filtered product, entirely suitable for this class of work.

Under each of these classes the oil is divided into five grades, with the following viscosity range at 100 deg. F. Saybolt Universal: Extra light, 140-160 sec.; light, 175-210 sec.; medium, 275-310 sec.; heavy, 370-410 sec.; extra heavy, 470-520 sec. The flash and fire and cold test range of all three grades are also the same. The refining requirements as expressed in the acidity, emulsion and carbon tests bring these classes of oils into different finished products, which will vary through a considerable range as to operating results secured and as to prices. These specifications are so drawn that they will admit suitable oils made from all crudes, which illustrates the point that this is possible if the necessary attention and knowledge enter into the transaction.

The official machinery for the establishment of methods and instruments in the American Society for Testing Materials, Committee D-2, has already reported upon and adopted many of the main instruments and methods. The Bureau of Standards at Washington should be the natural authority to go to in order to get the proper interpretation and to secure standard samples and readings on uniformly standard instruments, so that any laboratory can check its instruments. The Navy Department and War Department specifications, which have been written with the aid of the petroleum industry and generally accepted by them, can be taken as acceptable in form and nomenclature as a general guide to specification writers. It then remains for the engine manufacturer to select the classification and grade of oil that will best suit the condition of his machinery when new and after it is well worked in, and this had best be done with the assistance of the many able lubrication engineers in the petroleum industry. After this the machines can be marked with the established classification and grade of oil according to army specifications or other standards that may be generally accepted, and this will be the guide the oil manufacturer will gladly use in selling oil to the owner and operator of the machine.

Optimistic Reports Received of Coal Situation

The report of the Geological Survey for the week ended Nov. 6 showed a decrease of 9.4 per cent in the production of soft coal. The total amount of coal mined was 11,355,000 tons; this was 1,063,000 tons less than for the previous week. The reduced output was only natural in view of the occurrence of the two holidays, Election Day and All Saints' Day, but was nevertheless larger than had been expected. It was, in fact, greater than in the corresponding week of any of the last four years. The average daily production was 1,893,000 tons. It is expected that for the week ended Nov. 13 production will be high.

A bulletin issued by the National Coal Association takes the same view and reports noticeable improvement and reduction of shortages throughout the country. It is declared that prices are falling and will continue to drop wherever they are high. This is attributed to the aggressive coöperation of the Interstate Commerce Commission and the railroad executives. Through the priority order issued by the commission during the summer and fall and carried into effect by the railroads, the operators have been able to get the open-top cars needed to transport the volume of coal required to overcome the shortages.

Statements of coal prices received by *Power* in answer to its request indicate that those who have contracts are not suffering greatly from high prices, but that those who must buy in the open market are paying "all the traffic will bear." As an instance, one report gives the price of run-of-mine coal, *at the mine*, as $8; another sets it for the same kind of coal, *delivered*, at $3.85. The latter figure, of course, was for contract purchases.

The consumption of soft coal mined in the United States is divided as follows, according to Messrs. Smith and Tryon in *Coal Review*: 2.1 per cent for generating power at the mines; 28 per cent for railroad fuel; 6 per cent for electric public utilities; 21.9 per cent for coke, bunker coal and exports; 10 per cent for domestic use; 5 per cent for the steel industry, and 27 per cent for the general industrial demand.

The Virginia Ice and Freezing Corporation, of Norfolk, has had such success with two 300-hp. Smith gas producers it is preparing to install three more Smith Type E producers of 300-hp. each. These producers will be used to supply gas to the engines used in this plant and are designed for anthracite coal, being provided with shaking grates and baffle type scrubbers.

New Publications

ELEMENTS OF ENGINEERING THERMODYNAMICS. By Moyer, Calderwood and Potter. Published by John Wiley & Sons, New York City. Cloth; 196 pages; 47 illustrations; 4 tables.

As the authors state in the preface, this volume is an extension of a briefer work by Moyer and Calderwood. Considerable material that is essential in a textbook of thermodynamics has here been added to the original text, increasing the value of the present work to a considerable extent. Although written primarily for engineering students, it should be of benefit to all engineers having a knowledge of calculus.

LESSONS IN ELECTRICITY AND MAGNETISM. By W. S. Franklin and Barry MacNutt. Published by Franklin & Charles, Bethlehem, Pa., 1919. Cloth; 254 pages; 188 illustrations. Price, $2.25.

In this book is presented the theory of electricity and magnetism by making use of things that are found in practice. The material has been arranged to meet the need of a two years' course in elementary physics and is divided into seven chapters with four appendices, namely: Magnetism and the magnetic effect of the electric current; chemical effect of the electric current; heating effect of the electric current; induced electromotive force; electric charge and the condenser; electric field and elementary theory of potential; the atomic theory of electricity; magnetism of iron; elementary theory of alternating current; electrical measurements; corresponding equations of translation motion, rotary motion and electrical motion; and answers to problems. Although this book was written primarily for use as a text, the arrangement and the presentation of the material are such as can be easily mastered by the home student. Numerous problems are given throughout the text, and since the answers are given in an appendix, it greatly enhances the value of the book to those who wish to study the subject of electricity and magnetism outside the environs of the classroom.

Obituary

Arthur M. Waitt, who was a member of the commission which planned the electrification of the New York Central Railroad, died on Nov. 10 at his home in Sharon, Conn. He was born in Boston in 1858, and was graduated from the Massachusetts Institute of Technology with an engineer's degree. Mr. Waitt was with the New York Central for twenty-five years, and was a member of the New York Railroad Club, American Society of Mechanical Engineers, St. Louis Railroad Club and the Hartford Club.

Arthur E. Hauck, president of the Hauck Manufacturing Co., maker of oil-burning appliances, kerosene torches, furnaces and forges, died recently at his home in Brooklyn at the age of forty-one years. Mr. Hauck originally followed the coppersmith's trade in Germany, his native country, and later in Belgium, France and England. At twenty years of age he arrived in this country almost penniless and went to work in the Philadelphia Navy Yards. In 1902, three years later, he established himself in the oil-burning appliance business to which he devoted the remainder of his life.

Personals

George Macnoe is now associated with W. B. Connor, Inc., New York City, engaged in the sale of power-plant equipment.

Ralph K. Rowell has left the position of equipment engineer with the International Motor Corporation to affiliate with a firm the name of which will now be Hubbard, Harris & Rowell, Inc., consulting engineers.

Charles H. Israel, formerly works manager of the National Marine Engine Works for the Foundation Co., has been appointed Eastern representative of the Kingsford Foundry and Machine Works, of Oswego New York, for the sale of stationary and marine unaflow engines.

M. M. Shaw is now power engineer for the Cooley & Marvin Co. of Boston, Mass. He was formerly engineer with the Perry Barker firm of fuel engineers, Boston.

W. S. Quigley, president of the Quigley Furnace Specialties Co, New York City, has returned from Europe after an extensive trip made in connection with large installations of the Quigley Powdered Coal System in Italy and Belgium.

Business Items

The Manistee Iron Works Co., of Manistee, Michigan, manufacturer of Roturbo centrifugal pumps, vacuum pumps, rotary jet condensers, evaporating equipment for salt, sugar, potash, etc., has opened a Pacific Coast office in the Rialto Building, San Francisco, which will be in charge of L. M. Page, formerly general sales manager. The company expects to open other branches at Los Angeles, Portland and Seattle, which will also be under the supervision of Mr. Page.

Trade Catalogs

The Batterman-Truitt Co., 736-738 West Monroe St. Chicago, has issued a 3 x 6-in. 30-page revised catalog of ventilating equipment, including fans driven by pulley and d.c. or a.c. motors.

"The Technical Products Economist" for November, listing thousands of items of new and used machinery and equipment for sale, is ready for distribution. It contains five sections: Refrigeration, power, pulp and paper, tank, and chemical.

The Milwaukee Electric Crane and Manufacturing Co., Milwaukee, Wis., has ready for distribution an 8 x 11-in. 48-page catalog of electric cranes and hoists, and also of a horizontal boring mill. A great number of pictures show the manufacture, design and use of Milwaukee cranes.

New Construction

PROPOSED WORK

Mass., Charlestown (Boston P. O.)—The Charlestown Gas & Electric Company, 27 Main St., will soon award the contract for a 1 story, 50 x 50 ft. electric substation on Salem St. French & Hubbard, 88 Pearl St., Boston, Archts. and Engrs.

Mass., Provincetown—Andrews, Tower & Lavalle, Archts and Engrs., 274 Main St., are preparing plans for a fish plant on Cape Cod St. About $500,000. Owner's name withheld.

Mass., South Hadley—Mt. Holyoke College plans to build a new science building and an addition to the library. About $500,000. Archt. not selected. M. E. Wooley, Pres.

Conn., Hartford—The Aetna Life Insurance Co., 650 Main St., plans to build an office building on Trumbull St. Over $2,500,000. Archt. not announced.

Conn., Middletown—The Middlesex Hospital, 28 Crescent St., will soon award the contract for a 3 story, 40 x 108 ft. hospital addition including a steam heating system. About $250,000. Buck & Sheldon, Inc., 60 Prospect St., Hartford, Archts.

N. Y., Brooklyn—The Dept. of Educ., 500 Park Ave., New York City, is having plans prepared for a 5 story, 125 x 197 ft. school including a steam heating system on Sanford St. near De Kalb Ave., here. About $750,000. C. B. J. Snyder, 28th floor, Municipal Bldg., New York City, Archt. and Engr.

N. Y., New York—The Auditorium Association, c/o Slee & Bryson, Archts. and Engrs., 154 Montague St., Brooklyn, will receive bids until Dec. 1 for a 4 story 50 x 75 ft. club and office building at 250 West 25th St., here. About $250,000. Noted June 15.

N. Y., New York—The Bd. Educ. received bids for the installation of heating and ventilating apparatus in Public School 74 from Miller & Brady, Inc., 210 East 38th St., at $6,000; J. Dames Co., 1996 Nostrand Ave., Brooklyn, $6 278; D. J. Rice, 405 Lexington Ave. here $7 223. In Public School 81 from L. Ruetzle Co., Inc., $16,422; D J. Rice, 405 Lexington Ave., $17.182; Miller & Brady, 210 East 38th St., $17,339.

N. Y., New York (Bronx Boro.)—The New York Institution for Education of the Blind, 9th Ave. and 33d St., plans to build seven 2½ story institutional buildings including a steam heating system, on Bronx and Pelham Pakways, Bronxwood Ave. and Williamsbridge Rd. McKim, Mead & White, 101 Park Ave., Archts. and Engrs.

N. Y., Rochester—The Bd. Educ. is having plans prepared for a 2 story, 180 x 200 ft public school and two 2 story, 300 x 325 ft. junior high schools at $1,500,000 each. E. S. Gordon, 300 Sibley Block, Archt.

N. Y., Troy—The United American Iron & Steel Co., Van Buren St., is in the market for one double drum, steam power hoisting engine of ten ton capacity. F. Samuels, Jr., Gen. Mgr.

N. J., Maurer—The Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa., is having plans prepared for machinery and manufacturing buildings and a power house, here. About $1,000,000. Lockwood-Green Co., 101 Park Ave., New York City, Archts. and Engrs.

Pa., Philadelphia—St. Agnes' Hospital, Broad and Mifflin Sts., is having plans prepared for a 5 story, 84 x 161 ft. nurses' home including a steam heating system. F. R. Watson, 1211 Walnut St., Archt.

D. C., Washington—The General Pur. Officer of the Panama Canal, here, will receive bids until Nov. 26 for furnishing one 60-kva., 25-cycle, 3-phase, 2,200-2,080-volt primary, 230-volt secondary, transformer, delta-connected, oil cooled and insulated; indoor type for power service.

Va., Minnesota—The Bd. Educ. plans to build a 2 story, 150 x 250 ft. grade school including a steam heating system. About $300,000. Archt. and Engr. not selected.

W. Va., Clarksburg—Dr. W. P. Goff and Maj. G. D Goff plan to build an addition to a hotel. About $500,000. Archt. not selected.

W. Va., Huntington—The International Nickel Co., 43 Exchange Pl., New York City, will build a rolling mill plant here including a steam heating system, here. About $3,000,000.

N. C., Greensboro—The Piedmont Ice & Coal Co. plans to build an ice plant. About $75,000.

Ala., Birmingham—The city is having plans prepared for a 3 story, 150 x 300 ft. high school on 7th Ave. About $600,000. D. O. Whilldin, Title Guaranty Bldg., Archt.

La., New Orleans—The Marine Iron Wks., 1008-1014 Magazine St., plans to build a 1 and 2 story machine, boiler and blacksmith shop. About $75,000. J. de Tarnowsky, 602 Canal Bank Annex, Structural Engr.

Ky., Covington—The city voted on $250,000 bonds for the purchase of a 10,000,000 gal. pumping unit and boilers. R. Russel, Comr. of Pub. Property. Noted Oct. 12.

Ky., Walton—The city has authorized an issue of $10,000 bonds for a municipal electric plant on Main St.

O., Ashtabula—The Pierce, Butler & Pierce Co., 282 James St., Syracuse, N. Y., plans to build a plant here. About $1,000,000.

O., Cleveland—The Taylor Stores Co. will receive bids until Dec. 1 for a 17 story, 67 x 189 ft. department store and office building. About $1,250,000. D. H. Burnham & Co., 209 South La Salle St., Archt.

O., Columbus—The Bd. Educ. is having preliminary plans prepared for two 2 story, 110 x 200 ft. schools, one on Avondale Ave. and the other on Douglas Ave. About $265,000 each. Riebel & Sons, New First Nat'l Bank Bldg., Archts.

O., Dayton—The Dayton Power & Light Co., 4th and Jefferson Sts., plans to issue $1,000,000 bonds for the purchase of generators, turbines, transmission material, transformers, etc., for the purpose of increasing the output of the Miller's Ford plant

O., Sandusky—The Sandusky Cement Co., Engineers Bldg., Cleveland, plans to build a 1 story, [illegible] ft. addition to its power house here. About $[illegible]. W. B. Newberry, Engineers Bldg., Cleveland, Engr.

O., Willoughby—The Thor Tire & Rubber Co., c/o R. C. Gary, 805 Society for Savings Bldg., Cleveland, plans to build a 1 and 3 story, 60 x [illegible] ft. factory and power plant here. About $[illegible],000.

O., Youngstown—The Reserve Iron & Steel Co. plans to build and equip two blast furnaces and a puddling plant. About $1,000,000.

Ind., Hammond—The Masonic League will receive bids until Dec. 20 for a 1 story, 150 x 100 ft. temple including a steam heating system. About $250,000. R. G. Schmidt & Co., 151 West Randolph St., Archt.

Mich., Detroit—The Detroit Packing Co., 10 Bushey St., is having plans prepared for the first unit of a 5 story packing plant. Plans will also be prepared for separate power plant. About $1,000,000. Packers' Architectural & Engr. Co., Manhattan Bldg., Chicago, Ill., Archt. and Engr.

Mich., Detroit—The Orling Bros., Heidelberg and Elmwood Aves., are having plans prepared for a 3 story, 60 x 100 ft. meat products factory including a 100-hp. boiler for washed air heating system. Power motors and refrigerating equipment will be installed in same. About $200,000. Louis Kamper, 751 Book Bldg., Archt.

Mich., Detroit—Pollmar, Ropes, Archts. and Engrs., 15 State St., are preparing plans for a 1 and 2 story 100 x 160 ft. factory. Power motors will be installed in same. About $75,000. Owner's name withheld.

Mich., Detroit—Thos. Barlum & Sons, Cadillac Sq., are having plans prepared for a 1 story, 100 x 100 ft. market building. Refrigerating equipment will be installed in same. About $75,000. Rogers, Bonnah & Chaffee, 528 Farwell Bldg., Archts.

Ill., Chicago—The Masonic League, c/o Hyde & Brown, Archts., 8 South Dearborn St., will soon award the contract for the superstructure of a 4 story, 125 x 200 ft. temple including a steam heating system at 6107 College Grove. About $750,000.

Ill., Chicago—G. E. Spry, c/o A. Alshuler, 28 East Jackson Ave., is receiving bids for a 7 story, 80 x 140 ft. office building including a steam heating system at Morgan and Van Buren Sts.

Ill., Chicago—J. Stroh, Detroit, Mich., is receiving bids for an 18 story, 80 x 100 ft. office building, including a steam heating system at 14-20 Adams St., here. About $1,200,000. Gaiver & Dinkelberg, 80 East Jackson St., Archts.

Wis., Fort Atkinson—H. H. Smith, City Clk., is receiving bids for a 6 ft. water gas generator set, meter purifiers, air blowers, etc. for gas plant.

Wis., Merrill—The Secy. of the Bd. Educ. will receive bids until Dec. 15 for a 117 x 140 ft. grade school and a 75 x 120 ft. addition to high school, including a steam heating and mechanical ventilating systems. About $260,000. Parkinson & Dockendorff, Linker Bldg., La Crosse, Archts. and Engrs.

Wis., Milwaukee—The Milwaukee Electric Ry. & Lt. Co., Public Service Bldg., will soon award the contract for a 2 story, 20 x 30 ft. substation on Marshall St. About $10,000. R. Pinkley, c/o owner, Archt.

Minn., Owatonna—Toltz, King & Day, Consulting Engrs., 1410 Pioneer Bldg., St. Paul, are preparing plans for a municipal electric light, power, steam heating and gas plant, here. About $475,000.

Minn., St. Paul—The city voted to issue $3,000,000 bonds for enlargements to water plant including a pumping station, etc. Oscar Claussen, City Engr.

Kan., Montezuma—The City plans to build a 20 x 35 ft., 15-kw. gas plant including a 25-hp. gas engine. About $15.000.

S. D., Mitchell—Frank McGovern, City Aud., will receive new bids for a 1 story, 182 x 300 ft. corn palace auditorium including a steam heating system. About $300,00. C. W. & G. L. Rapp, 1200 State Lake Bldg., Chicago, Ill., Archts. Former bids rejected. Noted Aug. 10.

Tex., Corsicanna—The Navarro Manufacturing Company is in the market for a 30 to 35 hp. upright steam boiler. Second hand preferred.

Tex., Dallas—The Federated Jewish Charities, 1811 Ashland Ave., are raising funds for a hospital. About $1,000,000.

Tex., Dallas—The City and County of Dallas are having plans prepared for a hospital including an extension to the present steam heating plant. About $150,000. Herbert M. Greene, North Texas Bldg., Archt.

Tex., Lubbock—The West Texas Sanitarium Assn. had plans prepared for a 4 story hospital building including a boiler room, etc. About $110,000. Henry T. Phelps, Gunter Bldg., San Antonio, Archt.

Tex., Mineral Wells—The city voted on $200,000 bonds for installing pumping equipment at Lake Mineral Wells and building pipe line from there to supply city with water.

Tex., Port Arthur—The Bureau of Yards and Docks, Navy Dept., Washington, D. C. plans to build a 14 x 39 ft. radio building here.

Tex., Waxahachie—The city plans an election to vote on $100,000 bonds for a municipal electric light system.

Okla., Tulsa—The Masonic League, 518 South Main St., will soon award the contract for a 6 story, 100 x 140 ft. temple including a steam heating system. About $650,000. R. G. Schmidt & Co., 151 West Randolph St., Hammond, Ind., Archt.

Idaho, Idaho Falls—The Howard Pulp & Paper Co. will soon receive bids for a news print factory and an 18,000-hp. power plant. About $4.000,000. Thomas L. Tomlines, City Bank Bldg., Syracuse, N. Y., Engr.

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 1 for refrigerating equipment here.

Cal., Victorville—The Victor Valley Irrigation District is having surveys made for an irrigation system including a hydroelectric plant, booster pumping plant, 3 reservoirs, etc. About $7,000,000. F. C. Finkle, I. W. Hellman Bldg., Los Angeles, Consulting Engr.

Ont., London—The Young Men's Christian Assn., c/o E. T. Jenkens, 429 Wellington St., plans to build a new Y. M. C. A. building including a steam heating system. About $300,000.

Ont., Toronto—The Crouse Hinds Co. of Canada, Labatt Ave., Harvey Hubbell and the Hubbell Mack Machine Screw Co. plan to build a 3 story factory including a vacuum steam heating system on Coxwell Ave. for the manufacture of electric light fixtures. About $500,000.

South America, Peru, Lima—A. Grana had plans prepared for a cotton mill including a steam heating system. About $500,000. Lockwood-Green Co., 101 Park Ave., New York City, Archts. and Engrs.

CONTRACTS AWARDED

Me., Auburn—The Young Men's Christian Assn., 2 West 45th St., New York City, has awarded the contract for a Y. M. C. A. building including a steam heating system, to F. A. Rumery, Inc., 21 Portland St., Portland, at $250,000.

Conn., Bridgeport—The City Engr., c/o Bd. Sewer Comnrs., has awarded the contract for a pumping station to be known as the Island Brook Station, to the Bridgeport Constr. Co., 983 Broad St., at $30,000.

N. Y., New York—The New York Curb Market Assn., 25 Broad St., has awarded the contract for an exchange building including a steam heating system on Trinity Pl. to Thompson-Starrett Co., 49 Wall St., at $750,000. Noted Jan. 27.

N. Y., Utica—The Utica Steam & Mohawk Valley Cotton Mills, 801 State St., has awarded the contract for a boiler plant extension to Stone & Webster, 120 Bway., New York City, at $350,000.

Md., Annapolis—The city has awarded the contract for furnishing and installing one 150-hp. boiler in the municipal pumping station to H. E. Crook Co., Inc., 28 Light St., Baltimore, at $7,825.

Md., Baltimore—The United States Fidelity & Guaranty Co., Calvert & Redmond Sts., has awarded the contract for a 3 story office building including a steam heating system at Calvert and Mercer Sts. to Geo. Dose Engr. Co., 43 West 27th St., New York City, at $500,000. Noted Oct. 12.

Md., Baltimore—The City Council has awarded the contract for a 76 x 271 ft., 50 x 241 ft. school including a steam heating system at 76 Latrobe Park to the Standard Constr. Co., 1713 Sansom St., Philadelphia, Pa., at $195,000.

Va., Norfolk—The Beth El Congregation, c/o Herts & Robertson, Archts., 331 Madison Ave., New York City, has awarded the contract for a synagogue including a steam heating system here to E. W. Winter Co., Inc., 114 Bway., New York City, at $250,000. Noted Feb. 4.

O., Cleveland—The Babies' & Children's Hospital Assn., c/o Garfield, 915 National City Bldg., has awarded the contract for a 9 story, 60 x 150 ft. hospital at 11020 Euclid Ave. to Crowell & Little Constr. Co., 1951 East 57th St., at $500,000. A steam power plant will be installed in same. Noted Sept. 14.

O., Cleveland Heights (Warrensville P. O.)—The City Ice Delivery Co., H. D. Norval, Pres., East 20th St. and Euclid Ave., Cleveland, has awarded the contract for a 2 story, 66 x 84 ft. tank and engine room on Cedar Ave. and Lee Road here, to Younger & Farmer, 1670 Crawford Rd., Cleveland, at $75,000.

O., Elyria—The Bd. Educ., c/o S. S. Rockwood, has awarded the contract for a 2 story, 98 x 200 ft. school including a steam heating system at Gulf Rd. and Ohio St., to Drummond-Miller Co., 4500 Euclid Ave., Cleveland, at $300,000.

Mich., Detroit—The Bd. Educ., 5 Bway., has awarded contracts for addition to Abbott School including a steam heating system to A. W. Hutche, Ford Bldg., $217.213; Marxhausen School on Warren Ave. to F. N. Cooper, Penobscot Bldg., $190.000 and the Majeska School on Trombley St. to Brayton Engr. Co., 907 Kresge Bldg., $195,733.

Ill., Chicago—Joseph Klicha, West 20th St. and California Ave., has awarded the contract for several buildings including a 1 story, 18 x 38 engine house, a 1 story, 32 x 47 ft. boiler house, etc., to Stellwager & Co., 1583 Clebourne Ave., at $100,000.

Ill., Granite City—The School Bd. has awarded the contract for a 2 story, 125 x 234 ft. high school including a steam heating system on Alton Highway to R. B. Higgins Bldg. and Constr. Co., 1143 Childress Ave., St. Louis, Mo., at $320,000.

Wis., Carrollville—The U. S. Glue Co. has awarded the contract for a 30 x 40 ft. boiler house to P. Riesens Sons, 1018 Humboldt Ave., Milwaukee. Bids will soon be received for two 150-hp. boilers.

Wis., Fond du Lac—The Forest Ave. Hotel, c/o J. P. Walsh, Vice-Pres., 170 Forest Ave., has awarded the contract for a 4 story, 90 x 120 ft. hotel to L. Schroeder, Main Street, at $250,000. A steam heating system will be installed in same.

Wis., Wausau—The Wisconsin Valley Electric Co., 206 3rd St., will build a water power electric plant and dam. About $600,000. L. A. DeGuere Grand Rapids, Mich., Engr. Work will be done by day labor.

Iowa, Fort Dodge—The Bd. Educ., c/o Paul Gustafson, Secy., has awarded the contract for a 3 story, 190 x 260 ft. high school including a steam heating system, to Madsen & Peterson, 646 Builders' Exchange, Minneapolis, Minn., at $645,300.

S. D., Sioux Falls—Woodbury County has awarded the contract for engine, generators, switchboard, motors and oil tanks for gravel pit to Fairbanks-Morse Co., 900 South Wabash Ave., Chicago, Ill., at $20,000.

Kan., Portes—J. E. Kissel, City Clk., has awarded the contract for waterworks improvements including a 40,000 gal. water tower, 5-hp. motor, new well, etc., to C. H. Everett, Hutchinson, at $25,590. Noted Oct. 26.

Neb., Sidney—The city has awarded the contract for power house equipment including a 450-hp. Ball engine and a Westinghouse generator to the Mine Smelter & Supply Co., 17th and Blake Sts., Denver, Col., at $18,000. Noted Oct. 12.

Tex., Dallas—The Southwestern Forwarding Co., 1301-9 Broom St., has awarded the contract for a 1 story, 120 x 534 ft. warehouse to B. E. Howard, Harwood and Sante Fe Sts., at $150,000. Overhead monorail conveyors, electrically driven stacker, etc. will be installed in same.

Col., Denver—The city has awarded the contract for the installation of a steam heating system in the proposed junior high school, to Joseph Pfeiffer, 1140 California St., at $63,688. Noted Nov. 16.

POWER

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The Spotlight Engineer

By Rufus T. Strohm

SOME years ago Philander Potts was taken with the whim
That posing in the limelight would be flattering to him;
And so he donned his overalls and set to work with zest
To make his power plant surpass the city's very best.
He looked for signs of glaring waste, he hunted hidden leaks,
And thus he probed and nosed around for many weary weeks,
And when he found a shaky spot, he fixed it up for good,
Till finally he made the place run somewhat as it should.

By dint of ceaseless tinkering, it followed that in time
The state of his equipment rose from middling up to prime,
And thereupon he ran some tests, whose figures plainly showed
A marvelous efficiency at near the normal load;
And these — Philander took good care — were glaringly displayed,
To advertise to all the world the record he had made,
And engineers arrived in droves from distant parts to see
Philander's plant and shake the hand of such a man as he.

The engineering papers published pictures of the place,
And incidentally they showed our hero's smiling face,
For when the staff photographers performed their little stunt,
Philander somehow managed to be posing right in front.
And thus for many months he held the center of the stage —
Apostle of Efficiency and Engineering Sage.
But after while the fickle world lost interest in him,
And then Philander's star became a wan and sickly glim.

He found that mischief-making Fate had played a shabby trick,
Because the record he had reached could not be made to stick
Unless he kept his weather eye forever keenly peeled
To note development of leaks and have them promptly sealed;
Now, patient plodding was a thing Philander would detest,
And so he let his duties slide and took a lengthy rest.
Efficiencies went tumbling down, the pretty bubble burst,
And verily, the final stage was lower than the first.

* * * *

The biggest dub in seven states can patch things up a bit
And run a seven-hour test to show that he is IT;
But if you want your shekels saved, select for engineer
The sort of guy that's on the job each minute of the year.

The Heating Plant as a Source of Power

By IRA N. EVANS

STEAM used for heating is a source of power often wasted in large heating installations although the greater part of the equipment is operated and fuel provided seven to eight months of the year. Large savings may be effected by recovering the power in the steam and utilizing the exhaust for heating. In all heating problems the possiblity is present and is commercially profitable so long as the plant is of sufficient size to warrant the additional investment in equipment required. In the case of a new development no additional expense is involved beyond the necessary standard generating equipment. The rapid increase in the the cost of fuel and labor and the scarcity of coal should cause a revival of interest in this method of conserving coal.

In heating plants of five hundred horsepower and over large savings may be effected by operating at high pressure and recovering the power from the steam before it is passed on to the heating system. The power equipment proposed is a turbo-generator unit condensing into the heaters of a hot-water forced circulation system. The vacuum is varied arbitrarily to meet changes in outside temperature from atmospheric pressure to twenty-eight inches of vacuum. With this range of vacuum the water rate of any turbine will vary one hundred per cent, and owing to this fact the steam exhausted will practically balance the varying heating requirements, a constant electrical load may be recovered throughout the heating season, and in summer the power unit may be operated condensing.

In the past it was symbolical to picture a busy and prosperous factory with clouds of steam and great volumes of black smoke issuing from the chimneys. It is no longer so, as these symbols are absolute and never-failing evidences of waste in power development and imperfect combustion. Still there are engineers who, although knowing these facts, recommend heating by live steam and purchasing power. There may be some excuse for the small plant, but the larger installations have none to offer.

If this power that it is possible to recover from the heating fuel were purchased, although manufactured perhaps on a large scale for less cost, whatever labor, fuel or equipment was required would involve just so much duplication and waste as far as the community is concerned. The heating plant would have to be operated in any case, with all stand-by losses, labor, etc. There is, however, one necessary requirement for economy. Although the use of exhaust steam will always show a saving, its waste to the atmosphere at any time may nullify any previous saving for the combined operation.

Some simple experiments with a teakettle and thermometer on a gas range will demonstrate how much of the heat in the steam is available for heating and show its relation to that used for power. The accuracy will depend somewhat on the constant pressure and rate of flow of the gas, but the results will suffice for the purpose. Place a given amount of water in a teakettle and with the gas jet set the same throughout, raise the temperature of the water to 100 deg. Notice the time it takes to raise it from that temperature to the boiling point. Then notice the time required to boil the kettle dry. It takes, say, 5 minutes to raise the water from 100 deg. to 212 deg. and 43.5 minutes to boil the kettle dry, or nearly 8½ times as long. If the vessel were closed and of sufficient strength, 5 minutes more, after the water began to boil, would suffice to bring the pressure up to 200 lb. The tests show approximately the relations between the heat required to generate steam for heating and for power. From 10 to 20 per cent of the heat in the steam is available for mechanical work depending upon whether the plant exhausts to atmosphere or is operated condensing. The other 80 to 90 per cent is known as latent heat and is always a complete loss when only power is generated.

The open teakettle corresponds to the boiler of the steam-heating system, a large pipe leading the steam

FIG. 1. REASONS WHEN EXHAUST STEAM HEATING DOES NOT PAY

FIG. 2. AN INVESTMENT OF GENERATING EQUIPMENT COULD SAVE $65,000 PER YEAR

FIG. 3. THIS WASTE CAN BE SEEN NEARLY EVERY DAY IN THE YEAR. ALL CURRENT IS PURCHASED

to the different fixtures such as radiators and fan heating coils if hot-air heating is employed. A small pipe leads back to the boiler plant to return the water as the steam condenses.

This type of system is handicapped by the distance the steam may be transmitted, as a drop in pressure is required to overcome friction of the piping, and all pressure above atmosphere reduces the engine economy if exhaust steam is used. Besides grades must be given careful consideration in order to cause the condensation to flow.

FIG. 4. COMBINATION POWER AND HEATING PLANT WITH COOLING TOWER, RECOVERING $27,000 WORTH OF CURRENT PER YEAR FROM HEATING STEAM

On the other hand a hot-water system with forced circulation may be used for heating. Heaters or condensers transfer the heat of the steam at any pressure and temperature to the circulated water. Mechanically operated pumps are used to circulate the water through the same type of fixtures and radiators as are employed in the steam system. Supply and return pipes are of the same size, although both are much smaller than required for the steam system. The circulation is under control and will be the same whether the water is hot or cold. Grades and distance are negligible factors. Since the entire system is full of water, all that is required of the pumps is to overcome the frictional resistance of the pipes, the pressure due to the height of the system being the same on both sides of the pump.

The temperature of the circulating water may be varied from that of the steam system, say 220 deg., down to 100 deg., offering a wide range to compensate for outside weather changes and making it possible to operate the power end of the plant on a vacuum. The steam system, on the other hand, operates of necessity on nearly a constant temperature and regulation is obtained by shutting off units either by hand or automatically.

From the previous discussion it may be seen that a steam-heating system demands power generation on a non-condensing basis as against possible condensing operation with forced hot-water heating. Increase in distance and load affect the steam system of distribution by raising the initial pressure required for circulation and consequently increasing the back pressure on the engine. The result is a higher water rate and reduced power capacity. With a forced hot-water system the circulation is independent of the temperature of the medium.

In every large manufacturing plant using current and maintaining boilers for heating, theoretically 10 per cent more coal will make the steam available for power purposes. In this way the power may be recovered from the steam used for heating, latent heat being dissipated by the heating system and every heat unit utilized. The only precaution necessary for exhaust-steam heating to be economically successful, is that power generation be not continuous on a non-condensing basis. When not needed for heating, this same latent heat becomes a debit, if power is generated uneconomically, and the winter's savings may be dissipated during the summer. It is the correlation of functions for both power and heating on which exhaust-steam heating depends for ultimate economy.

It is entirely feasible to arrange equipment so as to produce a nearly constant power load recovery, utilize the latent heat in the heating system and yet generate the power load in summer at a low water rate, when heating is unnecessary.

What better condenser could be furnished than a hot-water heating system, as it is nothing more than a dissipator of heat with variable requirements due to the weather. Lack of a pond or river for cooling water in summer is no handicap, as a cooling tower may be used. The latter depends upon the mechanical evaporation of water by blowing large volumes of air through a fine spray. A roof or vacant lot will serve the purpose, and no more than 1½ lb. of water is used per pound of steam condensed. However, a large volume of water is circulated over and over, the figure given representing the actual loss from evaporation and wastage. Strange as it may seem, the actual water loss is less with the cooling pond or tower than when the engines exhaust to the atmosphere.

FIG. 5. TURBO-GENERATOR AND FORCED HOT-WATER PLANT THAT FOR 8 YEARS HAS BEEN RECOVERING 400 KW. FROM HEATING STEAM

The conditions required for economically recovering power from heating fuel may be stated as follows:

1. Ample capacity for heating in the coldest weather.
2. Flexibility in capacity to meet outside weather changes, that is, a variable temperature of the heating medium.
3. Power load recovered should be nearly constant in amount regardless of the heating requirements; that is, variable steam rate for power.

4. Ability to shift at all times to the lowest steam rate for power, as the heating requirements change, without interruption of the power or heating functions.

The apparatus that will fulfill these requirements is a hot water forced circulating system with the heaters used as condensers. If a constant amount of water is circulated, all that is necessary to regulate the room temperature is to vary the temperature of the water, and this may be done by varying the vacuum on the condenser to give the temperature desired.

For large plants the water system is somewhat cheaper to install, the variable temperature of the medium enables better regulation, and the steam may be used at pressures below atmosphere, thereby lowering the water rate of the generating unit. On the other hand, the steam system requires nearly a constant pressure, approximately atmospheric, and therefore the maximum steam power rate. The only way of varying the amount of steam for the system is by changing the power load.

To show the possibilities, the following data are presented to permit comparison. A kilowatt-hour is generated by the average central station on, say, 17 to 20 lb. of steam, all losses included, when operating under high vacuum.

On a non-condensing basis in the private plant the rate varies from 35 to 45 lb., with all losses included, the larger machine operating at the greater economy as before. This means a coal rate of from 2 lb. to 4.5 lb. per unit of power, dependent on whether the plant is operated condensing or non-condensing.

In most northern climates the heating season varies from 5,000 to 6,000 hr., dependent on the latitude. There are 2,500 to 3,000 hr. for power operation working one shift per day and 4,500 to 4,900 hr. for two shifts.

In most large plants the heating systems are operated continuously night and day throughout the season, with a general variation from 100 per cent capacity in extreme weather to 40 per cent as the minimum in moderate weather, the average being 65 to 70 per cent, dependent upon the flexibility of the system.

Public-service rates vary, depending upon the locality, the amount of current purchased and the relation of the maximum demand to the average load. The lowest net rate known to the author averages about one cent per kilowatt-hour. Although much lower than the average this figure will be used in the following computations.

If a manufacturer installs his own generating plant, double equipment has to be provided for breakdown service as, owing to the method of charging for this accommodation, the cost may be prohibitive.

There is no doubt that most public-service companies can equal or better the isolated plant in summer on a straight power-generating basis, particularly if the plant is operated non-condensing. The following case will show how exhaust-steam heating may prove uneconomical. Assume a plant requiring a maximum of 1,000 boiler-horsepower in zero weather for heating with the steam system on a non-condensing basis. Observing the figures given previously, the recovery in power for 3,000 hours, considering one shift only, would be as follows, with a constant noncondensing steam rate of 45 lb. per kilowatt-hour:

Recovery from maximum load $= 34,500 \div 45 = 766$ kw.; from average load, 65 per cent, $= 500$ kw.; from minimum load, 40 per cent, $= 300$ kw.

Unless exhaust steam is wasted to the atmosphere to balance the variable heating requirements, the power recovery will be far below the average and variable in amount. At the period of minimum load the engine would be operated at an uneconomical underload or steam would be wasted to the atmosphere.

If current beyond that supplied by the heating steam could be purchased from the public-service company for one cent per kilowatt-hour, so that no steam would be wasted to the atmosphere, the average load of 500 kw. could be recovered. Then the recovery would amount to $3,000 \times 500 = 1,500,000$ kw.-hr., which at 1c. would equal $15,000 per year. If the generating unit of, say, 800 kw. capacity cost $50 per kilowatt, the gross saving would be $15,000 \div 40,000 = 0.375 = 37.5$ per cent.

If this engine were operated in summer with fuel at $6 per ton and 4.5 lb. of fuel was required per kilowatt-hour, the fuel alone for unit power production would cost $600 \div 2,000 \times 4.5 = 1.35$c. This shows the necessity of the constant power load recovery and a minimum power rate when heating is not required. Otherwise the summer operation would nullify the winter saving. If this engine were exhausted into a low-pressure turbine on a condensing basis, no steam would be discharged to atmosphere, minimum water rates would be obtained in summer, and with a constant power load the whole gross saving of 37.5 per cent could be conserved. The public-service rates for current could be met in summer, but the investment would be excessive.

It is characteristic of the turbo-generator that its steam rate will vary 100 per cent between atmospheric pressure, or 212 deg., and 28 in. of vacuum, or 100 deg. With such a unit installed and the vacuum varied to meet the heating requirements, the heating and power steam will very nearly balance. Suppose 5,000 boiler horsepower is required for heating in zero weather, the maximum and minimum quantities will be as follows:

	0 Deg. Outside	75 Deg Outside
Heating, hp.	5,000	2,000
Per cent load	100	40
Steam available for both power and heating, lb.	172,500	69,000
Temp. circulated water, deg. F.	210	100
Terminal exhaust pressure	3 lb.	28 in. vacuum
Steam rate, lb. per kw-hr.	35	17
Power load, kw.	5,000	4,600

Notice there is the same variation in all these quantities, consequently they will balance for any intermediate point. It is evident that the power recovery will average in kilowatts about 90 per cent of the maximum boiler horsepower in zero weather.

Take a plant requiring 1,000 boiler horsepower in zero weather, operating one power shift, with a heating season of 5,000 hours. Then the average power recovery will amount to

$$0.9 \times 1,000 \times 5,000 \times 0.65 = 2,925,000 \textit{ kw.-hr.}$$

At 1c. per kw.-hr. the value of the recovered power is $29,250 per year. Assuming double equipment is required, with no public-service current, the investment for generating equipment would be 2,000 kw. × $50 = $100,000. Then the gross saving would amount to

$$29,250 \div 100,000 = 0.2925 = 29.25 \textit{ per cent}$$

There would be little additional labor or expense, as the boiler plant has to be maintained anyway and generally in summer. The cost of current in the summer season would be about the same as the public-service rate. Suppose that there was unlimited capacity for this recovered current, that the public-service current was available for breakdown service and only one machine was required. Then the machine could be run at full capacity for the 5,000 hours and the value of the recovered current would be

$$0.9 \times 1{,}000 \times 5{,}000 \times 1c. = \$45{,}000 \textit{ per year}$$

The cost of one machine would be $50,000, so that the annual saving on the investment would amount to $45{,}000 \div 50{,}000 = 0.9 = 90$ per cent. Also notice that the power recovery in the previous example with a constant steam rate, is only 1,500,000 kw-hr. as against 2,700,000 kw.-hr. when operating under vacuum.

The additional investment needed for this method of power recovery from heating steam is warranted in all plants of 500 hp. capacity and over. Condensing equipment is necessary and where no natural source of cooling water is available, cooling towers or spray ponds are to be used. All equipment needed is standard, its performance well known, and there is no question about the results.

To estimate the possible saving, take 90 per cent of the boiler horsepower required in zero weather for heating and determine the period of time the current can be utilized. The product of these two figures will be the total kilowatt-hours that may be recovered, and multiplying by the prevailing cash rate for purchased current in the district will give gross saving for the year.

Overhauling a Diesel Engine

By G. H. Grow

Recently, I was called in to operate an old Diesel engine until a permanent engineer could be secured. The operator who had resigned had not kept the engine in the best of shape.

I found the valve setting on all the cylinders somewhat late. The fuel valves all opened after dead center. The helper said that the operator had set them late to avoid pounding of the crankpin bearings. Late injection helped no doubt, but as the pistons were all worn, the compression even at dead center was not over 400 lb. per sq.in. With the late timing, five degrees after dead center, the compression was not up to this value since the air was escaping down along the piston. Even though the piston had not started to move downward at the beginning of injection, the compression was so low that the engine smoked badly.

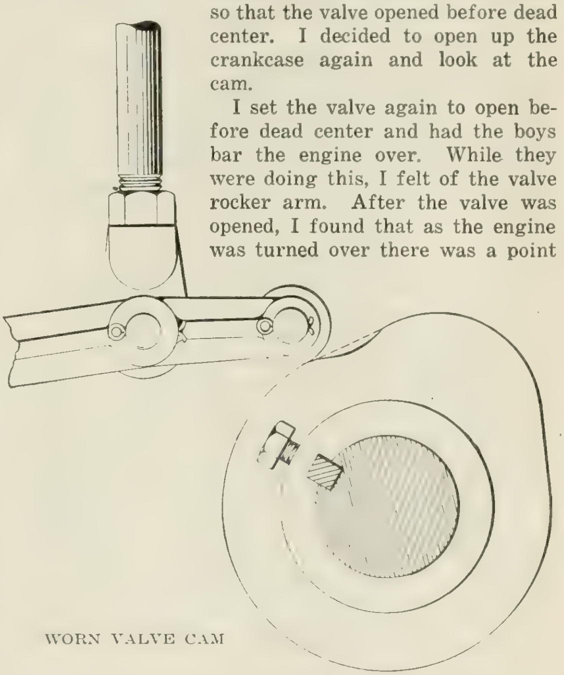
The fuel-valve push rods were adjusted to open the needle valve at five degrees ahead of dead center. The piston rings were removed and were found to be "set." Since no spare rings were at hand, the diameters of the old rings were increased by hammering the inside faces. This caused the rings to hug the cylinder walls more closely, lessening the leakage of air.

On examining the timing of the air-admission valves, all were found to open very late. I checked them up, making the opening point about fourteen degrees ahead of dead center. The cylinder-head joints had leaked slightly and the gaskets were burned in places. New copper gaskets could not be procured; as a makeshift several sheets of No. 22 gage galvanized sheet steel was purchased and gaskets made from these sheets. On tightening down the heads, these gaskets held without leakage. Such material is entirely too hard for general use, but will do as a makeshift.

After going over the engine, tightening up all bolts and making every bearing snug, the engine was started up. To my surprise, after getting one "kick" out of the starting cylinder, the air valve refused to open again. This was strange since no one had altered the length of the push rod. The crankcase doors were opened, whereupon it was discovered that the air starter rocker-arm roller had a flat on it. The roller had turned as the camshaft revolved, causing the flat to rest against the cam. As a result no movement of the starting-valve push rod took place. This was remedied by replacing the roller.

We set the engine in the starting position again and turned on the air. The engine turned over a few times and started firing. Everything seemed to be all right except one admission valve, which continued to chatter. We supposed the valve spring had set or was broken and stopped to replace it. After doing this and starting again, the valve continued its chattering. This was a puzzle to me until the helper said that it always chattered if the timing was made so that the valve opened before dead center. I decided to open up the crankcase again and look at the cam.

I set the valve again to open before dead center and had the boys bar the engine over. While they were doing this, I felt of the valve rocker arm. After the valve was opened, I found that as the engine was turned over there was a point at which the valve closed again and the rocker arms moved free. I found the cam was worn badly at one place.


WORN VALVE CAM

When the valve was set to open early, the roller touched the cam ahead of this worn spot as is shown in the sketch. As the engine revolved, the roller met this worn place; since the cam surface was much below its true shape, the roller moved downward, allowing the valve to close again. The worn portion was of considerable length, and the valve remained closed until either the suction pressure or the rocker opened it again. Since the cam was traveling at a high rate at this time, the valve was kicked open with considerable force. The rocker arm rebounded and the valve chattered. Evidently, the engine had been set to open late for a long time, and the hammer blows of the roller as the cam struck it while moving at a high rate of speed wore the cam surface. It was impossible to obtain a new cam at once, so the valve was set late until a new cam arrived.

Testing Direct-Current Relays

Inspection of Relays Before Installation—Testing Relay Switches—Methods of Obtaining Load for Testing—How Tests Are Made on Various Types of Relays—Interpretation of Test Data

By VICTOR H. TODD
Test Engineer, Westinghouse Electric and Manufacturing Company

NO MATTER how carefully a relay is constructed or tested, it is always well to remember that no piece of apparatus is infallible. For this reason all relays should be tested before being installed and should be subjected to periodic tests after installation. In well-equipped meter shops will be found adequate apparatus such as meters, loads and batteries for making simple or elaborate tests, as the case may be. This article will treat mainly of tests made on the relays while in service.

Practically every manufacturer gives complete directions for the installation of his particular type of relay, and these instructions, of course, should be carefully followed to obtain correct results. In general, they deal with mechanical features, such as seeing that the moving parts are free, that there is no dirt or packing material in the relay and that there are no loose screws or nuts or damaged parts. A diagram of connections also accompanies each relay, and this would always be used in the absence of another authoritative diagram, which might be used to include other instruments in the same circuit. A relay should always be mounted on a firm, solid support, such as a switchboard. It must be accessible for easy inspection and testing and never mounted in a place where it will be subjected to excesses in temperature, moisture, destructive fumes or stray fields. In case a relay must be installed in a dusty place—for instance, a flour or cement mill—it must never have exposed contacts; they must always be inclosed, preferably under a glass cover. If a cover does not accompany the relay, it should be inclosed in a glass-covered dust-proof box.

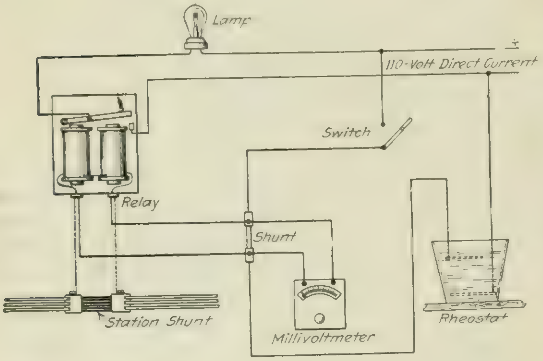


FIG. 1. TESTING CONNECTIONS FOR MILLIVOLT-TYPE RELAY

The circuit breakers and switches too, must receive periodic attention in order that they may not fail at a critical moment. In fact, manufacturers sometimes recommend that the whole protective combination of relays, relay switches and circuit breakers or automatic oil switches be used to open the circuit whenever it is necessary to open it, thereby insuring correct functioning of all units.

Before installing and before making a periodic test, the relay should be tested for "grounds." While this is really a test for live-metal-to-frame defects, it will readily detect defective spots in the insulation, which must be reinsulated against all possibility of breakdown in service.

TESTING RELAY SWITCHES

The relay switch is perhaps the easiest piece of protective apparatus to test. First make sure that all screws and nuts are tight; that it is firmly mounted; no loose connections; and that the contacts are clean and bright and not burnt. If they are burnt or pitted, take a piece of fine emery cloth (never use crocus paper, it leaves a muddy deposit) and after doubling work it back and forth between the contacts, which should be held firmly against the emery. In this way grind the surfaces until they meet accurately. Then energize the solenoid, correct voltage and see that the plunger rises freely and quickly, and closes the contacts positively and firmly. If the trip circuit is operated from a storage battery, it is well to see that the plunger rises satisfactorily when the solenoid is energized on 70 per cent and 130 per cent of the normal voltage. This is to insure correct operation no matter how low or high the battery voltage may go. Failure to operate should be carefully investigated and the cause removed. It may be due to foreign substances, damaged parts or rubbing magnetic surfaces.

If a direct-current circuit is available and the relay to be tested is of the millivolt type, a portable lamp bank or a resistance box may be used, connected as in Fig. 1. If undesirable to trip the breaker in making the test, substitute a lamp as shown connected to the upper, or trip circuit, terminals.

The series types, such as the plunger relays are not so convenient to test, as the whole load must be passed through the series coil. If possible, this is done by building up the load until the breaker trips. This test can often be made at night when an occasional interruption does not interfere seriously with the service. If the load is not too large, water rheostats may be used. A large barrel, filled with water, with an electrode at the top and bottom will handle considerable load. The variation is obtained by continually adding salt, meanwhile watching the ammeter and noting the point at which the relay trips. As an illustration of how great a current may be controlled in this manner, a barrel three-feet deep with electrodes two feet square should handle 500 amperes easily at 100 volts. The variation may also be obtained by moving the electrodes closer together or farther apart.

Another way of obtaining a load is to immerse an iron-wire rheostat of the necessary resistance in running water. For smaller loads and where it is undesirable to interrupt the load, two or three cells of storage battery, such as used for meter testing, may be used with a water rheostat or a carbon rheostat.

Assume, for example, that a millivolt-type relay must trip when the load reaches 800 amperes, but it is impractical to get this load from the line. First disconnect the operating coil leads at the shunt and the trip leads at the relay. Give the usual mechanical inspection, clean the contacts and make a ground test. Note the capacity of the shunt; say it is 50 millivolts at 1,000 amperes; therefore, at 800 amperes it would give $\frac{800 \times 50}{1,000} = 40$ millivolts. Instead of saying that the relay must trip at 800 amperes, we can say that it must trip on 40 millivolts; then it simply becomes a problem to obtain 40 millivolts from an external source. Take a standard shunt giving 50 millivolts at 5 amperes and connect as in Fig. 1. Gradually increase the load until the millivoltmeter reads 40 millivolts and then adjust the relay so that it trips. Several trials may be necessary. Note that the current is unknown exactly, but that it takes approximately four amperes in the test shunt to produce exactly the same effect on the relay as 800 amperes in the station shunt. Then when the relay is reconnected to the station shunt, we know it will trip on 800 amperes although it was only tested with a four-ampere load.

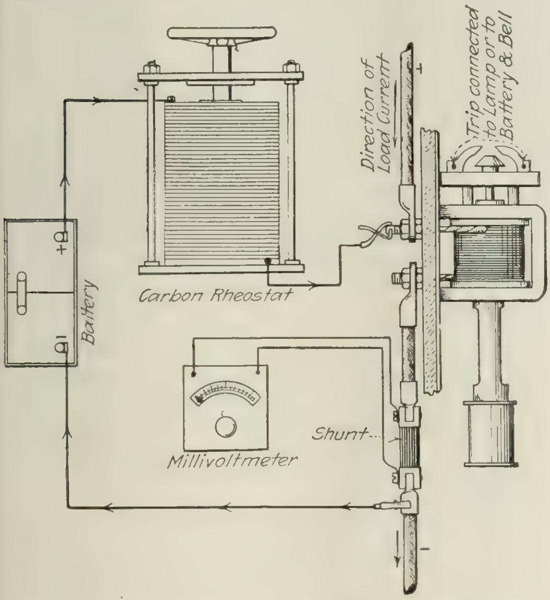

Direction of Load Current
Trip connected to Lamp or to Battery & Bell
+
+
Battery
-
Carbon Rheostat
Shunt
Millivoltmeter
-

FIG. 2. CONNECTIONS FOR HEAVY-CURRENT TESTS

When testing a plunger-type instantaneous trip relay, first give it a thorough mechanical inspection, carefully trying every nut and screw and looking for burnt coils and loose connections; clean the contacts and then make a ground test. If the current capacity is low, say below 25 amperes, it may be preferable to connect a jumper around the relay to completely short-circuit it and then disconnect the relay from the circuit, reconnecting it to the test load. If of a larger capacity, it is generally preferable to build up the load on the circuit itself if this can be done without interfering with the service. Otherwise, connect a storage battery and rheostat as shown in Fig. 2, being sure to include the station shunt in the battery circuit. This enables the main-load current to be used in addition to the test current; or if the load current is already too high for the lower settings, reverse the battery and buck the load current, through the relay, down.

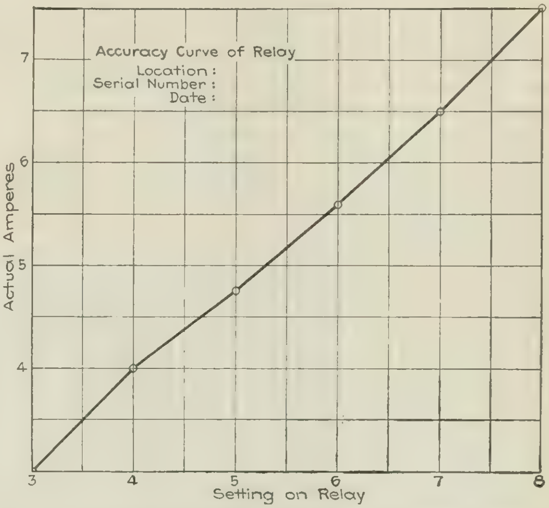


FIG. 3. CURVE SHOWING RELATION BETWEEN RELAY SETTINGS AND ACTUAL CURRENT

For instance, if a relay must trip on 600 amperes and the load current is only 500 amperes, then the battery must supply the extra 100 amperes. It is not necessary to measure these separately, but the station ammeter will read their sum.

After making all connections so the load, or overload, can be quickly applied, the time, required by a time-limit relay may be determined with a stop watch. First carefully set the rheostat to give the current value at which it is desired to take the time; disconnect and let the relay fully reset. Then quickly apply the load and start the watch, both at the same instant, press again to stop the watch when the contacts close. The watch hand indicates in fifths of a second the time required to close at that particular current. If impossible to apply the load quickly, quite close results can sometimes be obtained by building up the load and holding down the plunger by hand, releasing it and snapping the watch at the same instant. By varying the load and the time settings the time of the various combinations can be obtained.

Whenever relays are tested, the results of the test should be permanently recorded in curves or tables. On relays without time-delay elements, the actual amperes may be plotted against the setting as in Fig. 3. To do this, set the relay for the lowest setting, say 4 amperes; then slowly raise the current and note the reading of the ammeter just as the plunger rises. Assume that it takes 4 amperes. Make a dot where the 4-ampere horizontal and vertical lines intersect. Change the setting to 5; then it may take only 4.75 amperes, therefore, make a point where the 4.75 horizontal line intersects the 5 vertical. In the same way locate the currents required for 6, 7 and 8 amperes and draw a curve through them, as in the figure.

Now suppose a relay is set for 4 amperes and gives satisfactory service. Then, for some reason, it is desired to have the relay changed to 8 amperes. Before changing to the No. 8 setting, the operator would look up his curve and see that the relay trips at only 7.5 amperes at this setting. This might be satisfactory, or it may be necessary to readjust the relay to give 100 per cent accuracy at this point. In any case, the curve has saved the operator from depending on the relay to trip at 8 amperes only to have it trip at 7.5 amperes, perhaps throwing out the whole system without cause.

Time-limit relays require more elaborate curves and tables. It is generally best to plot the load on a certain setting against the time. This requires a separate curve for each setting although these are frequently made on the same sheet, as for instance in Fig. 4, which shows the curves for a time-limit relay of the dynamometer type. Curve A is made with 118 per cent of normal voltage on the field coil and the contact arm set to trip on a minimum of 2 millivolts. At 2 millivolts, it takes from 4 to 8 sec. to trip, this being a very indefinite point on the curve. With 5 millivolts applied to the same setting, it takes 1.4 seconds; 15 millivolts applied to this same setting takes only 0.5 second. With the setting changed to 5 millivolts minimum the time values are shown in curve *B*. The results when a 10-millivolt setting is used and the time of different applied millivolts taken, is given in curve *C*. Curve *B′* is made with the voltage lowered to 59 per cent of normal and the contact arm set for 5 millivolts. The table Fig. 5 gives the same results in tabulated form.

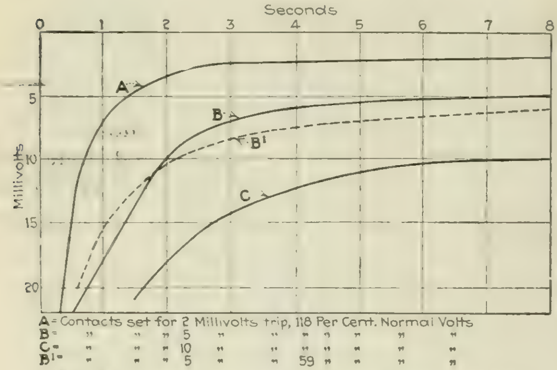
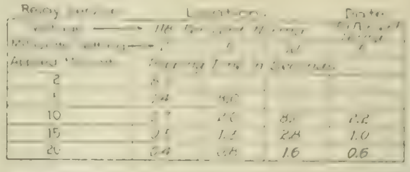


FIG. 4. TYPICAL CURVE OF TIME-LIMIT RELAY. DYNAMOMETER TYPE

Curves are generally to be preferred to tables when in intelligent hands, but there is less liability to error in using tables, and expert opinion is divided as to which is preferable.

In making a very accurate test, in which the trip circuit has been disconnected, time must be allowed for the closing of the relay switch and the opening of the breaker. In general this will be found to be 0.2 or 0.3 of a second, so when setting the relays for actual operation, it must be remembered that the breaker does not actually open until 0.2 or 0.3 second after the contacts close.

In setting time accurately, the type of relay must be considered and its limitations taken into account. This is especially true of the bellows and dashpot types. The bellows, unless carefully oiled every few months, will harden and the time of trippings cannot be depended upon at all. The dashpot relays will give greatly varying time due to a change in the viscosity of the oil if used where they are subjected to extremes in temperature. The oil supplied by the maker should be used to the exclusion of all others.



Relay [illegible]	Location.		Date
Voltage ——→ 118 Per [illegible]			[illegible]
Millivolts setting ——→			
Amperes	Tripping Time in Seconds		
2	[illegible]		
[illegible]	[illegible]	[illegible]	
10	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	1.3	2.8	1.0
20	[illegible]	[illegible]	1.6	0.6

FIG. 5 TABULATED RESULTS FROM FIG 4

When making tests, it must be constantly borne in mind that the circuit is left without protection and caution must be used that an overload does not occur in the interval of testing. Some modern boards have their relays arranged with testing switches which disconnect a relay but connect in a spare for protection during test. Even in this case too much caution cannot be used to insure against material damage, personal injury and avoidable interruptions.

Discrimination in Power Rates Forbidden

It was held by the North Carolina Supreme Court in the case of Salisbury & Spencer Railway Co. vs. Southern Power Co., in which a hydro-electric company induced the petitioner, another electric company chartered to retail current, to abandon its steam plant for generating current and to buy current from the hydro-electric company, that such hydro-electric company became a public utility in the sale of current for distribution by others, and cannot justify an attempted discrimination against petitioner on the ground that both petitioner and itself were chartered to generate current. Also the company in question, having almost a monopoly of water power, cannot discriminate against individuals or users of electric current on the ground that it has a right to select its customers.

In reaching this conclusion, the Court said:

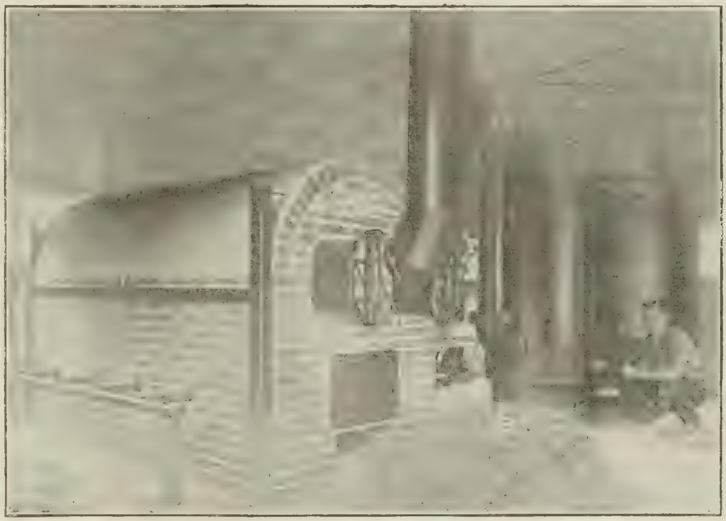
> It is of the highest importance that these claims of the defendant Southern Power Co. to discriminate in the rates charged by it to purchasers under like conditions should be clearly denied by the courts. If the defendant is thus permitted to charge cotton mills in which the owners of the defendant are interested the rate of 1.1, while it charges the plaintiffs and other mills and industries in which it is not interested 1.88, or a higher rate than it does others in like condition, it follows that in a comparatively brief time the defendant will have the power to destroy, and thereby acquire the ownership of, all the other cotton mills and industrial plants in the state, and thus create a cotton-mill monopoly wherever its lines extend; for by reason of the approaching exhaustion of the coal mines and the interruption of their operations, there can soon be left available for large industrial plants no other power than the monopolized water power of the state.

The Production of Gas by the Destructive Distillation of Straw

By HARRY E. ROETHE
Bureau of Chemistry, United States Department of Agriculture

ALTHOUGH numerous experiments have been conducted in Canada and the United States during recent years on the production of gas by the destructive distillation of straw, very little information has been made public regarding the utilization of such material by means of this process.

If dry straw is sufficiently heated in a closed container or retort, gas is given off which may be used in much the same manner and for similar purposes as coal gas. The byproducts consist of tar, ammonia and carbon char or residue. The process has also a possible application to the various industries confronted with the problem of economically disposing of waste fibrous or cellulose material. The destructive or dry distillation of straw is typical of the utilization in this manner of many waste vegetable products. In this connection corn stover, corn cobs, cane trash, various straws and saw- and planing-mill waste (wood), etc., might be mentioned. Realizing the possible application of the process to the farm, the Bureau of Chemistry, United States Department of Agriculture, is studying the problem as related to the farm or rural community.



STRAW-GAS PRODUCER

A gas-producing plant has been set up on the Government farms at Arlington, Va., to be operated as a small unit. Here tests will be made on the production of gas from various straws and other cellulose materials.

The unit as installed by the Bureau is shown in the illustration and consists of:

1. A cylindrical, sheet-steel retort eight feet long and three feet in diameter, incased in brick and resting on its horizontal axis above a firebox. In cross-section the retort is doughnut-shaped, permitting the passage of flue gases around the retort and back through the center.
2. A cylindrical, sheet-steel scrubber seven feet high and two feet in diameter, placed in a vertical position, and partly filled with water. The scrubber is equipped with several screens for supporting trays of coke to give greater scrubbing surface.
3. A steel, water-chamber gasometer of the ordinary type, having a capacity of approximately one hundred cubic feet, for storing the gas produced.

The volumetric capacity of the retort is a little over fifty cubic feet, accommodating a maximum of about two hundred pounds of unbaled straw. A charge of this quantity can be carbonized in thirty to forty-five minutes. The gasometer mentioned is not of sufficient capacity to store at one time all the gas produced from a maximum charge in the retort, lack of space and funds necessitating the installation of a small gasometer. The retort is charged with unbaled straw through the two oval openings at the front end, after which the two cover plates, equipped with gaskets, are tightly clamped in place. Heat is applied to the retort from beneath by the burning of straw or wood in the firebox. Gas begins to come off when a temperature of about 200 deg. C. (392 deg. F.) is reached, with a maximum production between temperatures of 500 and 600 deg. C. The gas generated is conducted through a six-inch pipe connected at the side of one of the front charging doors, to the scrubber, where it is cleaned by passing upward through water and coke; it then enters the gasometer for storage.

After the initial production of gas the carbonizing process can be continued, using as fuel a portion of the gas already generated for supplying the necessary heat. This is accomplished by means of several gas burners made of one-inch pipes, each equipped with a single row of holes and a mixing valve arranged transversely in the firebox. These burners are connected to a pipe line extending to the gasometer.

Based on the results of Canadian experiments, one ton of sun-dried wheat straw produces approximately 10,000 cu.ft. of purified gas, 600 to 650 lb. of carbon residue, which may be readily powdered to a very fine consistency, and about 10 gal. of tarry liquid. The gas has a calorific value of about 400 B.t.u. per cubic foot, burns with a blue flame and has a slight odor. The combustible constituents of the gas are carbon monoxide, methane and hydrogen. A ton of straw is equivalent to 32 gal. gasoline.

The equipment installed on the Government farms, while suitable for demonstrational and experimental purposes, does not represent the latest ideas and improvements which should later be incorporated in a perfected unit. The present unit will be used in conducting tests on the quality and quantity of gas and byproducts obtained by the destructive distillation of various fibrous and cellulose materials common to the farm or generally considered as waste. A study will also be made of the utilization of this gas for heating, lighting and power purposes on the farm. For this purpose miscellaneous equipment has been provided, consisting of several Welsbach-mantle lamps, a gas hotplate, a gas reflector stove, and a 1½ hp. stationary gasoline engine. These devices will be operated on the gas produced from the various materials.

While straw gas is not a new proposition, not a great deal has been done in perfecting equipment or in determining the practicability of the process. If funds are available, these problems as related to the agricultural wastes will be carefully and extensively considered by the Bureau of Chemistry.

An effort will be made to design and construct the most simple, inexpensive and effective equipment possible, with a study of its adaptation to the farm. In this connection reference is made especially to the size and shape of the retort, the different methods for storing the gas produced, and charging of the retort with baled and unbaled straw. Many economic studies will be made, among which might be mentioned the cost of producing gas, time and labor required, quantity of raw material necessary and the utilization of the byproducts in the most effective manner. Determinations must be made as to whether the equipment will be more practical and satisfactory in the various sections of the country as a unit for the individual farm or as a community plant for a number of farms.

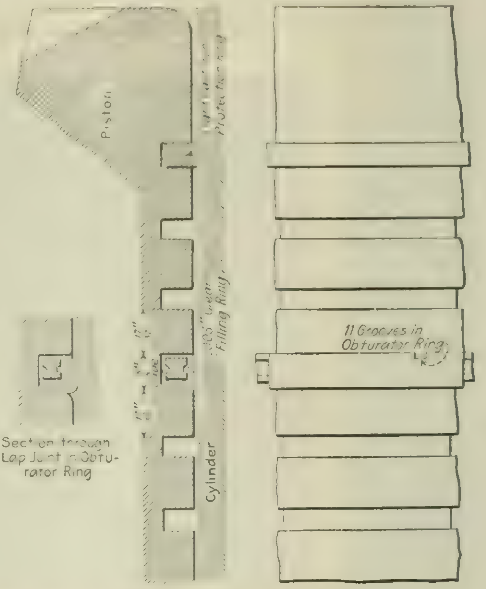
On account of the present shortage and high cost of gasoline the question has been asked, "Can straw gas be used for driving automobiles?" Tests have shown that this gas is very satisfactory for operating stationary internal-combustion engines. In several instances automobiles have been equipped with flexible bags containing about 300 cu.ft. of straw gas, a quantity sufficient to run the car fifteen miles. This arrangement was much the same as that used in England during the war for operating motor busses with coal gas. Straw gas for automotive power at least has possibilities. However, it will never be practical for this purpose under present conditions until the gas has been compressed or condensed, permitting the carrying of sufficient quantities on the automotive vehicle in a satisfactory and practical manner.

Aluminum Pistons for Diesel Engines

In an article read before the Institution of Naval Architects and reported in *Engineering*, C. J. Hawkes, R.N., discussed the use of aluminum pistons on an experimental Diesel engine. The piston design finally decided upon had the trunk divided at the gudgeon-pin center, the bearings for the pin being carried between the two halves. Lubrication was secured by force feed through the connecting rod from the crankpin. The gudgeon pin was fast in the rod while the pin ends rested in the bearings mentioned. Six rings and one "obturator" were used; the type of ring and location appear in the sketch. The weights of the aluminum-alloy piston and I-section rods are appreciably less than the weights of these parts on the usual Diesel, with the result that the inertia forces at 500 r.p.m. are the same as in the latter at 380 r.p.m.

The coefficient of linear expansion and the thermal conductivity are greater for aluminum than for cast iron; consequently it was found necessary to make the clearance about one and one-half the usual clearance to avoid seizing. Aluminum is of advantage if seizing does occur, since it never damages the liner, while a cast-iron piston, on seizing, always scores the liner. Furthermore, on cooling, a seized aluminum piston always frees itself.

There is no doubt, so far as present experience is concerned, that aluminum-alloy pistons, although greater in first cost, have many advantages over the standard cast-iron piston. In high-speed engines such as submarine units the decrease of weight and the allowable higher speeds are of practical benefit.


Piston
.005" Wear Filling Ring
11 Grooves in Obturator Ring
Section through Lap Joint in Obturator Ring
Cylinder

PISTON WITH OBTURATOR

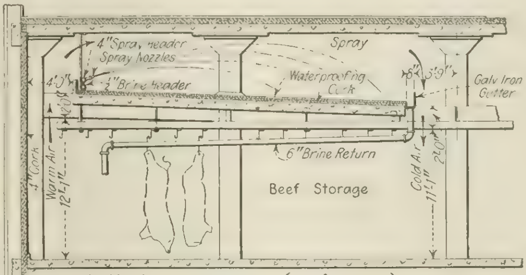
The arrangement of the L-sectioned obturator ring is shown in the sketch. This ring is of phosphor bronze, being 0.05 in. thick. A lap joint, riveted and silver-soldered to one end of the ring, insures gas-tightness. It was found that the ring bore against the cylinder only in spots and a number of slots $\frac{1}{32}$ in. wide were cut in the edge of the ring. This allowed the ring to press outward against the wall, insuring gas-tightness. Originally, some of the piston rings were left off, but to prevent the knocking or side slap of the piston the rings below the obturator were replaced. If the clearance had been less, no doubt the knocking would not have occurred even though the lower rings were absent.

After running for 150 hours the obturator ring was measured and showed a wear of 0.001 in. So far the ring has been tested under favorable conditions, and it is impossible to predict what results were to be secured in ordinary service over long periods of operation.

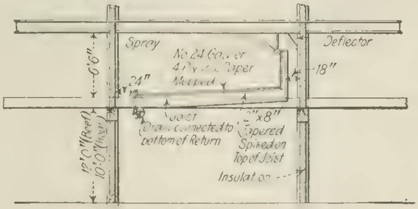
Refrigeration Study Course—XVIII. Cold-Storage and Packing-House Refrigeration

By H. J. MACINTIRE
Professor of Refrigeration, University of Illinois, Urbana, Ill.

IN THE previous article the matter of the applications of refrigeration was taken up, and it was shown that the high-pressure side was the same in nearly every case, except when stage compression was found desirable or the absorption machine was used. In other words, the application of refrigeration affects the low-pressure side, and it is here that the details become so varied and numerous. Ice making was described in some detail, and the fact that raw-water can ice making is becoming the favorite method generally was mentioned and reasons were given for its preference. Because of its bulk ice must not be handled much and is best produced in close proximity to the zone where it is to be consumed; for this reason artificial ice is rapidly replacing natural ice even where the latter is plentiful. Next to the importance of ice making comes the business of cold storage, which includes chilling, sharp freezers, and coolers for the preservation and curing of meats, fish, vegetables and fruits. Before going into the subject of cold storage, it will be wise to give the reason for its use. Meats are chilled quickly because otherwise the natural process of decay will set in. Vegetables, fruits, dairy products, etc., are kept at or about the point of freezing of water because it has been found that the bacilli which cause decay are prevented from growing actively when held at this temperature. Cold storage cannot preserve goods indefinitely (except certain meats when kept at extremely low temperatures) because the bacteria keep growing and increasing in numbers even at cold-storage temperatures. A large number of different goods cannot be frozen—fruits and vegetables for instance—without spoiling the cell formation and the internal structure of the goods, and therefore such goods cannot be kept in cold storage for more than a few months. Besides the matter of the temperature, there is the factor of the humidity of the air, which affects not only the holding power of the food stuffs but the quality as well. This is more marked in some cases than in others, but with eggs too great a humidity will spoil them and too low a humidity will cause them to shrink. In the packing-house chill room, dense clouds of steam come off the freshly killed animals, and the manner of refrigeration must also provide a convenient means of removing this vapor. Vegetables, fruits, etc., dry out during the holding process, which increases the humidity. As a moist air is bad for cold-storage goods, the refrigerating plant must provide the necessary means of removing this surplus water vapor and keep the temperature and the humidity correct for the particular goods being stored, this being different for each variety of foodstuffs. The humidity, as a rough rule, must be in the neighborhood of 70 per cent. The accumulation of frost on the expansion piping is an indication of the removal of moisture from the air in the room. There is no set rule in regard to the use of direct expansion or brine cold-storage piping. The same plant may have both systems, as, for example, the Bell Street and the Spokane Street plants of the Port of Seattle, Wash. Packing plants use brine for the greater part of their work, although one large company at least has little or no brine refrigeration. This is because some of the load is heavy and is of short duration and can be handled well by the use of brine storage tanks and a smaller compressor running a greater part of the time. Also it is safer to use brine where the pipes are exposed and are subject to accident. In addition the chill rooms are usually designed to have a loft with brine sprays, or a brine curtain, as brine can pull down the temperature more quickly and absorb the moisture better than any other system. (See Fig. 1.)



Packing House Refrigeration (GUNN'S LIMITED)
FIG. 1



Packing House Refrigeration (MORRIS & CO.)
FIG. 2

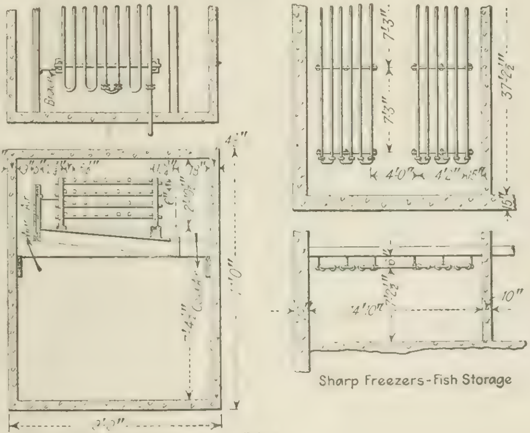
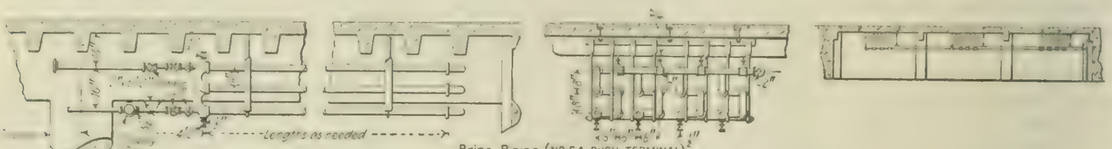

Small Refrigeration Boxes
Sharp Freezers-Fish Storage

FIG. 3

FIGS. 1 TO 3. COLD-STORAGE PIPING

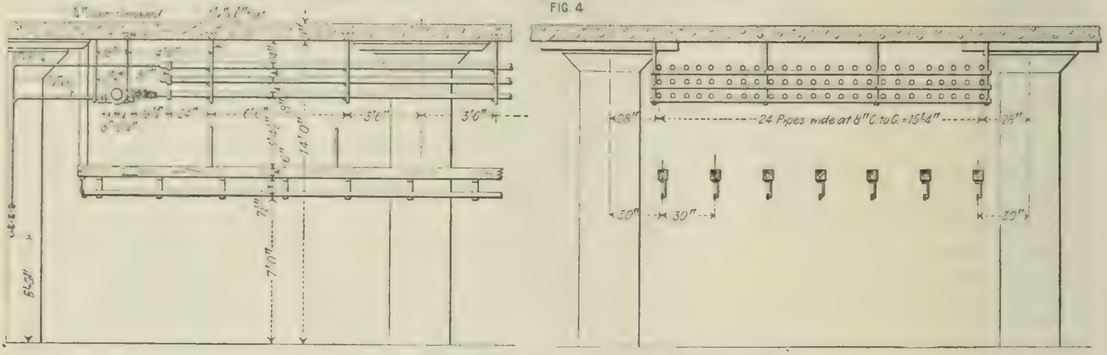
On the other hand, it is possible to operate compressors on the direct-expansion system more economically than with the brine system, because the boiling ammonia cools the air directly instead of indirectly by the use of brine. But it must be remembered that the direct-expansion system must be carefully laid out so as to return the gaseous ammonia with the least possible pressure drop to the compressor.

In a recent issue of *Power* were described the changes that have been made in the Anheuser-Busch plant, showing the necessity of unity in the piping design. The trouble in this plant was that it grew like "Topsey" and soon was a mass of large and small pipes of every description. Other factors that must be considered in deciding on the type of piping are the effect of the goods held in storage by a break in the pipe line, the cost of the ammonia piping as compared with brine piping, cost of the initial charge of ammonia, and its losses due to leaks or corrosion of the pipe line. The brine system is self-contained, having, with the exception of the ammonia condensers, the entire high side in the engine room under the easy control of the operator. It is to be remembered, however, that extra equipment is necessary with the use of brine, namely, the brine coolers, the brine pumps and the power necessary to circulate the brine. It may be added here again that the absorption system almost always uses brine, as direct expansion is not so advantageous as in the case of the compression system.



Brine Piping (No 54 Bush Terminal)

FIG. 4



Sharp Freezer Piping (U.S. GOV'T COLD STORAGE – CHICAGO, ILL.)

FIG 5

FIGS. 4 AND 5. BRINE PIPING

Bunker Coils Are Used

To better circulate the air, giving more ready control to both temperature and humidity, the outside bunker coil is used. In brief, this is an arrangement of coils in a separate loft or room, so arranged that the air may be forced through at a moderate velocity (where it is cooled to the proper temperature) and then through ducts to the distributing openings. The return is usually the reverse of the feed lines.

Such a system is recommended because it removes all piping from the cold-storage room. With care in the design a uniform temperature is possible and there is less danger of excessive cooling in certain parts of the storage room. Power must be provided to drive the fan which should be carefully selected so as to require the least power input for the volume of air circulated. But, whereas, less piping may be required than with the ordinary system on account of better heat transmission, there are some objectionable features. The motive power necessary for the fan also heats the air and requires additional refrigeration to neutralize it. The main objection to bunker coils, however, is in the matter of their cleaning. Usually, the coils are close together and, combined with the baffles, make a difficult piece of equipment to clean. As the ice accumulates on the pipes, the heat-transfer rate will drop until either the pipes are clean or service is unsatisfactory. This point is mentioned here because in the case of ice-cream hardening rooms the bunker coil is being replaced. The lack of success with hardening rooms is purely a matter of operation, but this service is the "court" of last resort when it comes to the proper design of a new refrigeration plant.

TABLE I. COLD STORAGE PRACTICE

Temperature of Storage, Deg. F.	Humidity, per Cent	Allowances
		1 bbl = 31½ gal of 231 cu in each 1 bushel = 1.245 cu ft = 2,150.4 cu in
35	80 to 90	1 bbl potatoes = 5 cu ft = 180 lb = 2½ bushels
32		1 box cheese = 60 lb = 2 cu ft
30 to 31	75	1 case eggs = 30 doz = 50 - 70 lb = 2¼ cu ft = 12 x 13 x 25
2		1 tub butter = 63 lb = 1½ or 2 cu ft (piles not over 6 ft.)
30 to 35	85	1 bbl apples = 150 lb, 5 cu ft = 2½ bushels
34	....	1 crate celery = 10 cu ft = 140 lb = 24x24x30 in (4 ft high)
34	80 to 90	1 bbl vegetables = 5 cu ft, piles 5 ft high
35	......	1 box oranges (packed on end) = 4 cu ft, 70 lb. = boxes 15 x 15 x 30.

Aisles—Allow ⅙ for eggs, celery and oranges
Allow ⅛ for potatoes and vegetables
Allow ¼ for mutton, pork, poultry (6 ft high)
Specific gravity of boned beef = 1.073 = 67.2 lb per cu ft.

The Sharp Freezer Room

The sharp freezer is the term used for a cold-storage room which is held at or near zero degrees F. It may have better insulation than the ordinary cold-storage room, usually about six inches of corkboard, and it generally has an ante-room. The piping has to be heavy to carry the heat leakage, which may be as great as double that of the general storage room for fruits and vegetables which are held at from 36 to 40 deg. F. Sharp freezers are designed usually for fish, frozen meats, eggs in bulk, etc. The temperatures carried are usually between 0 and —15 deg. F.

It is hardly within the scope of a study course to go much into detail except in fundamentals. The storing of goods, the duration of storage, the height of the boxes or packages, the amount of aisle, etc., are important details, but not necessarily of the kind that the operating engineer need keep in mind. A few figures are included, however, for handy reference. Particular attention is called to the piping layouts, which are all recent designs and typical of the kind of service being performed.

Do not put second-grade goods in storage. Cold-storage goods should be of the best quality. Fruits and vegetables should be carefully handled to keep them from unnecessary injury, and they must be re-sorted, after a period of time depending on the kind of goods, to remove the sprouts, spoiled parts or soiled containers.

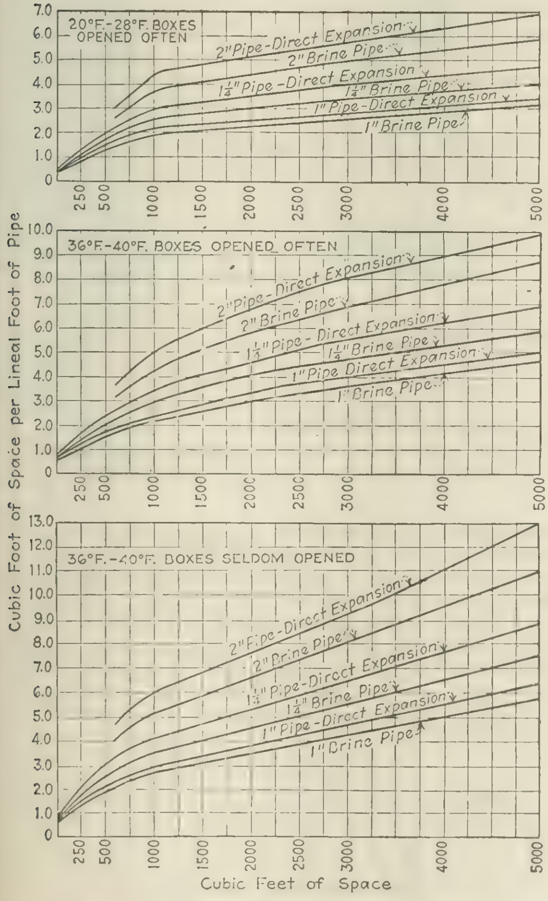


FIG. 6. VOLUME OF STORAGE PER LINEAR FOOT OF PIPE

Several curves showing the ratios of room space to piping and room space per ton of refrigeration are given. These curves show the cubic feet of refrigerator space allowed per linear foot of pipe. In each table the reader will note that this ratio is low for small storage rooms, increasing as the size of the room increases. For rooms that are opened frequently, the ratio is low. Considerable thought should be given to the entrances of rooms that are opened frequently to avoid excessive losses through the doors. A large saving of refrigerator can be made by the installation of proper door fittings and in all arrangements whereby the duration of opening is reduced to a minimum. There is much carelessness in this matter in the practice of many plants.

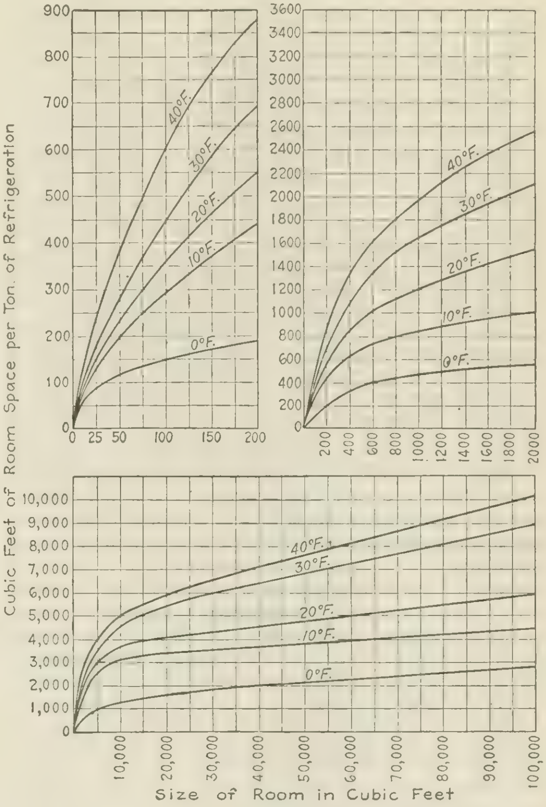


FIG. 7. CUBIC FEET OF ROOM SPACE PER TON OF REFRIGERATION

If the crank bearing of a Diesel engine is run slack, the inertia of the piston and rod as the crank passes top center may exert such a stress on the big end bolts as to elongate them. This condition will ultimately result in fracture of the bolts. In securing crankpin clearance, remove all shims, draw up the two bearing halves snugly against the pin; then measure with a clearance gage the distance between the two halves. This amount plus 0.006 in. is the thickness of shims required. In inserting shims between the two halves of the crankpin bearing, place equal amounts on each side. If this is not done, the bolt will be bent when drawing up. At each overhauling of the engine the big end bolts should be examined for flaws. Usually, any fracture starts at the root of a thread. A magnifying glass comes in very handy.

Behavior of Semi-Diesel Engines

Explanation of the Causes of Preignition — Practically All Such Occurrences Are Due to Mechanical Defects and Can Be Avoided

THE several letters that have appeared in *Power* of late, concerning pounding in semi-Diesel engines, fail to explain the real trouble. Without doubt a semi-Diesel engine will pound on heavy load as the writers state, but the reason for it goes deeper than any of them have revealed.

The term semi-Diesel is used to cover all engines wherein pure air is compressed in the cylinder and the oil is injected at a definite point in the compression stroke and where the compression pressure due to the decrease in cylinder volume is not high enough to cause ignition without the air of some hot surface. In engines of this type air is blown into the cylinder from the inclosed crankcase or from the compressor side of the piston, at the end of the power stroke. This scavenging air clears the cylinder of the burnt gases and supplies a charge of pure air. This air is compressed on the return stroke of the piston. As the piston advances, the density of the air charge becomes greater, the pressure increases, and the temperature is correspondingly raised. At the proper point the oil is injected into the combustion space and is gasified. When the temperature becomes sufficiently high, the gas vapor ignites.

Some of these engines have a combustion chamber in the shape of a bulb or spherical cavity in the cylinder head. Some employ the cylinder cavity as the combustion space. In all the designs some part of the cylinder head is uncooled or so poorly cooled as to remain at high temperature; this high temperature condition is necessary to gasify and ignite the oil properly. It follows that the higher the value at which the temperature can be maintained the quicker and more perfectly will the fuel be vaporized, provided the temperature is not so high as to cause oil "cracking."

TIME OF OIL INJECTION

From a consideration of these conditions it can be concluded that the higher the combustion-cavity temperature the later may be the point of fuel injection. None of the modern engines, however, is timed to inject oil earlier than 30 deg. ahead of dead center. This represents a piston position about 10 per cent from dead center. Fig. 1 shows the relative position of the piston and crank at the beginning of fuel injection. The air within the combustion space is highly concentrated, and the oil entering this dense, highly heated mass of air is rapidly vaporized and ignited.

It is quite possible that preignition, or ignition of the newly injected fuel charge, could occur if the cylinder-wall temperature was excessively high or the injection very early. There is no doubt that at high temperatures the oil undergoes a chemical disintegration, or cracking, upon striking a hot surface with the evolution of light hydrocarbons and the deposition of the heavy, sooty residual. This light gas undoubtedly will ignite more quickly than will the oil gas if the dissociation does not take place. But this type of preignition is always preceded by what may be termed detonation. The pounding called preignition, however, usually occurs after dead center is passed and the noise is due to the excessively rapid rate of burning. Apparently, as the oil leaves the ignition nozzle it is broken up into gas. The ignition of the fuel occurs at the point of highest temperature, which of course is in the neighborhood of the hot, uncooled surface of the combustion chamber. The explosion gives forth a decidedly metallic sound that can be distinguished from true preignition, although many engineers unknowingly clasify it as preignition. The wave of high pressure and temperature produced by the detonation travels across the combustion space, causing the gas vapors and air to be highly compressed and raised in temperature until the entire fuel charge explodes instantaneously. The resulting pressure produces a severe racking pound if the explosion has occurred before dead center. Even if this instantaneous explosion takes place at or after dead center, a characteristic thump is emitted. Such ignitions can take place only with excessively high combustion-chamber wall temperatures. It is obvious that the introduction of a water jet will keep the temperature below this point.

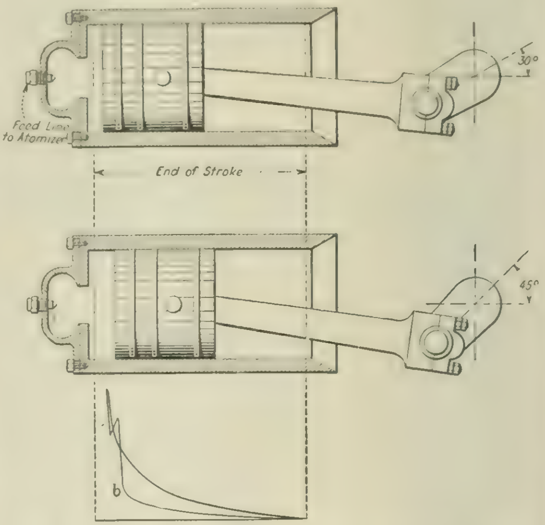


FIG. 1. CRANK POSITION AT THE INJECTION POINT
FIG. 2. CRANK POSITION AT PREIGNITION

TRUE PREIGNITION

If an engine has a decidedly early fuel injection timing, the vaporized charge will explode early in the compression stroke provided the cylinder temperature reaches the self-ignition point at this time. If this takes place before dead center, the resulting explosion is a true characteristic preignition. It should be understood that the injection must be very early to allow the entire program of detonation and preignition to occur before dead center. Even with gasoline the usual timing is not sufficient to produce preignition, even though the initial ignition be made positive by spark plugs. Detonations will occur, but the cycle interval is insufficient to allow the complete procedure to take place before dead center. In semi-Diesel oil engines detonation is frequently noticed, especially on heavy loads where the cylinder temperature is high. But true preignition seldom occurs if the engine is in good mechanical condition.

In all designs of two-stroke-cycle semi-Diesel engines the injection of fuel starts, as has been stated, at or later than 30 deg. from dead center. If a full load condition is assumed, 25 deg. is probably the average injection point. The delivery of the fuel into the combustion chamber is complete in a few degrees of the crank circle ranging from 6 deg. in one engine to as much as 20 deg. in one or two other designs. If this fuel is injected and properly sprayed into the combustion space, all of it will be entirely vaporized or gasified at the end of the compression stroke.

If there exists within the combustion space sufficient oxygen to combine with all this gas vapor, the latter will be entirely consumed. On the other hand, if the amount of air is insufficient for perfect combustion some of the vapor will remain in its original state and will mix with the burnt gases and be blown out the exhaust when the exhaust ports are uncovered. This statement presumes a fair degree of scavenging effect. If, for any reason, all the burnt gases and oil vapors are not blown out of the cylinder, they will be trapped in the cylinder when the piston covers the exhaust ports. These vapors, mixing with the air charge, will attain their ignition point much before dead center; preignition, so-called, will then take place. This is because the temperature required for self-ignition of a fuel depends upon the time interval.

CAUSE OF HOLDOVER IGNITION

It requires no argument to prove the statement that the degree of scavenging efficiency largely determines the question of this preignition, or, rather, "holdover" ignition. If the air currents succeed in removing all gases, burnt or unburnt, nothing remains in the cylinder to ignite. The design of the air ports and deflectors on the piston and the maintenance of these ports in a clean and unobstructed condition are of prime importance.

There exists a far more prevalent cause of these pre- or holdover ignitions. This is the action of the fuel nozzle or atomizer. All engineers will understand that the atomizer must spray the oil efficiently if complete combustion is to be secured. If the particles of oil entering the cylinder are fairly large in diameter, the time necessary to completely gasify the liquid is more than that occupied by the normal period of combustion. Some of this oil, the interior of the oil particles, is not completely gasified until the power stroke is completed. Part of the gas is trapped in the cylinder and explodes early in the compression stroke. The fuel atomizer must break up the oil charge into a fine fog. The design of the pump largely governs the spraying effect of the nozzle. If the velocity of the oil discharge varies with the load change, then the atomizing effect at the point of low velocity will be poor. Undoubtedly, a pump in which the velocity of discharge is constant at all loads gives the best atomizing efficiency.

The design of the atomizer can well be claimed to exert the chief effect in causing or preventing these so-called preignitions. If the check valve does not cut off the fuel inflow sharply at the end of the delivery, drops of oil will continue to enter the combustion chamber during the power stroke. This oil will vaporize and part of it will be trapped in the cylinder. Consequently the fuel nozzle check must work perfectly to avoid this condition. The nozzle must actually break up the oil and not merely allow it to jet into the engine.

FOUR-CYCLE SEMI-DIESEL SELDOM PREIGNITES

It is seldom that a four-stroke-cycle semi-Diesel engine preignites no matter what condition the atomizer is in. This is due principally to the better scavenging effect secured. On the exhaust stroke of the piston all the gases, burnt and unburnt, are expelled; there remains nothing to ignite since only pure air is contained in the cylinder on the compression stroke.

It is a matter of observation that, if no water injection is used, an engine having a separate combustion chamber in the cylinder head will not preignite on loads below three-quarters, while an engine where the fuel is deposited in the cylinder cavity will preignite at all but very low loads if the atomizer leaks or the scavenging is poor. The explanation is found in the segregation of the oil vapor in the combustion chamber. At the end of the power stroke the scavenging air removes the burnt gases from the cylinder, but the narrowness of the passage into the combustion chamber prevents its scavenging. The chamber is then left filled with burnt gases. If any oil leaks into it, the oil vapor is mixed with burnt gases and will not explode until the advancing piston forces pure air into the cavity. This will not occur very early in the compression stroke. If the load is heavy and some of the oil vapor fails to burn at the proper time, this vapor, increased by the dribble, fills the combustion space and flows into the cylinder and, mixing with the air, fires early.

That the pounding heard in the cylinder is not due to preignition of the fresh fuel charge, but results from the ignition of a hangover charge, is proved by the actual indicator diagram in Fig. 2. Here the almost vertical pressure line in the compression curve is produced by a preignition which took place at *b*, much in advance of the point of injection of the fuel charge. This is evidence that the fuel that exploded was left over from a prior charge or dribbled into the cylinder during the early part of the compression stroke.

WATER INJECTION

To maintain the cylinder at a temperature below the ignition point during all but the final part of the compression stroke, most engine builders resort to water injection into the cylinder. The water absorbs enough of the heat in the cylinder to prevent a high temperature until the end of the compression stroke is reached. The water serves to decrease the rate of combustion, thereby avoiding detonations. With such precaution preignition or "holdover" ignition is positively avoided. Engines of the "dry" type always have the combustion chamber in the cylinder head, and attempt is made to prevent preignition by isolation or stratification of the gas vapor. The water cooling of the combustion chamber, if it can be regulated, will assist toward keeping the temperature down. These preventives are not altogether successful. It is the universal experience that many dry engines tend to develop the so-called preignition on full load. When nothing but detonation or a metallic sounding explosion is heard, no loss of power is observed and the engine operates quite satisfactorily, although the exhaust may be smoky. If preignition does occur, increased water injection will eliminate it on a wet engine; on a dry engine a reduction of the load is necessary. If an engine has customarily carried the load without pounding, it is natural to expect that the fuel nozzle has begun to leak if a pound develops. A second source of pounding is poor scavenging. This is occasioned by the air port or exhaust ports clogging with dirt so that the scavenging process is indifferently performed.

Above all else, the engineer should realize that what is known as preignition in a gasoline engine cannot occur in a semi-Diesel engine—the preignition heard is a holdover ignition. When this occurs generally it is due to lack of cooling on heavy loads, leaky or imperfectly designed atomizer nozzle or to clogged air or exhaust ports. If the engine is cold, it sometimes happens that the fuel charge is not completely burned and explodes early on the next stroke. This is always accompanied by racing of the engine, missed explosions and smoky exhaust.

The McKenzie Forced-Draft Chain-Grate Stoker

With fuel prices high and equipment costing double former values, there has been a growing demand in the boiler room for higher rates of combustion, the primary idea being to increase the returns on the initial investment. The activity in the chain-grate field has been marked. Numerous forced-draft stokers of this type have been developed and, while still in the experimental stage, seem to show some improvement; that is, burn more coal per square foot of grate than was possible with natural draft.

One of the most recent developments in this field is the combination forced- and natural-draft chain-grate stoker of the McKenzie Furnace Co., of Chicago. As will be apparent from the illustrations, light loads may be carried on natural draft and forced draft applied for demands above rating. The system provided to distribute air under pressure over the entire grate area or to any section desired, is unusually simple and, in the initial installation of the new stoker, is reported to have given excellent results. Briefly, it consists of a main air duct entering at the front of the furnace and extending back in the side wall for the full length of the stoker. The duct, however, is not built into the wall, so that it may be pulled out of the furnace along with the stoker. From this duct transverse air chambers, tapering in section, with perforations in an arched top to discharge the air, lead across the grate area. These air chambers alternate with the rollers supporting the upper run of links, with enough space between to admit air from underneath the stoker for natural-draft operation. The number of air chambers will depend upon the length of the stoker, but in the usual installation will range from 8 to 12.

Division of the air supply is thus greater than usual, and the distribution is effected by sliding dampers placed over the ends of the air chambers and operated by pull rods from the front of the stoker. With this arrangement no necessity has been found for closing up the stoker front. In operation there has been no evidence of the gases passing out at the gate nor of the air from the chambers bypassing down below the stoker. At the sides of the stoker frames there are seal plates, as indicated in the detail view.

When using forced draft, the air is admitted into the main side duct at a pressure of 2 oz., but when all the dampers that regulate the supply of air to the small transverse chambers are open wide, this pressure reduces to 1½ oz. As the top of the air chamber is convex, the air is discharged through the various holes in the top at different angles, giving an even distribution of air over the grate area in the immediate vicinity. As previously stated, there is sufficient space between the air chambers and the rollers to allow air to pass up

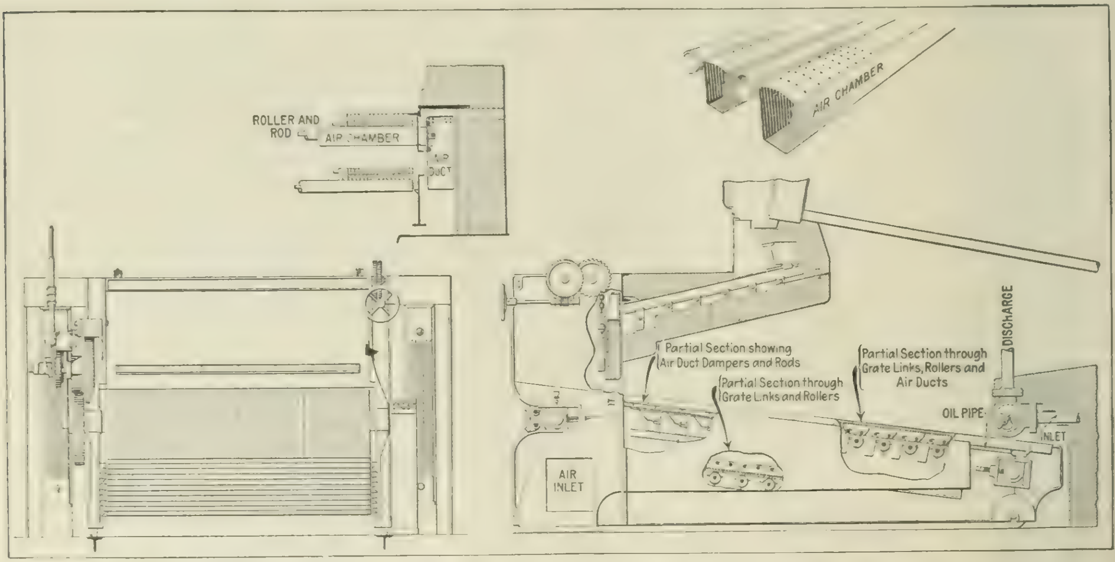

ROLLER AND ROD
AIR CHAMBER
AIR DUCT
AIR CHAMBER
Partial Section showing Air Duct Dampers and Rods
Partial Section through Grate Links and Rollers
Partial Section through Grate Links, Rollers and Air Ducts
DISCHARGE
OIL PIPE
INLET
AIR INLET

FIG. 1. DETAIL VIEWS SHOWING THE DESIGN OF THE NEW McKENZIE FORCED DRAFT STOKER

from below when the stoker is operating on natural draft. In addition the dampers of the forced-draft system are opened wide and a door in the main air duct at the front of the stoker is removed to give a sufficient supply of air for ordinary loads.

To give the expanding volume for the gases, particularly needed during high rates of combustion, the stoker pitches toward the rear and the arch slopes upward, as indicated in the longitudinal view of the stoker. The arch is of the flat suspended type, designed so that each individual tile can be removed without disturbing any of the others. To make this possible, each tile is suspended individually and the necessary clearances are allowed for expansion. The supporting members are provided with extensions so that the rear of the arch may be replaced without disturbing the main body of the framework.

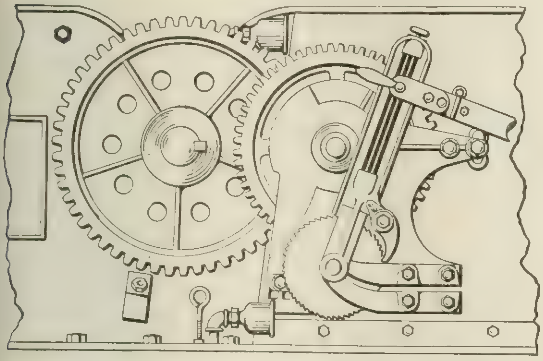


FIG. 2. SPUR-GEAR DRIVE OF STOKER

From the same longitudinal view the design of the feed gate will be evident. It is highly geared to a handwheel operated at the stoker front. The drive is of the substantial spur-gear type shown in Fig. 2. The speed of the chain is regulated through the ratchet lever, and a tension spring is provided in the connecting rod between the lever arm and the eccentric to protect the stoker against any sudden blocking of grate travel. The grate tension can be adjusted from front or rear. For burning all Middle Western coals standard links of the design shown in the drawing are used, and special links with suitable air spaces for stokers that are to burn high-carbon bituminous coal, anthracite, lignite or coke breeze.

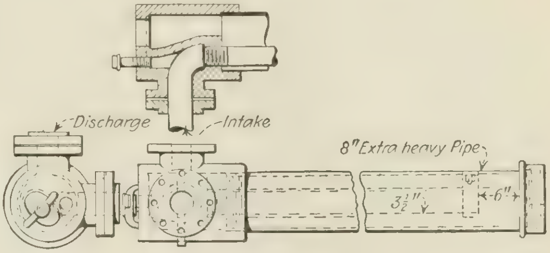


FIG. 3. WATER-BACK DESIGNED FOR CONVENIENT CLEANING

A feature varying from the usual is the water-back shown in Fig. 3. The external member is an 8-in. extra-heavy pipe which supports the overhang of the bridge wall. The inlet and discharge are at the same end. The water enters through a 3½-in. tube extending within the larger pipe almost to the far end. The return is through the large external pipe. When it is necessary to clean out the water-back, a hose is attached to the 1-in. nipple leading into the 3½-in. pipe, the hand-hole plate at the end of the fitting is removed, and the sediment or sludge that has collected is washed out.

Utilizing Freshet Water for Power Generation

BY CLEMENS HERSCHEL[*]

With a properly designed venturi tube installed in the discharge of a hydraulic turbine, power output can be increased a maximum of 30 per cent by utilizing the freshet water that would otherwise run to waste over the dam.

IN A recent editorial on the "Need of a Hydraulic Laboratory," *Power* mentioned the loss of head due to back water and told how "to get, by the use of a greater quantity of water under a lesser head, as much power as with the lesser amount under the greater head for which the turbines were designed, and this with the same machines." Several such methods have been devised, and one of them, the "Fall Increaser," invented and tested at the Holyoke Public Testing Flume by the writer (also tested by Duebi in Zurich, Switzerland), will be described in this article, and includes the experience of the past ten years endeavoring to introduce this device.

Of course more wheel capacity would solve the problem, some of the wheels to stand idle during normal and low flows of the river. However, more wheels would mean more generators, more wheelpits, tailraces and a larger power house. The chief purpose of greater wheel capacity—that is, more units—is to guard against machinery accidents and to facilitate repairs, and not to utilize freshet water.

Saugey, of Geneva, Switzerland, proposed discharging the water from the forebay out through the turbine discharge water into the tailrace in times of freshets, thus increasing the velocity of the discharge from the turbines. Experiment with this crude apparatus showed it to have an efficiency of 3 per cent; that is, 3 per cent of the power due to the additional amount of water discharged into the tailrace under the existing head was by this means added to the power developed by the wheels without the device.

If the same quantity of water just referred to, instead of being merely allowed to impinge as a stream upon, and mingle with, the tailrace discharge, be allowed to flow through a properly constructed venturi tube, as in the figure and thus create suction at the throat of the tube, with the turbine discharging out of an airtight chamber into which the turbine discharges, this same 3 per cent efficiency can be increased to over 30 per cent and can, by improvements that have naturally suggested themselves, be considerably bettered.

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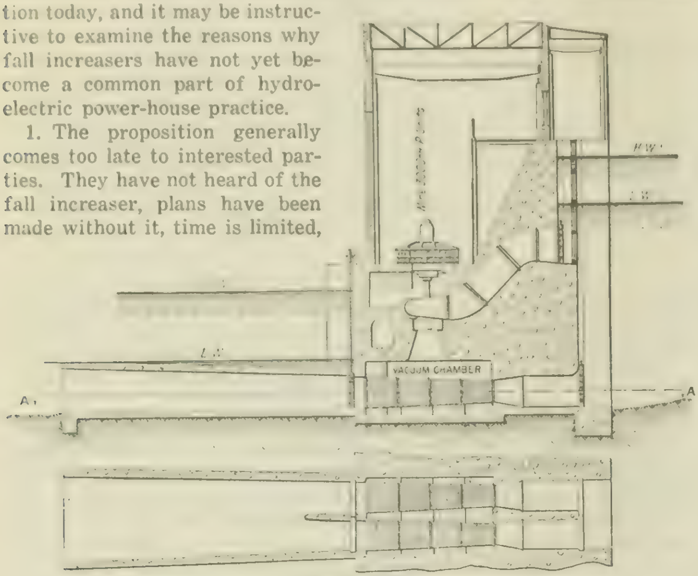
[*] Consulting civil and hydraulic engineer, New York City.

Five power plants have been built in the United States since Herschel's Fall Increaser was described in the public prints, which obtain only about 3 per cent of the energy from the excess water; when only at an insignificant additional expense the same water would have given them over 30 per cent. Such is the situation today, and it may be instructive to examine the reasons why fall increasers have not yet become a common part of hydro-electric power-house practice.

1. The proposition generally comes too late to interested parties. They have not heard of the fall increaser, plans have been made without it, time is limited, or the commencement of the work is desired, and it is easy to go ahead without it. Allied to this is the disinclination of engineers to change plans that have once been settled upon.



SECTION THROUGH POWER PLANT, SHOWING LOCATION OF FALL INCREASER

2. Fall increasers cannot, practically, in the vast majority of cases, be added after the plant is built.

3. The power house must be at or near the dam, and the tailrace cannot be a long one.

4. About half the river sites met with have not sufficient back-water in times of flood or a sufficient number of days of flood in a year to justify a fall-increaser outfit. Each case must be studied individually.

Without additional operating costs, by use of the turbines and generators already installed, merely utilizing the water that otherwise would waste over the dam, an increase of annual output is accomplished with this device, at a first cost which is returned to the parties by from one to two years of normal operation; and this increase of income thereafter goes on without charge as long as the plant exists. The statement "no additional operating costs" may even be improved upon. Fall increasers allow the rakings of the trash racks to be pushed down into the increaser intake and run through, instead of being compelled to lift them up and bring them ashore, thus saving largely in one item of operating expenditure.

Auxiliary steam power is needed as a rule during times of low water, in order to produce a maximum return on the investment, the outflow of the Great Lakes alone excepted. When fall increasers are already installed, for the purpose just stated, they are more economical to keep up the normal output in times of flood water than to burn fuel in the steam-power plant for this purpose during times of high water. The value of half the fuel thus saved for fifteen years, computations made and agreed upon to begin with, is what the use of the fall increaser has been offered for.

The sectional view in the figure, from a design for actual use, will show the general construction of the fall increaser sufficiently clearly, with what has already been said, without detailed explanation. As first designed, a separate outlet for the turbine's discharge was provided to be used in times of low water. It is, however, believed that this made the design needlessly complicated. The holes in the venturi throat, that suck in the turbine discharge, have so great a sectional area the velocity through them is less than four feet per second; that is, less than three inches of head is lost through these holes when the full turbine discharge is passed through them during times of low and normal water; and it is believed that this is a small price to pay for the other advantages presented.

Electrical Power Production in Soviet Russia

The generation and distribution of electric power in Russia is under control of the Soviet department for electricity. This department manages 10 nationalized power plants, 45 nationalized factories for electrical machinery, telephones and telegraphs, and 19 works not yet nationalized. The aims of the Soviet government are to build new power plants and to supply electric current to farmers, sawmills, mines and to all larger foodstuff producers.

A statement issued by the Soviet government regarding the future of the electrical industry in Russia is full of optimism and goes so far as to say that all the resources of the country will be utilized by electric power, bringing the country to a state of prosperity unparalleled in its history. The figures showing the power production of the Moscow and Petrograd plants from January to April, 1920, show, however, that practical conditions are very far behind these aims of the Soviet government. In Moscow only three of the existing five power plants were running in January; the other two have been put to work later on with insignificant results. Only 8,000,000 kw.-hr. is produced in Moscow per month. In Petrograd the power production is still less and was in March at its highest point, with 6,800,000 kw.-hr. In these two cities nine of the ten nationalized power plants are situated. The electric works in the provinces, such as exist, are still in private hands, but are mostly shut down for want of fuel.

The Baumé gravity has no direct bearing on the adaptability of a fuel oil. It happens, however, that most oils have a gravity fairly in proportion to their adaptability as a fuel oil. With Mexican untopped oil of 16 deg. Bé., enough gasoline is present to produce the primary ignition.

Operation and Adjustment of Turbine Machinery
XII—Oil Pumps

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

OIL PUMPS geared to the furnace are of one general type wherein a stream of oil is forced by two gears that mesh. The oil pressure is regulated by a relief valve that discharges the surplus oil into the reservoir. In some turbines the capacity of the oil pump is made close to that actually required by the oil system, so that there will be little unnecessary work for the oil to do.

Oil pumps that do not deliver the required volume and pressure should ordinarily be referred to the manufacturer, as they are so standardized that inability to perform is usually due to some defect of assembly or material. The main point in such pumps is to keep the clearance between the ends of the gears and the casing as small as possible (Fig. 1). This clearance is usually 0.002 to 0.004 in. Cases have been known where the standard clearance had been exceeded by 0.004 or 0.005 in. and a large reduction in the capacity of the pump resulted. An objection to the relief valve is the squealing noise that sometimes occurs. This can be corrected by using a spring of proper elasticity for regulating the relief pressure. Sometimes the spring used has too hard a temper, which can be reduced to advantage. It is often customary to place a strainer in the circulating system for the purpose of removing impurities such as lint, pieces of waste, core sand from the castings, broken-down oil deposits, and metal resulting from wear or cutting of moving parts. When the strainer becomes clogged the oil pressure drops, and if this should be on the suction side of the pump the pressure fall will be rapid. The strainer should therefore be frequently inspected. Dirt collects in excess when a turbine is first started or after repair work has been done.

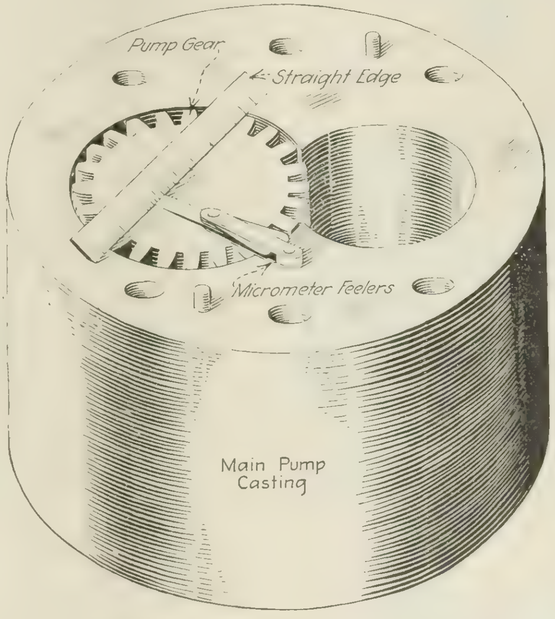


FIG. 1. MEASURING THE END CLEARANCE OF THE OIL PUMP GEAR

The usual method of cleaning the strainer is to shake out the large deposits and then blow steam through the wire mesh to clear the sticky material. This is not always effective, as, notwithstanding this treatment lint will stick to the meshes and often cause trouble when the strainer is replaced. A good way to clean the strainer is to pour some gasoline over it, let it partly evaporate, then touch a match to the mesh.

The piping system is usually arranged so that the strainer is bypassed automatically or else by hand-operated valves so that it can be withdrawn from the turbine while it is running. This procedure usually means the removal of a small quantity of oil from the system. The best time for cleaning the strainer is when the machine is shut down, if this is convenient.

Oil bafflers are for the purpose of reducing oil pressure so that one pump can be used for a high-pressure oil-valve gear cylinder and at the same time furnish low-pressure oil by means of the baffler for use in the bearings. Bafflers, which usually consist of a spiral passage for the oil, are so simple in character as to need no comment here.

Of all the various kinds of leaks which the engineer encounters in his daily experience there is none which usually present greater difficulties than oil under pressure. Few oil lines are actually tight. In almost all cases there is a damp spot or other evidence of a small leak. Oil lines can be made tight in every case if the proper methods are thoroughly followed. The "dopes" used in holding oil are shellac, soap, white lead and such corrosive substances as red lead and litharge. Oil lines are usually specified to be put up with shellac in the threaded joints. Shellac in this respect is sometimes effective, but with hot oil under pressure and some vibration of the piping it is seldom entirely satisfactory. The surest way to make pipe threads hold tight is to solder the connections. The threads of the pipe and fitting should be well tinned. The joint should be made up while these are hot enough to make the solder run a little. This will give a tight joint with brass piping. It is an easy and sure means. With iron pipe especially of large size, this method is not suitable. The best way to get such joints tight is to make sure that the threads are cut with good sharp tools. Thoroughly clean off these threads and then wipe with wood alcohol or turpentine to remove all traces of grease. Paint both threads with shellac and powdered graphite, or shellac and lampblack, and then screw tightly together. This will hold satisfactorily in most cases; if it is necessary to take more certain means soldering can then be resorted to.

Ground joints, such as those in bearing housings, can be made tight by using shellac and graphite in the proper way. It is necessary not only to scrape and wipe the surfaces clean, but most of all, to cleanse them thoroughly with wood alcohol or similar solvent to remove the oil which is in the pores of the iron. Otherwise shellac will not hold tight, unless the joint is unusually well designed.

Gasket unions should be put up in a similar manner. Hydraulic gaskets or heavy cardboard are most satisfactory. Ball-seated unions can sometimes be held with a lead gasket or a gasket of cloth reinforced with shellac and graphite. These, however, are difficult to make tight. When a leaky one is encountered it can be made to hold by painting the threads with shellac and graphite and also packing the nut with wicking soaked in shellac and graphite. Everything should be wiped and cleaned as before described in preparation for the shellac. This method is shown in Fig. 2.

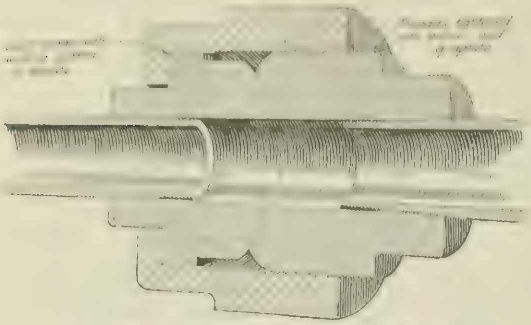


FIG. 2. HOW A BADLY LEAKING UNION MAY BE MADE TIGHT

Oil pumps are frequently made with several ground joints in such a manner that close clearance is necessary, therefore shellac and graphite would be too thick in such a joint and would interfere with the proper operation of the pump. The best means to employ is pure shellac after the surfaces have been properly cleansed.

Joints around governor casings where there is no bolt pressure for holding can easily be made tight by using a paper gasket or cotton thread together with the shellac and graphite.

Water pipes are sometimes equipped with glands where they are brought through the bearings housings. These glands are often difficult to make oiltight. Wicking soaked in heavy shellac will be found most effective provided the surfaces are all properly cleaned with alcohol.

Oil reservoirs are necessarily made of cast iron. This metal is naturally porous to oil. It is hardly advisable to attempt to correct such leaks where only an inappreciable amount filters through. If such a leak causes oil throwing, or if an oil tank contains sand holes or flaws so that a perceptible leak is encountered it can be made tight in the following manner: Clean off the paint and dirt with emery cloth and wash off with alcohol; when dry heat slowly with a blowtorch to a temperature above boiling where shellac will be boiled and baked into a hard covering. When at this temperature paint quickly with shellac and graphite. As soon as one coat hardens, apply another until the casting becomes cool. The shellac will stick closely to the pores of the metal and form a thoroughly tight covering.

It may be noticed that oil soaks out of the pores of the metal when it is first heated. Heating and cleaning should be repeated until such oil has been thoroughly removed. Wood alcohol is the secret of making shellac stick. This should be applied with a clean rag or brush.

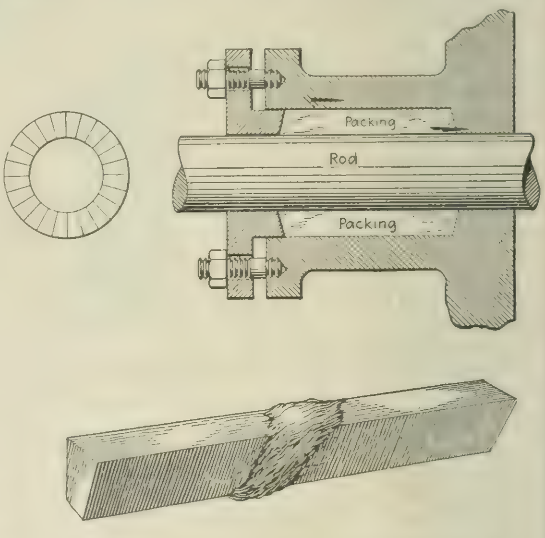
Other methods of making porous castings oiltight are tinning, brazing, plugging and welding. Tinning and brazing have been used in some instances; plugs are unsatisfactory for a truly porous casting, but are efficient where only a sand hole exists. The writer has had no direct experience with tinning and welding for this purpose and would appreciate advice from those who have had.

"Tiptop" Plastic Metallic Packing

Most piston-rod and valve-stem packing is placed in the stuffing boxes either by wrapping the packing around the rod or stem or by using split rings. There has recently, however, been put on the market a "Tiptop" packing that fits in the stuffing box lengthwise. Being wedge-shaped, it fits the stuffing box and rod, making practically a true circle when the packing is forced against the rod or valve stem as the gland is forced into place.

"Tiptop" packing, which is manufactured by the France Packing Co., Tacony, Philadelphia, Pa., is made of a soft shredded anti-friction alloy which is permeated with graphite and mica and then compressed into bars or segments, or into rings which may be cut diagonally with an ordinary jack-knife to fit the rod and box. It also comes in a loosely wound form like a string.

When made in bars, it can be cut into the required length to fit the stuffing box lengthwise, the lengths being packed around the rod as shown by the sketch. The packing is so soft that when it is compressed lengthwise it fills the wrinkles of the containing surfaces.



PLASTIC PACKING APPLIED TO STUFFING BOX LENGTHWISE

This packing is recommended for Corliss valve stems, steam and water valve stems, small valve stems on engines or pumps, water plungers on pumps, expansion joints or on any rod or tsem that travels in line. It is made for superheated steam and is guaranteed not harden in the stuffing box.

Pump Problems

By Roland Lester Tullis

Thoughtlessness or lack of knowledge on the part of the engineer when installing machinery often leads to an unlimited amount of trouble. I was visiting a plant one day when the engineer showed me a duplex pump that was giving him a great deal of annoyance. He complained that the pump was continually blowing out the head gaskets on the pump end; two or three of the heads had been cracked or broken, and the valve cover on the pump end had been broken in like manner. He was also having trouble with the plunger packing and the pump valves, which would last only a short time.

Improvised Float Valve Causes Trouble

The pump was used to force water to a condenser tank on the roof of a four-story building. I went to the roof and examined the tank and the outlet of the pump line. Here, the cause of the trouble was easy to see, for the engineer had installed a sort of improvised float valve on the end of the pump line to shut off the water when the tank was full. His ingenious arrangement consisted of a quick-closing gate valve connected with a float on the end of a long rod. Whenever the tank filled with water, the valve would close with a bang.

It was certainly quick and positive in action, but the engineer had failed to take into consideration the resulting water hammer and overpressure on the pump and line. The sudden closing of this valve and the fact that water is incompressible, caused a terrific strain to be thrown upon the pump, consequently gaskets or packing would blow out or the heads or valve cover would give way.

The trouble was remedied by an automatic pump control, or governor, which closed the throttle when the pressure on the pump line exceeded a certain point. It was also necessary to replace the float valve on the tank with a type that would gradually shut off the supply.

I have seen somewhat similar trouble experienced with a large duplex house pump that supplied water to a couple of large roof tanks on the top of a twelve-story building. In this case there was a disagreeable pounding and thumping in the line, which annoyed the tenants of the building. This was also caused by water hammer. By the installation of a suitable pump governor, which would slacken the speed of the pump when the float valve closed, and by the addition of an air chamber on the end of the pump line to act as a cushion, the pounding was stopped.

Water Pressure Was Insufficient to Operate Valves

I once encountered an interesting water-pressure problem when the owner of a small hotel called me in to find the source of his perplexity. The hotel was a six-story building of about 160 rooms. Practically every room contained a bath and toilet. The owner explained that they were having a great deal of trouble with toilet valves, especially on the upper floors. It seemed that when the toilets were flushed the valves would remain open and continue to run, sometimes for hours at a time. The proprietor wisely figured that he was losing a great amount of water in this manner, and water means money. He further explained that upon some days and certain hours of the day the valves worked perfectly; again they would go "on the blink" at the same time. He said that a plumber had charged him $500 to install a large water tank on the roof which he claimed would eliminate the trouble. It had failed to do so, and consequently he was a bit prejudiced in his feelings concerning plumbers in general.

Nowadays an engineer is required to have a general knowledge of all the mechanical arts, and I had had quite a little experience as a plumber in hotels, therefore I decided to give the problem some thought. There were no box toilets in the building, all being equipped with modern diaphragm valves connected to a 1¼-in. water line. This type of valve is closed by the water pressure admitted through a small pinhole bypass. The valve remains open until sufficient water can pass through this small aperture to equalize the pressure and close the valve. They are designed to work under a certain water pressure, and if the pressure is too low they will refuse to function properly.

In this section of the city the water supply was inadequate. At times the pressure was very low on the city mains. The valves on the upper floors of the hotel gave more trouble than those on the lower floors for the simple reason that it required approximately fifty pounds pressure to lift the water to the sixth floor of the building, and there was no pump on the line. The plumber's tank on the roof had failed to relieve the trouble because the head of water was insufficient to produce the required pressure to operate the valves, a small motor-driven centrifugal pump was substituted in the basement and it supplied the desired pressure at all times.

Trouble with Fuel-Oil Pumps

I was once employed in a large Western power plant that contained a battery of oil-fired boilers. We experienced a great deal of annoyance with two small duplex pumps that were used to supply oil for the burners. These pumps were automatically controlled in the usual manner by a diaphragm governor. There is a state law that requires the fuel-oil supply tanks to be located a certain distance below the level of the engine-room floor; consequently the pumps were compelled to lift oil ten or fifteen feet, depending upon the amount of oil in the tank.

At times when the load was light and the amount of oil supplied to the burners correspondingly small, the pumps would move very slowly. Then if the foot valve on the end of the suction line happened to leak, the pumps would lose their suction and the fires would go out. This called for immediate action on the part of the engineer, for an oil-burning plant will not run long after the fires go out. Usually, it is a difficult job to get one of these small pumps to regain its suction after it is once lost.

We had two or three shutdowns in this plant on account of the fuel-oil pumps losing their suction. The trouble finally developed into a daily occurrence. I eventually decided that there must be something wrong with the pumps. I removed the valve cover on one of the pumps and examined the valves. They were found to be in good condition. Then I removed the heads on the pump end and examined the plungers, where I discovered the cause of the disturbance. Instead of plunger packing, the plungers were fitted with large lead rings that were supposed to act as packing. These rings had worn until they were very loose. With this arrangement the pumps could hardly be expected to lift oil any distance. I removed the lead rings and packed the plungers with regular plunger packing, and the trouble was remedied.

Many Western power plants are finding it very difficult to secure a proper grade of fuel oil at anything like a reasonable price. The price of fuel oil has increased in the last few years, while the quality has deteriorated; we get oil of a heavy asphaltum base which contains sand and all kinds of foreign matter.

Burners and regulating equipment that were designed to handle the better grade of oil refuse to function properly with the poorer grade. An accessible and easily cleaned strainer should be a part of the oil fuel line to the burners. Some form of twin strainer is preferable for this service, as one strainer can be removed without interfering with the oil supply. Practically all modern types of burners contain minute openings which will clog with the slightest presence of foreign matter in the oil.

American High-Duty Ash Conveyor

A conveyor of the vacuum steam-jet type to handle high tonnages or to operate under unusually severe conditions has been perfected by the Conveyors Corporation of America, formerly known as the American Steam Conveyor Corporation, of Chicago. The new system operates on the same principle as the earlier types of steam-jet conveyor, but the pipe line intake tees and fittings are made up of semi-cylindrical sections bolted to a steel frame of parallel T-bars and angles. One section fits into another longitudinally through the use of a tongue and groove, and to give airtight construction the joints are cemented. At the joints between section lengths a cast-iron cap is bolted, and underneath it the cement or gasket material is squeezed into the crevices.

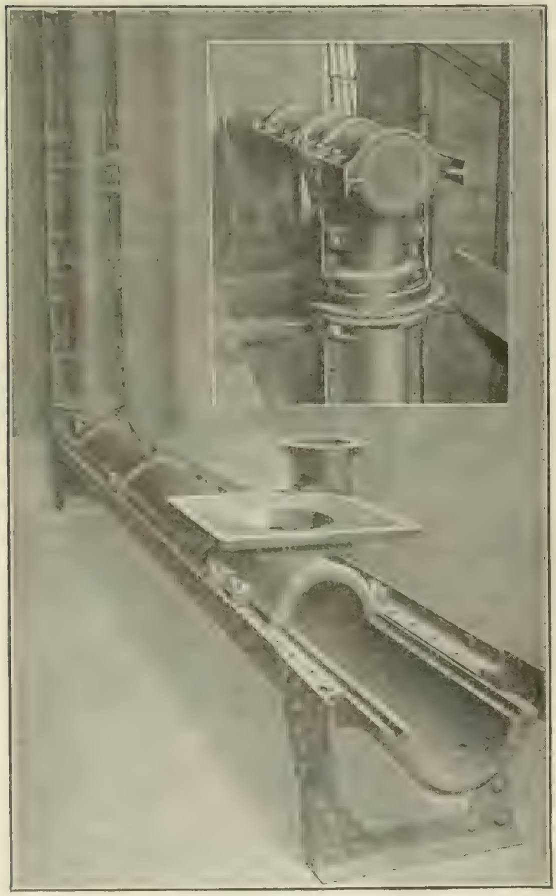


FIG. 1. A PORTION OF CONVEYOR LINE. INSERT. IMPACT ELBOW AT UPPER DISCHARGE RUN

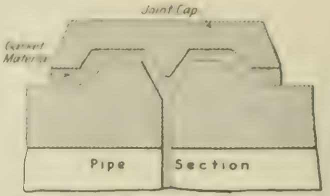


FIG 2 JOINT CONSTRUCTION BETWEEN PIPE LENGTHS

For the most part the sections are made in 2 and 4 ft. lengths, except where irregularly spaced ashpit doors make a variation from these standards necessary. When put in place, the half-sections are staggered with a view to equalizing the wear. The replacement of a worn section has been made so easy that no liners are employed. The metal is cast harder than it is possible to make full round pipes of the lengths formerly used. The frame takes the stress, so that it is not necessary to limit the hardness of the metal to secure the tensile strength that otherwise would be needed in the pipe line.

With the construction shown in the illustrations a straight pipe line is assured and there is no air leakage to reduce the capacity of the system. In Fig. 1, a portion of the conveyor line, may be seen the lugs provided for bolting each semi-cylindrical section of the pipe to the frame, the tongue and groove construction between sections and one of the intake tees. The insert shows the impact elbow. An important feature is the swivel allowing the upper horizontal run to be set in any direction. When a long overhead discharge line is necessary, the supporting structure is worked into a light truss carrying a walkway adjacent to the pipe line. This is intended to facilitate repairs to the upper line and to make the work safe. Fig. 2 shows the joint construction between lengths. The rib at the end of each section and the shape of the cap to conform with this design will be noticed.

The internal diameter of the pipe line is 9 in., and the diameter of the intake is 8 in.

A knock that apparently is in the piston pin of a Diesel engine is often a piston "slam" caused by excessive piston wear. At times this piston knock is caused by the connecting-rod bearings being out of line. A sharp metallic knock in the cylinder is usually the result of early fuel injection. This knock is produced by detonation and is termed "pinking." A dull knock or thump may be caused by a loose pin bearing or late fuel injection. At times it is caused by the piston striking the cylinder head—this applies to old-design Diesels where the clearance is very small at best. The piston rings should be cleaned every six months. If the top rings are gummed fast, strong lye will loosen them; kerosene and a brass scraper will do the work if the ring is not too tight. If a piston ring is broken, usually there is a click as the piston reaches the ends of the stroke.

EDITORIALS

The Federated American Engineering Societies

THE conduct of the Government of the United States involves the solution of engineering problems affecting the well being of millions of people and the expenditure of millions of dollars, but one may scan the roster of Congress in vain for the name of a prominent engineer.

Some time since, on account of the lack of participation in the affairs of the communities and the nation in those features with which the engineer is particularly familiar, the discontent of the rank and file of the engineering profession became articulate.

If the clergy or the legal profession were wiped off the slate, the world would go on much as usual; but without the engineer, industry, construction, transportation, all the complex material processes of modern civilization, would stop. And yet, ask the man beside you on the train for a list of the prominent people of his town and what do you get? Bankers, merchants, lawyers, doctors—but no engineers.

The engineer is tired of shifting the scenery and working the props back-stage to make the setting for another star. He wants to get out into the spotlight and have a speaking part and to feel that he is directly contributing to the common good.

Whether the organization of the American Association of Engineers was contributory to or the result of this state of unrest does not signify. Charged with inadequacy and inefficiency and lack of interest, the four great national professional societies appointed committees to consider how their activities could be extended. Representatives from these committees got together for conference upon their common problem, and the Joint Conference Committee was the result. Under its tutelage an attempt is being made to unite the professional engineering societies of the country in a movement which shall impress the collective wisdom and experience of the engineering profession upon public problems requiring technical skill and engineering analysis for their solution and put the engineer upon the map by giving him an opportunity for public service, and to have the public understand it.

A united profession, solidly organized and intelligently conducted, could accomplish wonders for the public and itself. In its hope for the latter there is nothing of unionism. The uplift is to be for the profession, broadly, and to carry the individual up with it, leaving him to manage the details of his own progress.

The movement was for solidarity in the profession, but a part of the outcome has been a schism. Some thirty-five per cent of engineers of the quality that was considered worthy of being invited have joined the movement; twenty per cent, in the Civils and the American Association of Engineers, have definitely determined to stay out of it; and the remainder, in the National associations of rather special character and numerous small locals, have not yet been able to consumate their membership or are waiting to see if the Federation succeeds instead of getting hold and making it a success. Furthermore, there is a schism in the Civils between those who would join and those who would not, those who are contented with and jealous of their professional standing and prestige and those who want to see the activities of the society broadened.

The American Association of Engineers is less exclusive. It is composed largely of the civil type of engineer, and includes in its membership and among its leaders many prominent members of that branch of the profession who are members of the A. S. C. E., but many also who would not be considered eligible to the older society. There is talk of a coalition between the Civils and the Association, the Civils to represent the high-toned technical end of civil engineering and to embody the preferment and recognition which come with achievement and success, the Association to take care of the so-called betterment work concerning more particularly the material condition and emolument of its members.

There are great possibilities of usefulness in the Federation. Under the inspiration and leadership of Herbert Hoover, with a united profession behind it, with means such as would be afforded by a contribution of a dollar or two per year from every professional engineer in the country, it could in a few years make the engineer a headliner in the drama of national life, impress his knowledge and analytical processes upon the problems with which the future has to deal, to their satisfactory solution and his everlasting credit. It is to be hoped that with a more general understanding of the purpose and methods of the Federation and with a realization of the fact that it is so well started that it is bound to be a success anyway, those who have viewed it with suspicion or disfavor will conclude to become a part of it, and make it a more immediate success and contribute their part toward making the engineering profession a factor in advancing civilization.

The Heating System As a Source of Power

IN POWER-PLANT practice there is no subject at the present writing more important than the conservation of fuel. The high prices emphasize the necessity of economy, and periodic shortages of coal make it obligatory to utilize fully all available sources of power. In the latter connection the article published on another page of this issue on "The Heating Plant as a Source of Power," is deserving of consideration. The plan of co-ordinating the power and heating functions so as to obtain maximum over-all results and to avoid duplication of equipment has possibilities that it would be well to investigate, particularly by large industrial heating plants buying current, and central district heating stations.

As the article states, the chief elements are the heating boilers, a forced-circulation hot-water heating system, with a turbo-generator exhausting into condenser heaters. The arbitrary control of the vacuum and terminal pressure effects a one-hundred per cent variation in the steam rate of the power unit, as well as the temperature control of the circulating medium of the heating system. The salient features resulting from this arrangement are a variable power steam rate, constant power load recovery from the fluctuating steam requirements of the heating system, and temperature control of the heated spaces. It is evident that the heating system is modified to suit the characteristics of the condensing turbo-generator rather than the reverse.

This may be contrasted with previous practice of varying the power load with a constant power steam rate, as would be necessary with all systems of steam distribution. The variable steam rate enables nearly one hundred per cent more power to be recovered from the heating fuel. The maintenance of condensing conditions with minimum power steam rate when no heating is required eliminates the losses in summer attending non-condensing power generation.

Individually metering the quantity of heat to consumers would be unnecessary as increased consumption would be accompanied by additional power recovery. Low temperatures would govern the plant economy rather than quantity production. The equipment, however, lends itself to the employment at the source of meters and thermometers on water and current, so that accurate accounting could and should be established.

In the article the large plants illustrated offer a fertile field for improvement along these lines. Our inefficient household heating plants would afford another source of power that in the aggregate would permit of conservation on an immense scale. Efficient centralization of this heating within an economical radius could be effected by a central "block" plant equipped as previously outlined. The necessary requirements would be a load of sufficient size and a market for the recovered current. Over the wasteful apparatus and methods of the householder, the central plant would possess the advantage of the economies of centralized purchase and combustion of fuel aside from the salvaged commercial electric power.

There should be little question as to the ability of the central plant to show a good return on a heating charge equivalent to the cost of the domestic fuel where the householders' property is adequately heated. This would bring the advantages of central heating within the scope and income of most people.

Exhaustion of Our Oil Supply

A DEMAND echoed from practically every corner of the civilized world today is "More Power!" The reason for this is easily understood when it is realized that a reliable power supply has become as indispensable as food, water and heat. Power supply might be considered of even greater importance than the others, for our food, water and heat depend very largely upon the application of power. If modern civilization is to endure, it must have an abundance of cheap power. No wonder, then, that men of vision are giving so much attention to a power supply for the future. There are two important sources of power—fuel and water. The former is being rapidly used up. In fact, the exhaustion of some of our fuel resources is near at hand, while that of others is farther in the future. Our waterfalls, although limited in extent, are the only dependable source of power perpetuated by nature, therefore these should be used to the limit they are capable of serving. Already, natural gas, the ideal fuel, has been exhausted in a number of localities and is fast being depleted in other regions, so that today it is a mere incident in our industrial progress. Yet with the depletion of natural gas as a warning of how rapidly a fuel may be exhausted, we are attacking our oil reserves with ever-increasing vigor.

In this issue is published an abstract from a paper, "A World View of the Oil Supply," by George Otis Smith, Director, United States Geological Survey, in which he analyzes the oil situation in the world today, and suggests methods for its more economical use. How near we are approaching the exhaustion of our oil resources is shown by Mr. Smith in the statement that if the best steam practice of today is adopted as known in the largest central stations where fuel oil is used, the oil reserves of the United States are sufficient to supply our total power requirements for only approximately nine years. With the oil field of the United States perhaps forty per cent exhausted, we are still burning millions of barrels of oil in locomotives to haul trains over mountain grades, where there awaits development more than sufficient water power to operate these trains. Furthermore, hauling trains with electric locomotives supplied by power from hydro-electric stations is no longer an experiment, but is in actual practice on a large scale. In marine service a very large percentage of the oil used is burned under steam boilers, while the same quantity if utilized in internal-combustion engines of the Diesel type, would produce two and one-half times as much power.

During August and September our daily output was one and one-fourth million barrels and our consumption one and five-eighths millions barrels; that is, this country is today depending on outside sources for three-eighths of a million barrels of oil daily, and the ever mounting curve of consumption seems to know no limit. It is no longer a problem where to find a market for oil, but where to find the oil to supply the market. What are we going to do regarding our oil supply? Shall we wait until it is exhausted, as is the supply of natural gas, when it will be too late to act, or shall we join with the rest of the world in drawing up a world policy to safeguard the future.

The Council of the Federated American Engineering Societies negotiated its first breakers when it squelched an attempt to mitigate the stand taken by the organization congress for the fullest, freest publicity of all its acts and deliberations. Service to the public, which is urged as its leading motive, will thrive in the daylight and requires no sunshade. An unqualified declaration in favor of open covenants openly arrived at and a square deal with all the cards face up on the table will have a psychological effect in this formative and probative period which provision for no amount of imaginary and improbable contingencies could offset.

The selection of Washington as the headquarters of the newly organized Federated American Engineering Societies is a happy one. If the purpose were to impress the engineer on business, a commercial or industrial center would have had a prior claim. But the engineer is already impressed upon business. It is upon public affairs that he needs a chance to make himself heard, and Washington is the heart and pulse of the nation in this respect.

CORRESPONDENCE

Low Voltage Caused by Blown Fuse

Where the primaries of an electric-light line passed under a bridge, trouble by grounding and short-circuits interrupted the service to such an extent that it was deemed advisable to relocate the primary wires in order to avoid the cause. So an extension was built as shown in the figure. Beginning at point *A*, the line was run along a side street to point *B*, thence to point *C*, where a transformer was installed and the secondaries extended to *D*. The primary line from *A* to *D* was discontinued and the secondaries from No. 1 transformer were extended to *D*, and as the drop in voltage was excessive, the two secondaries were connected in parallel. This worked satisfactorily for a time, then trouble suddenly developed and the lights on transformer No. 3 dropped to about half candlepower and remained so. Linemen were sent out over the line to find the cause, but failed.

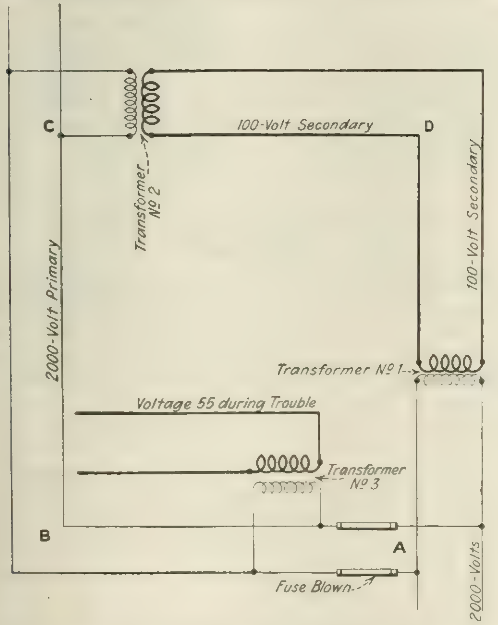


DIAGRAM OF PRIMARY AND SECONDARY CIRCUITS

The trouble continued for several days, and then someone suggested looking at the point *A*, where there were cutouts for the circuit recently installed. This was done, and one of the fuses was found blown. After a new fuse was put in, the lights came back to normal candlepower. It was then seen that when the fuse blew at *A*, the current followed the circuit from No. 1 transformer to No. 2 transformer, by way of *D*, through the secondaries. The current was then stepped up through No. 2 transformer and flowed to No. 3 transformer, where it was stepped down. The cause of the low voltage on transformer No. 3, after the fuse blew, was due principally to the line loss, as the distance from No. 1 to No. 3 transformer by way of No. 2 is about 4,000 feet. **Leon L. Pollard.**

Fairfield, Me.

Where Should the Beginner Start?

On page 711 of the Nov. 2 issue Mr. Winters, commenting on "Where Should the Beginner Start?" says: "About the poorest place for a man to learn to become a first-class fireman is in a stoker-fired plant."

The ordinary fireman in a hand-fired plant can, by wasteful methods, squander perhaps three or four tons a day if he is of very powerful build and the draft is good. Three tons of good coal wasted in one day of eight hours would be some work for one fireman. In a stoker-fired plant the same fireman could, in the same time, if he were so inclined, waste fifty tons of coal.

Sometimes the able fireman who can so thoroughly shovel coal into a furnace and hold the steam steady is worthless as a stoker man. In fact, I decided several years ago that I would rather take a boy off the farm and break him in on a stoker than to break in a hand-fired graduate.

Do not get the idea that a modern plant operates automatically and does not need a first-class fireman. The stoker plant needs the highest-class fireman if my experience has been worth anything.

For the benefit of Mr. Noble, whose letter appears on the same page, I would state that the pump that lost water at 30 ft. plus had one elbow in its suction line. This was of extra-long radius and the pump cylinder was only 6 ft. from the well. The brass lining was nearly new, and when water failed, a line was dropped in the well to determine draft. This well took water from a river which fell and caused the pump failure.

If Mr. Noble has a condenser and will make a connection to from 1-in. to 2-in. or larger pipe, he will be able to satisfy himself that a hole at the water line will serve to deliver a mixture of air and water to a surprising height. I heartily agree with him that a 27-ft. lift is mighty good. **C. W. Peters.**

New York City.

Mechanical Stokers and Their Operation

With reference to the article on "Mechanical Stokers and Their Operation," as published in the Sept. 7 issue of *Power*, and the letter of Mr. Riley in the Oct. 9 issue, I would state he is correct in his statement that in the description of the stokers shown, a single-retort type is referred to instead of the multiple-retort stoker.

We do not class the stoker illustrated in Fig. 4 of the original article as a gravity-feed multiple-retort stoker (as mentioned in Mr. Riley's letter), as *gravity* plays no part in its operation. The bottom of the retort is practically level, as will be noted by the illustration mentioned. F. A. DeBoos,

Detroit, Mich. General Sales Manager,
The Under-Feed Stoker Co. of America.

Commutator Made from a Copper Block

The letter of H. E. Weightman in *Power* of Oct. 12, page 591, relating to a patent on making a commutator from a copper block, is very interesting inasmuch as the work described in the article referred to was done by myself while employed by the Sevenoaks Iron Works, England, in 1908, or eight years before the patent was issued. Vernon Pearson.

Macleod, Alberta, Canada.

[Mr. Weightman's letter says the method was patented in the United States in 1916 (No. 1,195,861). William J. Cummings states in the Nov. 2 issue that in 1900 the Eck Motor Works, Newark, N. J., made commutators from solid stock.—Editor.]

Records Tube Blowing and Blowoff Opening

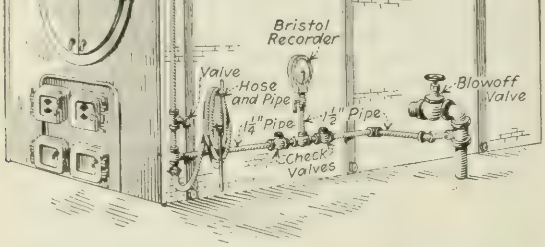


FIG. 1. ARRANGEMENT OF RECORDING PRESSURE GAGE

In order to be sure that the boiler tubes are blown twice and the boiler blowoff valve is opened four times in twenty-four hours, I arranged a recording pressure gage as shown by Fig. 1, which records the events as they happen. The pipe line from the blowoff is ½ in. and gives full boiler pressure on the gage; the pipe from the flue blower is ¼ in. and does not show quite so high a pressure. Two check valves are used. One prevents the blowoff water from going into the tube blower, and the other prevents the steam from the tube bower from going into the blowoff line.

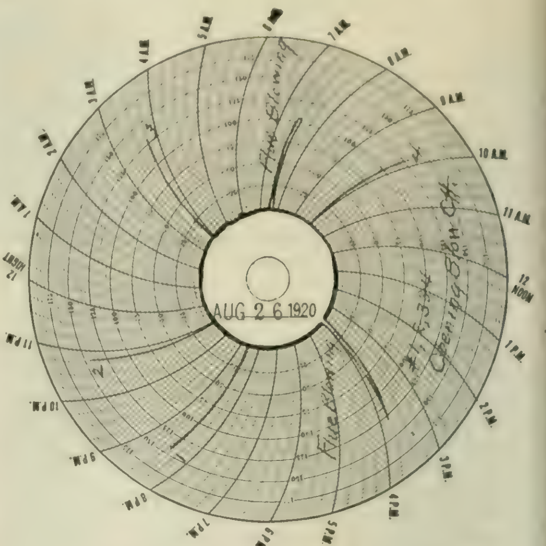


FIG. 2. CHART SHOWING BLOWING PERIODS

A sample chart showing the blowing periods is reproduced in Fig. 2. John T. Sharp, Jr.

Canton, Miss.

How Can Shavings Be Burned with Coal?

Mr. Schatz's trouble with burning shavings and coal is caused by too much air blowing in with the shavings going into furnace, thus producing a blast effect upon the boiler. In a certain planing mill where the ashpit doors were closed and the cyclone discharged dust only into the furnace with a strong blast, it actually burned up an entire set of grates, the blast being downward.

It is inferred that Mr. Schatz blows his shavings through the front of the furnace, which causes a blast against the boiler with the effect complained of. The cyclone in his case is too small for the service required else the air outlet is choked, thus causing too strong a blast into the furnace.

Feeding the shavings into the furnace is the correct method, but it should not have more than a natural draft equivalent of the blast discharging into the furnace with the shavings, as too much blast or draft will cause a waste of unburned fuel to pass out through the stack.

If it is not desired to burn the shavings direct from the cyclone, then the best method is to bed the coal on top of a layer of shavings at each interval of firing. This method seems to work satisfactorily when not enough of one kind of fuel is on hand.

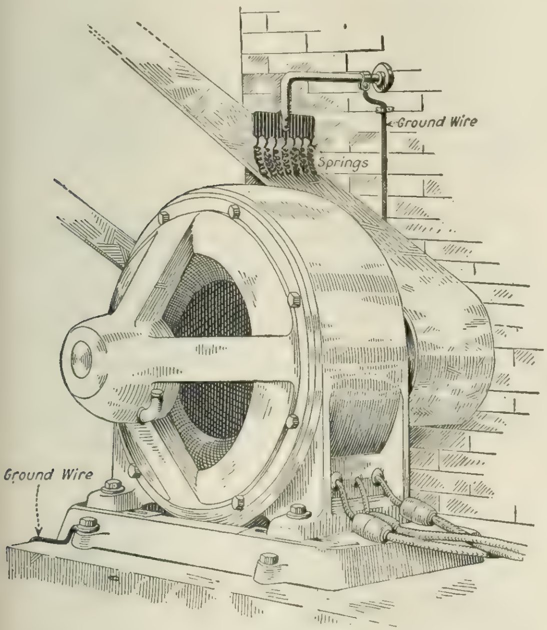
The requirements of each individual plant must govern the amount and interval of firing.

Cairo, Ill. E. G. Hoppe.

Static Electricity in Belts

On page 631 of the Oct. 19 issue, B. A. Briggs asks for information relative to static electricity. I have had considerable experience with static and static-electricity troubles, having been connected with the electrical department of a textile plant for a number of years. A few years ago we had a 15-hp. motor that was connected to a lineshaft driving a group of braiding benches and located on a platform suspended from a wooden ceiling. The frame of the motor was not grounded, the only electrical connection being that of the leads.

Trouble was reported with the motor and was immediately looked into. Flashing was observed between stator and rotor at intervals of from four to ten minutes and was very vicious on dry days. The motor was tested for short-circuits, open-circuits, grounds, etc., and in all cases tested clear. The insulation was charred on the stator where the flashing occurred, but did not seem very deep. As soon as the motor was started up, flashing occurred at regular intervals, and before an opportunity was given to do something to remedy the troubles, the motor burned out. A spare motor was immediately substituted and operated for a short time, when the flashing occurred again. By this time the other motor had been rewound, and it was replaced in its original position. But this did not improve matters; the flashing reappeared, and I was given the job to locate the trouble. The motor tested free as before, but I observed that it was highly charged with static electricity when running, so I decided to ground its frame. As soon as this was done, the flashing ceased. I immediately proceeded to devise means of arresting the static from the belt, which was done by installing a comb made from a sheet of copper with fine springs soldered to its teeth, as shown in the figure. These fine springs were allowed to touch the belt, as they did not injure it. The trouble never appeared again, and it seems evident to me that the static charge would build up in the rotor until it jumped the air gap to the stator and traveled along the power circuit through the ground detector to the ground.



DEVICE INSTALLED TO REMOVE STATIC ELECTRICITY FROM BELT

We now make it a part of the installation of each motor where it is belt-connected, at the first indications of static, to install one of these static arresters, and no further trouble has been experienced. When any machine, motor or belt is troubled with static charges, ground the frame of the machine permanently and effectively, making sure that the ground is a good one, such as a water pipe and that all the connections are clean, also ground the belt in the manner explained, and my experience shows that the trouble will disappear. In some places humidifying apparatus has been installed. This is helpful and in several cases has eliminated static charges, but where there is no such apparatus grounding the affected parts generally proved to be the remedy.

Ansonia, Conn. **William T. Estlick.**

B. A. Briggs asks about static electricity. A case of trouble worked out some years ago comes to mind and will perhaps be worth something to your readers.

While acting as construction superintendent for an elevator company, I was called one night to repair a passenger elevator which had been installed only a few days. The control board was found alive with static and the small fuse on the control circuit blown out. It was replaced and a little later the same thing happened again. A close inspection showed that the slack-cable device contacts were burned by an arc. These contacts were well insulated and were about one-half inch from the metal box inclosing them, which was thoroughly grounded.

Having found evidences of heavy static charges on other elevators in the same city, I asked the chief electrician about conditions at the plant. It was found that they had belted generators and that they had just rebuilt the power line uptown, so it was well insulated. We had the engineers install a metal comb within a half-inch of the belts (the best place is on the tight side of the belt as close to generator pulley as possible) and ground this comb. This stopped all our trouble and, I think, proved my theory to be right as to the cause of trouble, the theory being that the static jumped to the grounded metal box after which the 500-volt current held an arc till the 15-ampere fuse blew out in the control circuit. If the insulation of the power line had been poor, the static charges would have leaked to ground along the line.

I would consider static as being more or less of a menace to motors and generators. It is easily eliminated, and this should be done in my opinion.

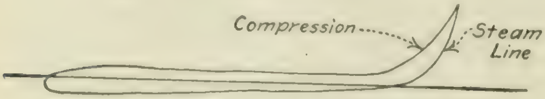
Snyder, Tex. **D. P. Yoder.**

In answer to B. A. Briggs I would say that the static charges established on motor belts would not affect the efficient operation of electric motors. Of course there is the objection of slightly shocking persons coming near such belts and in contact with the machine, especially if it is ungrounded. Experience has shown that static charges from such belts may accumulate to the extent as to break down the insulation of motors or generators. To prevent such charges, a grounded metal comb should be installed, close to the belts.

Linton, Ind. **John R. Luxton.**

Indicator Test Diagrams

On page 515 of the Sept. 28 issue, G. B. Longstreet presents some indicator diagrams that were taken to show that his engine does not leak. Although these diagrams are interesting, it is my opinion that they do not prove non-leaking valves. I had this impression some years ago, and having a 250-hp. engine, I took the diagram shown, immediately after tripping the ball clutch to let the valve rod telescope. This, it will be understood, closes both steam valves, shutting down the engine without closing the throttle valve, which practically will give the results Mr. Longstreet gets.



MR. WALDRON'S TEST DIAGRAM

But my engine did leak, both in the steam and in the exhaust valves and also the piston. It was 23 years old and had never had anything done to it during that time. No doubt a similar diagram would look much different now. We have all heard the statement, especially in regard to compression, that the object compressed will give out all it takes to compress it. While this is true of a steel spring, it is not true of steam compression.

In considering Mr. Longstreet's second diagram of Fig. 1, where *B* is the compression curve which runs up while the engine is passing the center, what made the curve *C* depart from *B* while coming down? Is this leakage or condensation or a little of both? If condensation, why did not re-evaporation do better and make *C* go back nearer the line *B*, since but a second before the same cylinder had a temperature far in excess of that due to the compression line *B*?

I believe condensation is responsible for the most of this difference between *B* and *C*, and the best test I know of is to take off the head and see if steam comes through the steam valve or indicator pipe on the crank end. For the exhaust with the head on, disconnect the exhaust pipe; for piston leakage I block the crosshead and admit steam. I am glad to see these freak cards and hope others will also experiment, as it shows a progressive mind.

A. WALDRON.

Malden, Mass.

Socketing Hoisting Cables

Referring to the article in *Power*, Sept. 21, covering experiences with cable sockets, I wish to add the following:

At a certain mine shaft two failures of cables at sockets caused the wrecking of both cages each time, but fortunately, as coal was being hoisted, no loss of life resulted. The failures occurred about seven months after cables were resocketed, and the mine was operating at less than half capacity; the number of trips made by the hoist were less than 50 per cent of what was normal for that period.

In making a careful survey of conditions it was discovered that the head sheaves were loose on their shafts. Having about 1/16 in. larger bore than the diameter of the shaft, these sheaves were keyed to the shaft with a feather key and as they revolved they would hang (so to speak) on the key until the latter was nearly on top of the shaft, when the sheave would drop, which gave a severe jerk to the cables and set up vibration and unusual strains with the results mentioned. Refitting the sheaves with new shafts pressed on tight stopped any further breakage of cables at the sockets.

Regarding the use of zinc for fitting sockets, I find it is best to clean each wire with sandpaper, before immersing in the muriatic acid, then each is certain to be well galvanized and will take its share of the load. The usual instructions for doing this work are rather loose regarding the cleaning of the wires. Anyone who has had experience in soldering knows how essential it is to have the work scrupulously clean. To properly prepare and pour a socket on a 1⅛- or 1¼-in. cable requires not less than five to six hours.

Just previous to pouring the zinc in a socket, I preheat it to a temperature of 400 or 500 deg., then slip the socket over the wires, then quickly seal around the cable and pour the zinc, being sure that it is hot enough.

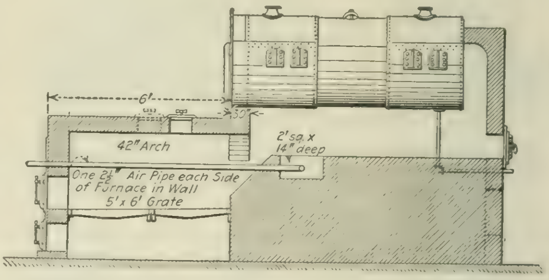
W. F. SHUTT.

Dolores, Tex.

Trouble in Burning Hog Fuel

The following may help C. W. Fields, who is having trouble burning hog fuel. The clinkers that form on the grates are caused by the grit on the logs which is carried into the furnace with the sawdust. The furnace nearest the mill or the one that gets the fuel first will generally have the most clinkers.

His feed hole should be set six inches nearer the boilers, as shown in exaggerated form in the illustration; then the front end of the grates would get the fuel first, and that would save tamping and leave the end next the firedoors open. There is too much combustion area behind the bridge wall. As there is not as much carbon in hog fuel as there is in coal, the combustion chamber should be cut down. The cleaning-out door in the rear should be raised above the blow-off pipe as shown, and the grates should be of the crown type for burning sawdust; then they will be fairly clean at the end of a ten-hour run.

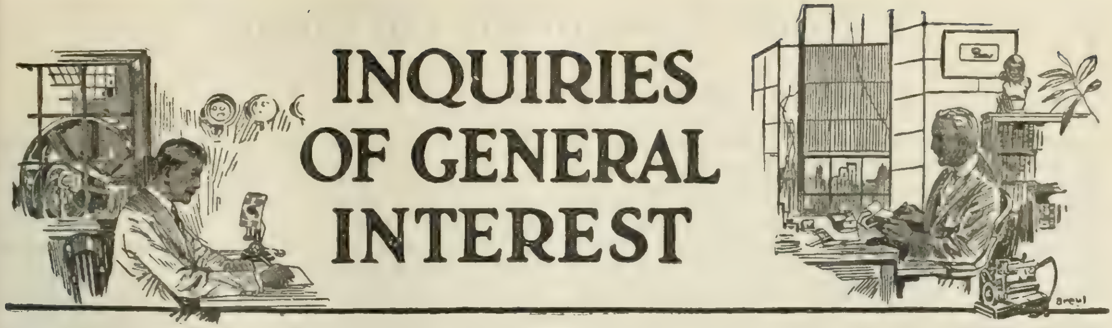


MR. FIELDS' FURNACE IMPROVED

We are operating a battery of boilers equipped in this way and they are doing fine work. The sketch shows the area of the combustion space that should be filled in.

G. L. BALDWIN.

Millsite, Vt.



INQUIRIES OF GENERAL INTEREST

Alternate Firing More Economical—In firing four 300-hp. vertical boilers each equipped with two firing doors, with two firemen to a watch, is it better to fire each boiler through both doors at the same time or to have one man firing one side of one boiler and the other firing one side of another boiler? R. J. N.

If the firing is performed quickly, leaving the firedoor open as short time as possible, greater perfection of combustion can be secured and better coal economy by firing alternately with equal intervals of time; that is, first at one door and then at the other, thereby making the stoking more nearly continuous.

Steam Pistons of Duplex Pump Cushion on Exhaust—What prevents the pistons of a duplex pump from striking the cylinder heads at the ends of the strokes? R. M.

Before either steam piston reaches the end of a stroke it passes over and closes the opening of the passage for escape of the exhaust that is ahead of the piston. Any exhaust steam thus trapped in the cylinder between the piston and cylinder head, or that may fill the separate steam passage from the cylinder back to the steam valve, becomes compressed by further motion of the piston and acts like a cushion for gradually arresting the motion of the piston and prevents the piston from striking the end of the cylinder.

Removing Scale From Water-Tube Boiler—What treatment can be employed for removing lime scale from a water-tube boiler used for heating? J. A. B.

Add to the boiler water about one-fourth pound of soda ash or caustic soda per rated horsepower. Then carry only enough fire to hold about 10 lb. gage pressure for 48 hours and blow off the boiler when the setting has cooled down. The soda should soften up the deposit so it can be washed out with a hose. Two or three such boilings and washings might be necessary. After the final boiling the boiler and fitting and connections, especially the safety valve, should be thoroughly washed clean of all traces of the soda and special care should be taken to wash out the mud drum. If the soda boiling will not remove the scale from the tubes it may be necessary to clean them by the use of a mechanical tube cleaner.

Attention to Bagging of Boiler—Is it objectionable to continue firing a horizontal return-tubular boiler that has a slight bag in the shell over the fire? W. H. F.

A bag usually is produced from a deposit of oil or scale which prevents the shell from being kept cool by the water in the boiler, and the material of the shell becomes more or less burnt. A depression of the kind, once formed, becomes a pocket for gathering deposits of non-conducting substances followed by greater overheating and more bulging and thinning out the plate from internal pressure, which is likely to develop rupture without notice. Hence, a bag should be repaired at the earliest opportunity, by bumping the bag back if the bulging is so little that bumping-back is practicable, or if bumping-back cannot be performed, the bag should be cut out and the boiler shell should be properly patched from the inside and thereafter used with a reduction of pressure, the amount of reduction depending on the condition of the material and character of the patch.

Providing Injector Capacity—Why should a new injector be provided with capacity for delivery of more water than the rated evaporative capacity of a boiler? W. E. G.

The working capacity of the injector should be at least double the rated evaporative capacity of the boiler to cover emergencies of low water from accidental leakage, blowing off and oversight of attendance, as well as the evaporative requirements when the boiler is forced to its highest possible capacity, which in many plants exceeds 75 per cent beyond the rated capacity. To insure the proper working capacity after the injector has become worn, clogged with scale or otherwise impaired from use, the injector's capacity when new should be two and one half to three times the rated evaporative capacity of the boiler.

Speed of Direct-Current Motor—Why will a direct-current motor accelerate in speed when its field current is decreased and be retarded in speed upon increasing the field current? W. M.

The speed of direct-current motors is controlled by their counter-electromotive force. The armature current is equal to the applied voltage minus the counter-electromotive force, divided by the armature resistance. This may be written:

$$\textit{Armature current} = \frac{\textit{applied voltage} - \textit{counter-emf.}}{\textit{armature resistance}}$$

The counter-electromotive force is proportional to the field flux, multiplied by the speed; that is

$$e \propto N \times S$$

where e is the counter emf. which varies as N the flux times S the speed. Consequently if N is increased by increasing the field current, S must decrease if e is to remain the same, and vice versa.

Advantages of Superheating Steam for Turbine—What percentage of saving is superheated steam to a steam turbine; for instance, what is the saving from superheating dry saturated steam at 150 lb. gage, 366 deg. F., to a temperature 50 to 60 deg. higher? H. G. D.

Manufacturers of steam turbines usually furnish a statement or a set of curves based upon actual tests showing the amount that the steam consumption per kilowatt-hour will be increased or diminished by stated variations from standard conditions, as the economy of any steam turbine is greatly influenced by the conditions of pressure and vacuum as well as quality of the steam. In high-pressure turbines the steam consumption is improved approximately 1 per cent for every 7 to 13 deg. superheat, the better value holding good for about 50 deg. superheat while the lower value holds good for about 200 deg. superheat. Hence, for 50 deg. superheat the steam consumption would be about 7 per cent less and for 60 deg. superheat the consumption would be reduced about 8½ per cent below that for dry saturated steam. The actual plant saving would depend on the additional cost of increasing the degrees of superheat.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

A World View of the Oil Supply*

By GEORGE OTIS SMITH
Director, United States Geological Survey

THE world needs more power. The central theme of modern history has been man's increasing use of mechanical power. Yet it remains for the world to be motor-driven to the degree that would balance the need of humanity for increased productivity. The economic law of this power demand is tersely expressed in an editorial heading in a recent issue of the technical journal *Power*—"Horse Power per Man Power Is a Measure of Modernism."

One of the byproducts of the co-operative efforts by the Government scientific bureaus in the aid of our Peace Commission was an inventory of the water-power resources of the world, and this is now being prepared for publication by the United States Geological Survey. It shows that only about one-twentieth of the potential power of the world's rivers has been utilized, and over half of this in North America, with Europe credited with one-third and the rest divided between Asia, South America, Oceanica and Africa, in the order named. In its potential resources, however, Africa ranks not last, but first; it has over 40 per cent of the world's supply of water power and is followed in turn by Asia, North America, South America, Europe and Oceanica.

Distribution of World's Coal and Oil Reserves

In the division of coal resources among the continents, at least of the better grades of coal, similar inequalities are seen. North America has more than half, Asia about a quarter, Europe a sixth, and the rest is divided between Oceanica, Africa and South America in the order named. Accepting the Stebinger-White distribution of the world's oil reserves, we may roughly set down the continents in order of wealth in oil as North America, Asia, South America, Europe, Oceanica and Africa.

The resources of the world's oil shale are far too large to be lost sight of as a substitute source of oil. The United States alone is believed to possess deposits of oil shale that contain at least ten times as much oil as there is natural petroleum available in North America, but oil won by mining and distilling these shales, situated in the interior of a continent, cannot enter the world's markets as labor-cheap as the petroleum that flows from Mexican wells close to the coast.

In this rapid review of the world's sources of energy we see North America taking first rank among the continents, with Asia a close second and Europe a poor third, although we should remember that Europe has a much smaller area than either of the other two.

Differences in the Three Great Sources of Energy—Water, Coal and Oil

Now, in considering how the world may best manage its ever-increasing power load, some aid may be found in a few comments on the differences between these three sources of energy—water, coal and oil. Man has learned how to harness flowing water with great efficiency, but even in Europe and North America only about one-fifth of the potential power has yet been developed. But we may expect our rivers to take on an even larger share of the base load in any power program that seeks to conserve the energy supplies in coal, oil and men. Of course, even with wisest utilization, coal must again take up the burden as full development of water power is approached, for coal is the world's great source of heat and power, and the largest development of water powers is practicable only with coal power as the dependable "stand-by," ever ready to meet promptly any special demand.

Oil and natural gas are the popular fuels, regarded as highly efficient because they are preëminently labor saving—easily produced, easily transported and easily used. As a source of power these fluid fuels present a marked contrast with water. Hydro-electric energy is even more easily distributed and used, but water-power development involves large capital outlay and in any national emergency no quick response in water power is possible; the water-power projects planned to meet the power needs discovered in the course of our wartime expansion of industry are even now hardly under way. But when the large necessary investment of labor and material is once made in water power, the output of energy continues for generations. Oil and gas, on the contrary, are quickly developed and quickly exhausted. Already we realize that natural gas, the ideal fuel, is a resource so temporary that its use forms merely an incident in industrial progress; it has been a wasted as well as a wasting resource. The sorry lesson we have learned in natural gas may have its value if we apply the truth to our use of oil. Unless we check the increase in the consumption of oil it, too, will be but a flash in the pan.

Relative Positions of Water, Coal and Oil

If we leave the world point of view for a moment and look at the power problem in our own country, we are able to see in more detail the relative position of water, coal and oil as sources of energy. To compare these three resources, we may start with the country's present total power requirements. If we take 50 million horsepower as an average figure for the potential water power of the United States, without storage, we find that if fully developed and if used at the average load factor of today our rivers and streams would just about meet the country's present needs and would supply that amount of power for all time; moreover, with storage and an improved load factor they could provide a considerably increased output of energy to meet the growing demand.

If, however, we should put the whole burden on our coal mines, not using even the water power now used, we would find that by adopting the best steam practice of today the present power requirements of this country could be met with coal for 57,000 years.

Adopting the best steam practice of today as known in the largest public-utility stations where fuel oil is used and trying to carry the whole power load of the country with oil alone, we find that the oil reserves of the United States, although measured by billions of barrels, would last only 9¼ years. Without allowing for the fact that steam-raising for power is but one of the many uses of coal, these two figures—57,000 years and 9¼ years—are sufficiently impressive to make us fairly receptive to the general truth of Mr. Eckel's statement in his recent book "Coal, Iron and War": "We have just as much real chance of replacing coal by oil as we have of finding enough gold to use it in place of steel."

Priority in Use of Oil

Granted, then, that we have not enough oil to permit its use where either coal or water power can be had, we face the question of priority in use. In view of the rapid increase in the employment of machinery first thought should be given to the unique function of oil—that of saving power. The world will always need a supply of lubricants, and as the demand will be an increasing one no adequate substitute for the lubricating oils and greases now derived from petroleum appears to be available. The claim of illumination for priority is less well established if we regard the future, for the kerosene lamp and even the fixtures burning oil gas or enriched water gas must eventually give place to the electric light.

The real competition comes in the relative claims of automotive gasoline and of fuel oil, for the larger yield of gasoline through more efficient cracking is gained at the expense of the fuel-oil content of the crude oil. This is conclusively shown in the statistics collected by the Bureau of Mines, for in the last four years the fairly constant gain in the percentage of gasoline yield is offset by a similar loss in the yield of fuel oil and gas oil. These two uses are to that extent already rivals, and we may expect refinery practice to be responsive to the automatic control of prices, which in turn ought to express relative demand. A logical plea for motor fuel can be made by the trucks that already form so large a part of our distribution system and the tractors that by the million will soon be helping to meet the world's increased demand for food. Truck and tractor must be given the first places in the long line of automobiles seeking motive power at the gasoline station.

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*Abstract from a paper presented before the American Petroleum Institute, Washington, D. C., Nov. 17, 1920.

Fuel oil has won favor as a source of power for transportation because it has been relatively cheap, is easier to handle and occupies less space than the equivalent heat units in the form of coal. In these respects fuel oil is superior for use in transportation, and this use deserves priority over that for firing stationary boilers, for which coal should be substituted. Indeed, thoughtful regard for the future leads us to disallow even the claim of steam locomotives for fuel oil, for electrification of the railroads by water power alone or from water-power stations and steam stations linked together is now the obvious way to make the best use of our resources of expendible fuel. Austria, bankrupt in fuel, having lost her coal and oil, has begun to electrify half her railway mileage. Shall other nations wait until they, too, are bankrupt in oil before awaking to the need of change in sources of power? The program of conservation through electrification has started, and while this simply emphasizes our future dependence in larger measure upon coal, it should at once make us abandon fuel oil as a source of motive power for our railroads and industries. In a word, the world has not oil enough to burn under either stationary or locomotive boilers.

ADVANTAGES OF DIESEL ENGINES IN MARINE SERVICE

The very facts that support the argument for the marine use of fuel oil—greater efficiency and economy of space and labor—can be cited in favor of the internal-combustion engine of the Diesel type as against the steam engine. The increased thermal efficiency of the new engine with its resulting addition to available cargo space or to cruising radius, is more than 2½ times that of the steam engine. The experience of the Bethlehem Steel Co. is that their new oil-engine ore-carrier, the "Cubore," in continuous service between Cuba and Sparrows Point, Md., uses only 36.7 per cent of the fuel oil consumed by a sister ship, differing only in that it has the most modern type of steam plant. The tremendous economy thus possible in the marine consumption of fuel oil demands the immediate adoption of internal-combustion engines if the world wants to make the largest use of its oil resources for the longest time.

How to supply the world's needs in oil thus comes to be an international question of the first order. Our monthly statistics take on the importance of danger signals, which must be read "Run slow." Perhaps these figures can be best grasped if they are stated in terms of a daily balance sheet. In September of this year, as in August, the daily output of the United States oil wells was slightly over 1¼ million barrels, but the daily consumption rose to 1⅝ million barrels. This daily deficit of three-eighths of a million barrels was met by imports from Mexico. In meeting the world's need for oil, the United States has played a large part. In the last sixty years our contribution to the world's output of oil has been never less than 44 per cent (the figure during the brief period when Russia led) and earlier reached even 99 per cent, while of the total 8 billion barrels so far consumed by the world 5 billions came from the wells of the United States.

DANGEROUS RATE OF INCREASE IN OIL INDUSTRY

With the oil fields of the United States perhaps 40 per cent exhausted, it is not reasonable to assume that 60 per cent of the world's output will continue to come from wells in the United States. It is true that no other primary industry has shown anything like the growth of our oil industry, and even now the dangerous rate of increase continues; for the normal output of most commodities we can take the year 1913 as an index, but our output of petroleum in 1920 promises to exceed that of 1913 by nearly 75 per cent, and we may add that our output of gasoline has shown almost an equal increase in half that time. We who have watched this marvelous growth of the oil industry have seen within a few years the transition from oversupply to over-demand, and the ever-mounting curve of consumption seems to know no law.

A world policy, if it is to safeguard the future, must draw up a program that will favor thrift in the use of the oil currently produced, and in that program also there must be a joining of the nations in continued effort for the common good. When the world runs short of oil, all nations will suffer, regardless of the geographic location of the remaining wells. America has led in teaching the world to use petroleum, whether in lamp or automobile or tractor, and it should be America's special duty to teach the world to use petroleum most efficiently. No longer is there any need to make a market for oil; the task is to find the oil to supply the demand already created.

The substitution of fuel oil for coal has had no noticeable effect on the consumption of coal, although it has materially increased the consumption of oil. Thus in the industrial zone between Washington and Boston, fortunately, little fuel oil is used by the public-utility electric plants, the quantity even now being equivalent to less than 2 per cent of the coal used, yet it is significant that this use has more than quadrupled since January of this year. An authoritative statement, moreover, can be made that over the country as a whole this competition by fuel oil, generally referred to as the "fuel-oil menace," has had but little effect on the demand for coal. Two inquiries were made in 1919 and 1920 by the United States Geological Survey to ascertain the stocks of coal held by the electric utilities and general industrial plants, and incidentally any change in the fuel used was reported. The substitution of oil for coal in the year ended March 1, 1920, as indicated by these reports, affected about 3 per cent of the plants, but represented only about 1 per cent of the coal consumption. This substitution was confined to the seaboard and to localities close to the oil fields. In short, fuel oil is not a competitor to be feared by coal, and its use under stationary boilers is a menace only to the higher use of fuel oil or some other product of petroleum.

NECESSITY OF ECONOMY IN TRANSPORTATION OF OIL

Economy in the transportation of oil is a topic that especially deserves the world view. As in the interstate traffic in coal, so in the world commerce in oil, cross-hauls are to be avoided. Economy on a large scale demands that the oil come from sources as near at hand as possible. The conception of American tankers encircling the world with cargoes of Texas fuel is more picturesque than practical if other and nearer supplies are available. The Western and Eastern Hemispheres should be as independent as possible, for it is indefensible waste to burn oil to carry oil across the Atlantic or the Pacific in both directions. The ideal plan for fuel-oil bunkering will provide well-distributed stations, backed up with near-by reserves of oil, and such a system seems to be an essential part of any shipping program, whatever the flag of the oil-burning ship. This type of thrift in oil would mean foreign supplies of oil with which to bunker American ships.

With five-sixths of the world output of oil coming from the Western Hemisphere, however, it is too soon to expect the economy in the transportation of oil that has here been suggested, yet it is not too much to seek to make the rest of the world more self-supporting in oil and less of a drain upon the Caribbean region. A kind of oil-zoning system for the world may some day not be too extreme a proposal if we are to give full force to plans for economy in oil. So, too, a question that may sometime be asked is whether national or international oil-bunker stations are better justified.

Brazil has extensive plans for the development of interior transportation, including the construction of power plants for industries and the electrification of railways. Rio de Janeiro is to have a 270,000-hp. plant erected in the near future by an internationally organized company having American interests, according to Dr. Julius Klein, United States Commercial Attaché to Buenos Aires. Two hydro-electric stations are to be built and an electric street-car service inaugurated in the vicinity of Rio de Janeiro.

The Federated American Engineering Societies

Holds Its First Meeting—Herbert Hoover Elected President—Conditions of Labor and Production Discussed

THE first meeting of the American Engineering Council of the Federated American Engineering Societies was held at the New Willard Hotel, Washington, on Thursday and Friday, Nov. 18 and 19. In his opening address Richard L. Humphrey, chairman of the Joint Conference Committee of the four founder societies under whose tutelage the Federation has been brought about, said that the committee had kept in active touch with the 116 organizations invited and had received replies from all but about 3 per cent of the aggregate membership represented by them. Organizations represenative of 35 per cent of this aggregate membership had accepted the invitation, and including participating organizations which are still giving the matter of joining favorable consideration but have not taken final acton, 50 per cent of the aggregate is represented at this meeting.

The unanimity of desire of the engineering and allied technical professions for a comprehensive organization that can speak for them in matters of public welfare, where technical training and engineering experience are involved, as well as in matters of common concern to these professions, culminated in the unanimous creation of the Federated American Engineering Societies and of its governing board, American Engineering Council, and has attracted world-wide interest. There has been a fear among the members of some of the societies invited to membership that this organization will become a political machine and will indulge in lobbying and pernicious practices in the promotion of causes favoring special interests, and not for the general good of the profession. In all the meetings of its organizers this is not one of the matters on which there has been a division of opinion. The organization was not formed for a purpose inimical to its success.

THE FEDERATION NOT A LABOR UNION

The organization has also been characterized as a labor union. This is distinctly what it is not. Engineering Council has undertaken the preparation of a schedule of classification and minimum compensation for engineers in various lines of work, and it is expected that this work will be continued by American Engineering Council. If this schedule is backed by this representative party, it will effectively establish standards which will be instrumental in raising the minimum compensation of engineers. It is assumed that it will not be the function of this body to enforce the minimum compensation, since this will be left to the individual. This marks the important distinction between the functions of this body and those of a labor union.

There is an opportunity now to render a great nation-wide service by the establishment of an Engineering Societies' Service Bureau, furnishing a point of contact for engineers desiring employment and those who desire to employ engineering service, and having in every city branches that will exert a great co-ordinating influence over the profession and industry. The vital need for constructive suggestions, based upon careful study of the great national problems, such as transportation, conservation of labor, water, fuel and other natural resources, should be met through the work of this organization. Such methods are especially within its field, and it should devote its energies to helpful work in this direction as far as the non-technical phases are concerned.

The securing of a National Department of Public Works, of assisting in many problems connected with the National Budget System, are among the important phases of desirable activity for this organization.

It is earnestly desired that this body shall not dissipate its powers in work on unimportant details, but show a capacity for leadership, forming public opinion by bending its energies to those problems which involve technical training and engineering experience.

In conclusion he said: "The first step in realizing the dream of the engineering and allied technical professions for solidarity has been taken. The wisdom of your acts will be reflected in a measure of success which shall result in increased support from the engineering and allied technical organizations. If you live up to your best, no organization will wish to be outside the pale of membership. The keynote of whatever policy you may agree upon should be service."

E. S. Carman, of Cleveland, Ohio, president-elect of the American Society of Mechanical Engineers, was elected temporary chairman, and William E. Rolfe, representing the Associated Engineering Societies of St. Louis, temporary secretary.

Owing to the decision of the American Society of Civil Engineers, which society he represented on the Joint Conference Committee, not to participate in the Federation, Mr. Humphrey was without official standing in this meeting. The body, however, voted its appreciation of his past efforts, its regret at the circumstances which prevented his being present as a representative, and extended to him the privilege of the floor.

Following the appointment of temporary committees on program, credentials, constitution and bylaws, nominations, plan and scope, budget and resolutions, a discussion regarding the place of meeting came up, and the question was undecided at the noontime adjournment.

HEADQUARTERS TO BE IN WASHINGTON

In the afternoon J. Parke Channing gave an address reviewing the work of Engineering Council, of which he is chairman. This was followed by a discussion of the Field of Activity for the Federated American Engineering Societies, after which the discussion upon the location of the headquarters of the American Engineering Council was resumed and resulted in the choice of Washington. The afternoon's activities concluded with an address by Lewis B. Stillwell, of New York, upon Transportation.

On Friday morning, pending the report of the Committee on Nominations, L. W. Wallace, of Baltimore, addressed the council on the Conservation of Labor.

The Committee on Nominations suggested the following list of officers, who were unanimously elected: President, Herbert Hoover; vice-presidents, Calvert Townley, of New York; William E. Rolfe, of St. Louis; Dexter S. Kimball, of Ithaca, and J. Parke Channing, of New York; treasurer, L. W. Wallace, of Baltimore.

The council avoided its first rock when, in the discussion of the report of the Committee on Constitution and Bylaws an effort was made to modify the declaration adopted by the organizing conference that the proceedings of the council, executive and other committees, and the records thereof should be available to the public and the press. After a rather lively discussion the provision for open covenants openly arrived at was allowed to stand.

ADDRESS OF HERBERT HOOVER

In the evening a meeting to which the public had been invited filled the ballroom of the New Willard. The feature of the program was an address of the newly elected president, Herbert Hoover, in the course of which he said:

Enormous industrial expansion of the last fifty years has lifted the standard of living and comfort beyond any dream of our forefathers. Our economic system under which it has been accomplished has given stimulation to invention, to enterprise, to individual improvement of the highest order, yet it presents a series of human and social difficulties to the solution of which we are groping. The congestion of population is producing subnormal conditions of life. The vast repetitive operations are dulling the human mind. The intermittency of employment due to the bad co-ordination of industry, the great waves of unemployment in the ebb and flow of economic tides, produce infinite wastes and great suffering. Our business enterprises have become so large and complex that the old personal relationship between employer and worker has to a great extent disappeared. The aggregation of great wealth, with its power of economic domination, presents social, economic ills which we are constantly struggling to remedy.

The populations of our modern states have been built up to numbers dependent upon an intensity of production that can be maintained only by stimulation of individual effort through the impulse of self-interest, and a departure from this primary incentive to production has now been demonstrated to lead only to famine and flame and anarchy.

We have built up public agencies intended to preserve an equality of opportunity through control of possible economic domination. Our mass of regulation of public utilities and of many other types of industry, aiming chiefly to prevent combinations in restraint of free enterprise, is a monument to our attempts to limit this economic domination—to give a square deal. This regulation is itself also proof of the abandonment of the unrestricted capitalism of Adam Smith. While our present system of individualism under controlled capitalism may not be perfect, the alternative offers nothing that warrants its abandonment. Our thought, therefore, needs to be directed to the improvement of this structure and not to its destruction.

A profound development of our economic system apart from control of capital and service during the last score of years has been the great growth and consolidation of voluntary local and national associations. These associations represent great economic groups of common purpose and are quite apart from the great voluntary groups created solely for public service. We have the growth of great employers' associations, great farmers' associations, great merchants' associations, great bankers' associations, great labor associations—all economic groups striving by political agitation, propaganda and other measures to advance group interest. At times they come in sharp conflict with each other and often enough charge each other with crimes against public interest. And to me one question of the successful development of our economic system rests upon whether we can turn the aspects of these great national associations toward co-ordination with each other in the solution of national economic problems, or whether they grow into groups for more violent conflict. The latter can spell breakdown to our entire national life.

This engineers' association stands somewhat apart among these economic groups in that it has no special economic interest for its members. Its only interest in the creation of a great national association is public service to give voice to the thought of the engineers in these questions. And if the engineers, with their training in quantitative thought, with their intimate experience in industrial life, can be of service in bringing about co-operation among these great economic groups of special interests they will have performed an extraordinary service.

HERBERT HOOVER, PRESIDENT OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES

The employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers, and yet the labor organizations, as they stand today, are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possibile initiative on the part of the employer; and further, that in the long run we can expand the standard of living only by the steady increase of production and the creation of more goods for division over the same numbers.

The American Federation of Labor has publicly stated that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance not only to the Federation of Labor, but also to the other great economic organizations interested in this problem, such as the Employers' Association and the Chamber of Commerce.

In the questions of industrial conflict resulting in lockouts and strikes one mitigating measure has been agreed upon in principle by all sections of the community. This is collective bargaining by which, whenever possible, the parties should settle their difficulties before they start a fight.

It is founded not only on the sense of prevention, but on the human right to consolidate the worker in a proper balanced position to uphold his rights against the consolidation of capital. This measure, advocated for years by organized labor, was agreed to by the employers' group in the First Industrial Conference. It has been supported on the platform of both political parties. The point where the universal application of collective bargaining has broken down is in the method of its execution.

Increased Production and Wasteful Unemployment

There are questions in connection with this entire problem of employer and employee relationship, both in its aspects of increased production and in its aspects of wasteful unemployment, that deserve most careful study by our engineers. There lies at the heart of all these questions the great human conception that this is a community working for the benefit of its human members, not for the benefit of its machines or to aggrandize individuals; that if we would build up character and abilities and standard of living in our people, we must have regard to their leisure for citizenship, for recreation and for family life. These considerations, together with protection against strain, must be the fundamentals of determination of hours of labor. These factors being first protected, the maximum production of the country should become the dominating purpose.

We must take account of the tendencies of our present repetitive industries to eliminate the creative instinct in its workers, to narrow their field of craftsmanship, to discard entirely the contribution to industry that could be had from their minds as well as from their hands. Indeed, if we are to secure the development of our people, we cannot permit the dulling of these sensibilities.

There is an immediate problem in increased production that is too often overlooked by the theorist. While it is easy to state that increased production will decrease cost and by providing a greater demand for goods secure increased consumption and ultimate greater employment, yet the early stages of this process do result in unemployment and great misery. It takes a variable period of time to create the increased area of consumption of cheapened commodities, and, in the meantime, when this is translated to the individual worker he sees his particular mate thrown out of employment. We accomplish these results over long periods of time, but if we would secure co-operation to accomplish them rapidly we must take account of this unemployment and we must say to them, the community, that if it is to benefit by the cheapening costs and thus the increased standard of living, or alternatively if the employer is to take the benefits, the entire burden should not be thrust upon the individual who now alone suffers from industrial changes.

Interest in Creation and Craftsmanship Must Be Kept Awake

If we are to secure increased production and an increased standard of living we must keep awake interest in creation, in craftsmanship and the contribution of the worker's intelligence to management. Battle and destruction are a poor solution to these problems. The growing strength of national organizations on both sides should not and must not be contemplated as an alignment for battle. Battle quickly loses its rules of sportsmanship and adopts the rules of barbarism. These organizations, if our society is to go forward instead of backward, should be considered as the fortunate development of influential groups through which skill and mutual consideration can be assembled for co-operation to the solution of these questions. If we could secure this co-operation throughout all our economic groups we should have provided a new economic system, based neither on the capitalism of Adam Smith nor upon the socialism of Karl Marx. We should have provided a third alternative that preserves individual initiative that stimulates it through protection from domination. We should have given a priceless gift to the Twentieth Century.

Mr. Hoover's address was followed by an informal reception and smoker tendered by the local engineering societies.

Facts About the Tonawanda Switch Station Explosion

When, on Monday morning, Nov. 1, engineers as well as laymen read in the daily newspapers the reports of the accident at the substation of the Tonawanda Power Co., at Tonawanda, N. Y., the former wondered what had happened to cause the catastrophe, and the latter accepted the report as something incident to electrical power generation and transmission. Since the occurrence of this accident it has been learned from the officials of the Niagara Falls Power Co., Niagara Falls, N. Y., that that company has a switching station at Tonawanda, adjoining the Tonawanda Power Co. substation. This switching station had no operator, since it contained no switching apparatus that was operated under load, the operator from the Tonawanda Power Co.'s substation making any changes in the disconnecting switches that might be necessary when repairs were made on the transmission lines, this being at intervals of several months.

On account of increased demands for power at Tonawanda, it became necessary to install two new current transformers in the switching station there. These transformers were insulated for 45,000 volts, while the potential of the line was only 22,000 volts. The Tonawanda Power Co. supply was shut down and a picked crew was sent by the Niagara Falls Power Co. to install the transformers and make some other connections for the enlargement of the Tonawanda company's substation. After this work had been completed and the workmen were ready to go home, the disconnecting switches were closed by the Tonawanda substation operator, this making the new installation alive. About three minutes after this a snapping sound characteristic of static discharge was heard in the switch station, and an explosion occurred involving the whole switching station.

At the time of the accident there were thirteen men in and around the station, nine of them being employed by the Niagara Falls Power Co. and the rest by the Tonawanda Power Co. Four of these men were killed instantaneously, eight died within twenty-four hours after the accident and one five days later. Apparently a number of the men sacrificed their lives in a heroic, although unsuccessful, effort to save the lives of their fellow workmen. Contrary to the belief created by the newpapers that transformers containing large volumes of oil were in the station, the only apparatus containing oil consisted of four current transformers and two potential transformers. The cases of both of the new current transformers were found broken when the fire was extinguished. Other transformers of this type have been in service for several years on the Niagara Falls Power Co. system without giving any trouble. On account of the nature of the accident it will be very difficult to determine the exact cause of the trouble.

The plans for the hydro-electric development of the Upper Adige in Italy contemplate the erection of three large generating stations. The first will be located between Glurns and Chladerns and will develop 50,000 hp.; the second will be at Castelbello and will provide 60,000 hp.; and the third, which will be the largest, will furnish 100,000 hp., making a total of 210,000 hp. Proposals to convert three lakes on the river into impounding reservoirs have been given up, since this is liable to prove disastrous to three rural communes.—*Electrical Review*, London.

Senator Edge's Version of Coal Profiteering

Intervention by the Government, rather than the nationalization of the coal industry, is the desire of Senator Edge of New Jersey. The announcement made by the Senate Committee on Reconstruction and Production has led to a general assumption that Senator Edge is willing to see the coal mines nationalized, if the industry itself does not clean house before Dec. 6. To correct any misunderstanding of this point, a formal statement was made public at the Senator's office Nov. 20. Excerpts from the statement follow:

> In the recent and prevailing high prices and shortage of coal, both bituminous and anthracite, a condition has arisen in that industry which, unless soon corrected, will in my judgment compel the people to intervene. Who is to blame for these high prices—these apparently unreasonable and unjustified prices—must be determined, and those to blame must be brought to reason, even if it be necessary for the people, through their own agency in "Government," to take steps toward that end. Apparently, the various elements engaged in the coal industry are unable to place this blame where it belongs. So much time, energy and ingenuity are expended in the merry sport of "passing the buck" that the man on the sidelines is inclined to wonder how the industry finds time to provide coal.
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> "I'm not to blame," says the miner, "it's the operator." Then, "Not guilty," says the operator, "it's the middleman"; and he in turn blames the railroads for car shortage, and the gladsome game of "Here we go round the mulberry bush" continues with enthusiastic cheer. But, with each of these groups accusing the other, the people are moved to wonder whether, after all, each one of them is not somewhat to blame and whether all may not be involved in the boosting of prices.
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> At all events, the people have been suffering and are suffering from high prices and short supplies. The average American citizen is the most patient mortal of all the peoples of the earth, but even his patience has a limit. The cold fact is that the people now look on the coal industry as a private oppressor of the public, and when the American people are driven to this extremity of view, their alleged oppressor may do well to pause and ponder. As I said, when the people suffer, the business which causes that suffering is bound to suffer also.
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> When, recently, I spoke of possible "Government intervention" to remedy the apparent evils in the coal industry, the ogre of bureaucratic intervention arose to plague some folks at interest. So dim is the recollection in these days that the people are "the Government" that such folks saw visions only of some autocratic agency despotically taking possession of their business and "meddling in their affairs." The truth would be that the people themselves had rebelled against oppression and had instructed their chosen representatives in the Legislative and Executive departments to act for them in relieving such oppression.
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> The situation is desperate. In my own state, New Jersey, coal is unobtainable in many sections and, where obtainable, may be purchased only at sky-high prices. Identical reports come from virtually every state in the Union. Who is to blame for this situation? If the component groups of the coal industry cannot ascertain, then the people, through their chosen representatives, must do so. If the coal industry will not, or cannot, immediately remedy conditions, the people through their chosen representatives must and will do so.
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> Sound business men and the average citizen will hope that such intervention may be only temporary and even of short duration, and that the Government, which is the people, soon may be relieved of the task of directing an industry of private nature. But in their extremity of suffering, their experience of Government management of the railroads is nearly forgotten and the possibility of Government control of coal does not appall them. For the people have been accustomed to seeing the Government, under the present Administration, intrude into numerous lines of private business. They have seen the Government engaged in the real-estate business, in hotels and boarding houses and theaters, in the wholesale and retail grocery trade, in women's hosiery handled by the War Department—in everything, from cough drops to coffins and from antiques to ziziths. They still disapprove Government ownership or control, but they may be driven to a state of willingness to try the experiment.
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> The people do not ask much: Only reasonable prices and adequate supplies for the consumer, legitimate profits for the operators and distributors, fair wages and treatment for the miners and reasonable dividends for the owners of the railroads over which coal is transported.

"The Engineering of Men" To Be Discussed

The Taylor Society, which has for its object the promotion of the science and the art of administration and management, has arranged a meeting for Friday evening, Dec. 3, at which the subject will be "The Long Day in the Steel Industry—A Problem in the Engineering of Men." This meeting will be a joint session with the Metropolitan and Management sections of the American Society of Mechanical Engineers and the New York section of the American Institute of Electrical Engineers, and will be held at 8 o'clock in the Engineering Societies Building, New York City. Fred J. Miller, president of the A. S. M. E., will preside.

A report on "The Three-Shift System in the Steel Industry" will be presented by Horace B. Drury, who was recently associated with the United States Shipping Board and who has been for the last few months visiting practically all the steel plants in the United States that are working under the three-shift system, collecting technical data on the details of their operation and figures showing the results obtained.

William B. Dickson, vice president of the Midvale Steel and Ordnance Co., will give the point of view of the manufacturer, after which there will be a general discussion, led by Robert B. Wolf, consulting engineer, of New York City.

The Taylor Society's business session will be held on Dec. 2, but throughout the day on Friday and Saturday, Dec. 3 and 4, public sessions will be held to which those interested are invited. The subject of Friday's session will be "Scientific Management in the Sales Department," and on Saturday "Standardization of Products" will be discussed. A final meeting will be held Saturday evening at 8 p.m.; at which there will be a general discussion of "Risk—A Retarding Factor in Production."

Research Information Bureau Established

The National Research Council has established the Research Information Service as a general clearing house and informational bureau for scientific and industrial research. This "Service" on request supplies information concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc.

Ordinarily, inquiries are answered without charge. When this is impossible because of unusual difficulty in securing information, the inquirer is notified and supplied with an estimate of cost.

Much of the information assembled by this bureau is published promptly in the "Bulletin" or the "Reprint and Circular Series" of the National Research Council, but the purpose is to maintain complete up-to-date files in the general office of the Council. Announcement will be made from time to time of special informational files which have been prepared.

Requests for information should be addressed: Research Information Service, 1701 Massachusetts Avenue, Washington, D. C.

Mining Engineers Working on the Coal Problem

The American Institute of Mining and Metallurgical Engineers' Committee on the Stabilization of the Bituminous Coal-Mining Industry has prepared a set of conclusions, which are as follows:

1. That the bituminous industry, by the nature of its organization, functions economically in a too inefficient manner. Employment in the industry averages less than 220 days per annum, with a minimum district average of less than 200 days. Thus a labor staff and capital investment of fully 30 per cent more is required than otherwise would be necessary. From this flow a high daily wage, a considerable portion of the just complaints of labor and a higher cost of coal to the consumer.
2. The causes are very largely (a) intermittency in seasonal demand, (b) irregularity of car supply and (c) the lack of storage facilities and incentive for their use.

3. The cure lies in: (a) The co-operation of railroads in the establishment of seasonal differentials in rates that will induce summer demand; (b) increased transportation facilities and a more efficient and equitable distribution of cars; (c) increased use of central and interconnected electric-power plants; (d) lower selling prices in dull seasons made possible by differentials in profits, freight rates and wages; (e) recognition by the larger consumers, such as the Federal, state and municipal institutions, railroads, public utilities and industrial plants, that not only continuity of operation, but also the safety of the public from the stoppage of supply, demands that they provide adequate storage to be replenished in the dull season.

4. Such storage is feasible and can be made financially remunerative by differential rates and prices. Public safety demands the installation of storage facilities at the place of consumption.

5. No adequate solution can be found, except through organized co-operation of operators, labor, railroads and large consumers. Under existing laws as to combinations, such co-operation cannot be carried on. Therefore, we believe that some Federal legislation is necessary, permitting such co-operation under competent Government authority.

Engineering Examiners Form National Council

Representatives of seven state boards of engineering examiners met in Chicago on Nov. 8 and 9 in response to a call sent out by K. C. Kastberg, city engineer, Des Moines, and formed the National Council of State Boards of Engineering Examiners. The purpose of the new organization is "to examine the state laws providing for registration of engineers and the customs and rule of procedure of the different boards in the examination of applicants, with suggestions and recommendations for uniformity of practice so far as it can be done legally by the different state boards, and to provide for reciprocal relations between the state boards for granting registration licenses to applicants from other states on equal terms of examination."

It was realized that there was little chance of ever getting a uniform law in all the states, so that the practical thing to do would be to provide as nearly as possible for uniformity in administration. Seven states are now represented in the Council, and it is to be hoped that the four other states that have license or registration laws will join. The states represented are Iowa, Illinois, Florida, Louisiana, South Dakota, Michigan and Colorado.

Throughout the meeting there was prolonged discussion of the provisions in the proposed draft of the uniform law recently approved by Engineering Council. The following resolutions, which were finally passed, indicate the unanimity of opinion on reciprocity: (1) That where a qualified engineer obtains a contract he be permitted to proceed after filing an application and pledging himself to appear for examination at the next board meeting; (2) that efforts be made by the several states to standardize the examination; (3) that the members of the various boards be granted reciprocity license or registration without examination.

The officers elected were as follows: President, Marcel Garsaud, New Orleans; vice president, C. S. Hammatt, Jacksonville, Fla.; secretary-treasurer, Alvin LeVan, Des Moines, Iowa. The next meeting will be held on Oct. 3, 1921, in St. Louis.

Admiral W. S. Benson, Chairman of the United States Shipping Board, discussed the "Demands of the Shipping Board for Oil" before the American Petroleum Institute recently. He impressed it upon his hearers that "we are now facing the most unrelenting and stifling competition of nations trained in all the fine points of ship operation. One of our greatest advantages lies in the fact that about 75 per cent of our entire fleet burns oil for fuel, as compared with about 15 per cent for all foreign shipping. This advantage cannot be realized to the fullest extent unless the Shipping Board and the American Merchant Marine as a whole can be assured of an adequate supply of fuel oil not only now but, of more importance, in the future as well, at reasonable prices."

The Bureau of Mines is conducting tests at the Northwest Experiment Station, Seattle, Washington, for the purpose of developing efficient methods of washing coal. This is made necessary by the very poor quality of coal which is frequently mined nowadays. The process under consideration depends upon differences in specific gravities between the clean coal and its associated impurities. The co-operation of several coal-mining companies has been secured and gratifying results obtained.

From 8,000 to 10,000 tons of American coal per month is sent to Constantinople at prices ranging from $35 to $42 per ton.

New Publications

LESSONS IN MECHANICS. By Franklin and McNutt. Published by Franklin & Charles, Bethlehem, Pa. 218 pages; 175 illustrations. Price, $2.

This volume was prepared for use as a textbook in technical high schools and covers the field of elementary mechanics in a very praiseworthy manner. The method of treatment should be highly satisfactory for schoolroom work since the examples given deal with familiar objects. It is rather difficult to treat of mechanics without the use of calculus, and since the student is not supposed to have covered calculus a very successful attempt is made to explain the higher mathematics evolved in motion and elasticity.

EFFICIENT OIL BURNING. By Arthur H. Light. Published by the Coen Company, San Francisco, Cal. Cloth; 70 pages: Price, $2.50.

The author of this unique little volume on furnace combustion, with many years of experience in the use of fuel oil, conceived the idea of implanting knowledge of the elementary principles of combustion in the minds of engineers through the agency of a simple text embellished with innumerable figures or moving pictures. The author terms it "Graphic Description." On first opening the volume the reader may be struck by the apparent childishness of the figures termed oxyes, nitroes, carbies, etc., but on reading a few pages, will be constrained to acknowledge that the method of treatment does impress the mind with the basic principles of combustion more effectually than would a more abtruse work. The engineer will find the volume well worth the price asked for it.

MODERN WELDING METHODS. By Victor W. Page, M. S. A. E. Published by Norman W. Henley Publishing Co., New York, 1920. Cloth; 5½ x 8 in.; 292 pages; 113 illustration; 16 tables. Price, $3

Autogenous welding for joining metals has made rapid progress during the last few years, so much so that it has become almost an indispensable art in many industries. In the welding process it is now recognized that the welder is a very important factor in the making of a good weld, therefore this book, which treats of the practice in the use and practical application of oxyacetylene welding and cutting torches, spot, arc and butt systems of electric welding, thermit process, brazing and soldering processes, and forge welding and heat treatment of steel, has a wide field of usefulness. The subjects are treated in a simple non-technical manner for the use of students and practical mechanics rather than the engineer—for those who are more interested in the practical applications than in the theory of welding.

THE A B C OF STORAGE BATTERY MANAGEMENT. By Ernest C. McKinnon, A. M I. E. E. Published by Electrical Press, Ltd., London, England. Size 5 x 8 in.; 95 pages; 31 illustrations. Price, 3s. 10d.

In this little book an attempt has been made to present in plain language the essential features in the installation, care and maintenance of storage batteries, also the rudimentary points that anyone undertaking the operation and management of storage batteries should be familiar with. The text is divided into eight chapters: What to guard against in storage battery operation; battery-room requirements; how to take hydrometer readings: daily inspections; general upkeep; battery terms and definitions. Although the book represents British storage-battery practice, most of the material is equally applicable to lead batteries of every make. The collection of 200 battery terms in the last chapter should prove of particular value to those who are non-technical and wish to become familiar with the storage-battery subject.

DIRECT-CURRENT MOTOR AND GENERATOR TROUBLES. By T. S. Gandy and E. E. Schacht. Published by McGraw-Hill Book Co., Inc., New York City, 1920. Cloth; 5 x 8 in.; 274 pages; 109 illustrations. Price, $2 50.

In general, the designing, construction and installation of power equipment covers a comparatively short period when measured by the operating life of the machine. It is the operating man's job to keep the equipment going throughout the life of the machine after it has been installed, and this book has been written for the purpose of giving the methods which many years of experience have proved to be both simple and effective for testing and remedying direct-current motor and generator trouble. In addition the selection, operation, care and repair of direct-current machinery are analyzed from the standpoint of the operator. The book is divided into nine chapters: Types of motors and their uses; types of generators and their uses; erection and assembly of direct-current motors and generators; starting and operation of direct-current motors and generators; direct-current switchboards: troubles and their remedies; tests and repairs and useful data. Features of plant operation that are always closely associated with the operator's interests are motor and generator troubles, their remedy and repair. In this book 150 pages have been devoted to these subjects, and the authors' long experience with direct-current machinery has familiarized them with this class of equipment in all its conditions.

Personals

DeWitt M. Taylor has been appointed instructor in mechanical engineering, Massachusetts Institute of Technology, Cambridge. He was formerly Associate editor of *Power*.

John A. Stevens, consulting engineer, of Lowell, Mass., is leaving for a month's relaxation in Europe. Can you see John relaxing?

William Miltz, formerly manager of the Certigraph Co., Cincinnati, is now general superintendent of construction for the Lamson Co., Boston, Mass.

F. R. Stevens, chief engineer of the American Locomotive Co., has been transferred from the Richmond (Va.) to the Schenectady office of this company.

D. W. Frazer, formerly general manager of the Montreal Locomotive Works, Ltd., is now located in New York City. Mr. Fraser is vice president of the American Locomotive Company.

L. A. Baldwin is now associated with the H. W. Johns-Manville Co., St. Louis, Mo. He was formerly superintendent of the boiler department of the Empire Gas and Fuel Co., Eldorado, Kan.

Charles G. Keshen is now associated with The Gifford-Wood Co., of Hudson, N. Y., as an engineer on coal-handling and conveying apparatus. He was formerly with the Lamson Co., of Boston, Mass.

L. L. Jordan has left the Foxboro Co., of Foxboro, Mass., and is now sales engineer with the Chadburn Engineering Co., of Troy, N. Y., which has recently placed a new type of CO_2 indicator on the market.

Leon H. Johnson has severed his connection as general manager with the Anderson Foundry and Machine Co. and will in the future be at the head of an engineering firm specializing on oil-engine power plants as well as manufacturing oil engines, at Anderson, Ind.

Society Affairs

The American Society of Refrigerating Engineers is to hold its annual meeting on Dec. 6, 7 and 8 at the Hotel Astor, New York City.

The Detroit Section of the A. S. M. E. is to hold a joint meeting with the Michigan Heating and Ventilating Society on Dec. 3. "Modern Efficiency of Heating and Ventilation" will be discussed by Dr. Hill.

The Detroit Engineering Society will meet on Dec. 3 to hear an address by Dexter S. Kimball, professor of engineering at Cornell University, on "A Broader Field for the Engineer."

The Engineer's Club of Philadelphia will hold a meeting on Dec. 3, at which "The Use of Powdered Anthracite and the Recovery and Use of River Coal" will be discussed by members and engineer guests.

The Taylor Society will hold its annual meeting on Dec. 2, 3 and 4. On the evening of Dec. 3 a joint meeting with the A. S. M. E. and the A. I. E. E. will be held, at which the subject will be "The Long Day in the Steel Industry." The program appears elsewhere in *Power*.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will hear an address on Dec. 4 by H. C. Boynton and W. A. Voigtlander, on "Instruction in the Care, Use and Inspection of Flexible Steel Cables." Technical sessions of the association are held at 8 p.m., preceded by informal dinners at 6 p.m.

Business Items

The Chicago Pneumatic Tool Co. announces the removal of its rock-drill plant from 864 East 72nd St., Cleveland, Ohio, to its Boyer Pneumatic Hammer plant at 1301 Second Blvd., Detroit. The location of the cmpany's Little Giant Air Drill plant at 1241 East 49th St., Cleveland, remains unchanged.

COAL PRICES

Eastern Seaboard—Wholesale prices on bituminous are about as follows:

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$4.50@$5.50	$5.00@$6.50
F.o.b. Philadelphia, gross tons........	7.70@ 8.80	8.25@ 9.90
F.o.b. New York, gross tons........	8.15@ 9.25	8.70@10.35

New York—Quotations at mines: Pool 14, $4.50@$4.75; Pools 71 and 9, $5.75@$6.25; Pool 10, $4.75@$5.50; Pool 11, $4.50@$4.75.

Midwest—Mine prices of principal coals used in central Ohio:

Hocking lump....................	$4.50@$5.75
Hocking mine run................	4.00@ 5.00
Hocking screenings...............	3.50@ 4.25
Pomeroy lump....................	4.50@ 6.00
Pomeroy mine run................	4.00@ 5.25
Pomeroy screenings...............	3 75@ 4 00
West Virginia splints, lump........	5.00@ 6.50
West Virginia splints, mine run....	4.75@ 5.50
West Virginia splints, screenings...	4.25@ 5.25
Pocahontas lump.................	6.50@ 7.00
Kentucky lump...................	5.25@ 6.50
At mines in Southern Illinois:	
Prepared sizes....................	$5.25@$6.50
Mine run.........................	4.75@ 5.50
Screenings.......................	3.75@ 4.25
At mines in Springfield District:	
Prepared coal.......	4 75@ 6 25
Mine run.........................	3.25@ 4.00
Screenings.......................	2.75@ 3.25
At Mines in Northern Illinois:	
Mine run.........................	3.75@ 4.50
Screenings.....	4 00@ 4 50

South—Birmingham, Ala., reports the following quotations: Cahaba and Black Creek mine run, $5.50@$6; Carbon Hill grades, $4@$4.50.

New Construction

PROPOSED WORK

Mass., Cohasset—The city had sketches prepared for a 2 story municipal building. About $500,000. G. F. Newton, 6 Beacon St., Boston, Archt.

Mass., New Bedford—The Bd. Educ. will soon award the contract for a 2 story, 171 x 184 ft. grammar school including a steam heating system on Summer St. About $600,000. Smith & Howland, Bartlett Bldg., Archts.

Mass., South Hadley—The Mt. Holyoke College, M. E. Wooley, Pres., is having plans prepared for a 3 story dormitory including a steam heating system. About $500,000. Brainerd & Leeds, 89 Franklin St., Boston, Archt.

Conn., Fairfield—The DuPont Fabrikoid Co. plans to increase its sub-station capacity to 100 kva. and the motor load by 250 hp. L. A. Beecher, Supt.

N. Y., Brooklyn—The Y. M. H. A., c/o Mr. Moscowits, 189 Montague St., plans to build a 13 story Y. M. H A. building including a steam heating system at 4th Ave. and Dean St. Archt and Engr. not selected.

N. Y., Middletown—The State Hospital Comn., Capitol, Albany, will soon receive bids for a 3 story, 44 x 320 ft., 3 wings, 37 x 76 ft. chronic hospital at the Middletown State Hospital here. About $400,000.

N. Y., Oswego—The city plans to build a 3 story, 200 x 264 ft. high school, including a steam heating system on Utica St. J. A. Randall, S. A. & K. Bldg., Syracuse, Archt. and Engr.

N. J., Atlantic City—The Bd. Educ., c/o Mr. Power, Atlantic and Pacific Aves., plans to build a 3 story high school including a steam heating system. About $1,000,000. Archt. not selected.

N. J., Burlington—The Masonic Order of Burlington, 15 West Union St., will soon award the contract for a temple including a steam heating system. About $300,000. W. T. Arnold, Meriden, Conn., Archt. and Engr.

N. J., Trenton—R. C. Maxwell Co., 413 East State St., will soon receive bids for an 8 story, 97 x 193 ft. office building. Walter Hankin, 241 South Warren St., Archt.

Pa., Altoona—The City Commissioners, c/o H. G. Hinkle, City Mgr., plans to build a 30 x 60 ft. reservoir and install two electrically-driven, automatically-controlled pumps. F. D. Hain, City Hall, Engr.

Pa., Butler—The Butler Memorial Hospital, c/o Dr. T. M. Maxwell, Pres., plans to build a 3 story hospital extension including a steam heating system on Brady Street. About $500,000. E. L. Tilton, 52 Vanderbilt Ave., New York City, Archt. and Engr.

Pa., New Wilmington—The Water Supply Co. is in the market for a 25-hp. gas engine, a force pump and air compressor.

Pa., Philadelphia—The Colonia Garage, 28 East Mount Airy Avenue, is in the market for an 8 x 36 ft. upright boiler.

Pa., Sharpsburgh (Pittsburgh P. O.)—The Borough received bids for pumping station from Pitt Constr. Co., Fulton Bldg., Pittsburgh, $41,900; D. T. Riffle, Keenan Bldg., Pittsburgh, $45,763; Fort Pitt Constr. Co., Martin Bldg., Pittsburgh, $46,369.

Va., Winchester—Estate of Judge Hanley, c/o F. E. Clark, is having plans prepared for a 3 story Handley Memorial School. About $1,000,000. S. H. Edwards, and W. R. McCormack, East 6th St., Cleveland, Associate Archts.

W. Va., South Charleston—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., received bids for direct-current distribution centers in machine shop at the U. S. Naval Ordnance Plant here, from the General Electric Co., River Rd., Schenectady, N. Y., $14,565 and the Westinghouse Electric & Mfg. Co., 803 Hibbs Bldg., Washington, D. C., $18,382.

N. C., Kinston—The city plans to enlarge the electric light and power plant and install machinery and boilers. About $300,000.

N. C., Lenoir—The Granite Falls Mfg. Co., Granite Falls, has applied for permission to build dam, power house, reservoir, etc., on Wilson Creek for public service here. A. A. Shuford, Secy.

N. C., Scotland Neck—The city plans to install a new lighting system. About $50,000.

N. C., Spruce Pine—Col. D. W. Adams, Old Fort, is promoting a hydro-electric project on the Toe River near here. About several hundred thousand dollars.

Fla., Apalachicola—The city voted $50,000 bonds for an electric light plant.

Ala., Montgomery—The Alabama Power Co., Birmingham, has been granted a writ of convenience from the State Public Service Comn. for the construction of a dam and hydro-electric power plant on the Coosa River near Lock 12.

Ky., Louisville—The Ford Motor Co., 2500 South 3rd St., plans to build a 100 x 200 ft. addition to the present automobile assembling plant. About $500,000.

O., Cleveland—The Hayden Investment Co., c/o H. Kangesser, Park Bldg., has purchased site on East 30th St. and Prospect Ave. and plans to build a 5 story, 80 x 210 ft. garage and commercial building including a steam heating system. About $400,000. J. L. Weinberg, Schofield Bldg., Archt.

O., Cleveland—S. S. Koslen, 1077 East 97th St., plans to build a 7 story, 69 x 190 ft. hotel including a steam heating system on Euclid Ave. About $500,000. Archt's. name withheld.

O., Dayton—The Association of Jewish Congregations plans to build a 4 story hospital on Forest Ave. About $400,000. S. Meyerburg, North Jefferson St., Chn. Archt. not selected.

O., Dayton—The Bd. Educ., C. H. Britton, Secy., plans to build a 3 story high school on Summit St. About $750,000. Schenk & Williams, Mutual Home Bldg., Archts.

O., Massillon—The First Nat'l Bank, P. L. Hunt, Pres., plans to build a 6 story, 40 x 144 ft. bank and office building including a steam heating system on Main St. About $300,000. Wm. R. Powell, Rose Bldg., Cleveland, Archt.

O., Milo (Columbus P. O.)—The Bd. Educ., Columbus, is having preliminary plans prepared for a 2 story, 110 x 200 ft. school here. About $265,000. Riebel & Sons, New First Nat'l Bank Bldg., Columbus, Archts.

O., Springfield—The Wittenburg College, c/o Dr. C Huckert, Pres., College Hill, plans to build a 3 story gymnasium and auditorium. About $500,000. Archt. not selected.

O., Youngstown—The Central Bank & Trust Co., Central Sq., plans to build a 1[illegible] story, [illegible] x 18[illegible] ft. bank and office building. About $1,500,000.

Ind., Evansville—The Evansville College, 6 North Michigan Ave., will receive bids in December for a 3 story, 66 x 174 ft. college building on Lincoln Ave. About $400,000. Fullenwider & Dowling, Chicago, Ill., Archts.

Ind., Gary—The First Methodist Episcopal Church is having plans prepared for a [illegible] x [illegible] ft. church and community building including a steam heating system at West 6th St. and Washington Ave. About $[illegible]. Lowe & Bollenbacher, 108 South La Salle St., Chicago, Ill., Archts.

Mich., Birmingham—The Bd. Educ. will soon award the contract for a 2 story, 128 x 16[illegible] ft. school including a steam heating system at Adams St. and Oakland Ave. Baxter, O'Dell & Halpin, 1024 Hammond Bldg., Archts.

Mich., Detroit—The Northwestern Bldg. Corp., 2063 West Grand Boulevard, is having plans prepared for a 2 story theater and office building including a steam heating system. About $2,000,000. C. W. & G. L. Rapp, 190 North State St., Chicago, Ill., Archts.

Mich., Detroit—St. Thomas' Church, Thomas Ave., is having plans prepared for a 2 story 64 x 98 ft. school and a 34 x 48 ft. steam heating plant annex. About $175,000. Van Leyen, Schilling, Keough & Reynolds, 566 Cass Ave., Archts.

Mich., Lansing—The Lansing Agriculture College had preliminary plans prepared for a club house including a steam heating system. About $500,000. Pond & Pond, 64 East Van Buren St., Chicago, Ill., Archts.

Mich., Saginaw—The Bd. Educ. is having plans prepared for a 3 story, 173 x 282 ft. school including a steam heating system on Weadock and Park Sts. About $1,000,000. Cowles & Mutscheller, Chase Block, Archts.

Ill., Chicago—The Lake Shore Trust & Saving Bank, Michigan Ave. and Ohio St., is having plans prepared for a 6 story bank and office building including a steam heating system. Marshall & Fox, 721 North Michigan St., Archts.

Ill., Chicago—The Chicago Women's Club, 410 South Michigan Ave., is having preliminary plans prepared for a 9 story, 104 x 120 ft. club house including a steam heating system on 11th St. About $1,100,000. Pond & Pond, 64 East Van Buren St., Archts.

Ill., Chicago—The Evangelical Lutheran Immanuel Church, c/o E. E. Hall, Archt., 123 West Madison St., is having plans prepared for a 1 and 2 story, 123 x 210 ft. church and social center building including a steam heating system at Ellendale & Greenview Aves. About $400,000.

Ill., Chicago—Cook County, c/o Eric E. Hall, Archt., 123 West Madison St., is having preliminary plans prepared for a 3 story juvenile home including a steam heating system at Roosevelt Rd. and Ogden Ave. About $600,000.

Ill., Chicago—The Sheridan Trust & Savings Bank, B'way. and Lawrence Ave., is having plans prepared for a 10 story bank and office building including a steam heating system. Marshall & Fox, 721 North Michigan Ave., Archt.

Ill., Chicago—B. H. Rosen, 4854 North Irving Ave., plans to build a 5 story, 100 x 130 ft. hotel including a steam heating system at Rogers Park. About $350,000. Ralph C. Harris, 190 North State St., Archt.

Ill. Chicago—The Pilgrim Congregational Church, 64th St. and Harvard Ave., plans to build a 2 story, 100 x 122 ft. church and community house including a steam heating system. About $500,000. C. B. Falkner, 140 South Dearborn St., Archt.

Ill., Chicago—The First Methodist Episcopal Church, 77 West Washington St., is having preliminary plans prepared for a 20 story, 80 x 180 ft. church and office building including a high pressure steam heating system at Washington and Clark Sts. Holabird & Roche, 104 South Michigan Ave., Archts.

Ill., Waukeegan—The Victory Memorial Hospital, c/o Schmidt, Gardner & Mortin, Archts., 104 South Michigan St., will soon award the contract for a 2 story, 40 x 340 ft. hospital and a 1 story, 25 x 90 ft. power house. About $300,000.

Wis., Jefferson—The Jefferson Rubber Co., c/o C. Girton, is in the market for several electric motors, to be used in connection with a new rubber tire factory.

Wis., La Crosse—The Wisconsin Minnesota Light & Power Co., 1[illegible]0 North 5th St., plans to build a new 10,000 kw. steam power plant and extend its electric lines to Hokah, Minn. and Sparta, Wis. About $50,000. F. G. Felton, Mgr.

Wis., Milwaukee—The Milwaukee Bridge Co., 1400 34th St., will have plans prepared for the installation of additional boilers. Cahill & Douglas, 217 West Water St., Engrs.

Iowa, Cedar Rapids—The Bd. Educ., K. Mategil, Secy., will soon receive bids for four high schools including steam heating systems. About $1,200,000. Rugh & Zalesky, 811 Securities Bldgs., Des Moines, Archt., F. Tustison, 355 Auditorium Bldg., Minneapolis, Minn., Engr.

Minn., Annandale—The Bd. Educ. is having plans prepared for a 2 story, 110 x 154 ft. high school including a steam heating system. About $250,000. C. H. Parsons, 600 Builders' Exchange, Minneapolis, Archt.

Minn., Eveleth—The Bd. Educ., J. M. Stearns, Clk., will reecive bids in January for a 3 story, 140 x 200 ft. vocational high school including a steam heating system. About $750,000. W. T. Bray, 817 Torrey Bldg., Duluth, Archt.

Minn., Minneapolis—Dr. A. H. Parks, Chn. of a group of 100 physicians and dentists, 706 Physicians & Surgeons Bldg., plans to build a 12 story office building. About $1,000,000. Archt. not selected.

Minn., Minneapolis—The Bd. Educ., G. F. Womrath, Supt., 305 City Hall, plans to remodel a grade school into a junior high school including a steam heating system at 410 James Ave., North. About $250,000.

Kan., Belleville—The Chicago, Rock Island & Pacific R.R., 139 West Van Buren St., Chicago, Ill., is having plans prepared for a 1 story, 32 x 80 ft. ice manufacturing plant, here. About $80,000. A. T. Hawk, c/o above address, Archt.

Kan., Pleasanton—The city will soon award the contract for a new power plant and two 250-hp. boilers, direct-connected 200-kva. generator, switchboard, condenser, etc. A. T. Archer Co., 609 New England Bldg., Kansas City, Mo., Engrs.

Neb., Norfolk—The Bd. Educ., B. Wolford, Secy., had plans prepared for a 2 story high school including a steam heating system. About $450,000. J. C. Stitt, Archt.

Neb., Wymore—The Wymore Hotel Co., c/o J. S. Jones, is raising funds for a 100-room hotel including a steam heating system. About $350,000.

S. D., Watertown—The South Dakota Packing & Shipping Co. plans to build a 4 story packing house. About $300,000. F. R. Hewitt, Pres.

Mont., Ronan—Mayor J. P. Swee, Missoula County, has made application for permission to build a dam, power house, etc., at Crow Creek, here.

Mo., St. Louis—The Smith & Davis Mfg. Co., 1925 Locust St., plans to build a furniture factory on Goodfellow Ave. About $1,000,000. Archt. not selected.

Mo., St. Louis—The Knights of Columbus, c/o L. E. Hart, LaSalle Bldg., plans to build a clubhouse on Lindell Blvd. About $1,000,000.

Mo., St. Louis—The Power Truck & Tractor Co., Beard and Goldsmith Sts., Detroit, Mich., plans to build an auto truck factory at Mead St. and the Wabash RR., here. About $250,000. Architect not selected. B. B. Craven, Chemical Bldg., St. Louis, Mo., Agt.

Mo., St. Louis—The Southern Car Wheel Co., Ry. Exchange Bldg., plans to build a car wheel factory at Marcus Ave. and Terminal R.R. About $500,000. Archt. not selected.

Tex., Dallas—The Methodist Episcopal Church, c/o Bishop W. N. Ainsworth, Austin, plans to build a hospital here. About $1,000,000. Engr. not selected.

Tex., Port Arthur—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 15, for a 14 x 39 ft. radio station here. Noted Nov. 23.

Wash., Seattle—The University of Washington Y. M. C. A. plans to build a 4 story, 65 x 85 ft. club at North 42nd and East 15th Sts. Baker, Vogel & Evans, Men's Building on university campus, Archts.

Wash., Seattle—J. D. Ross, Supt. of Lighting, has asked the Board of Pub. Wks. for permission to equip 4 of the 14 boilers at the Lake Union steam plant with automatic stokers at a cost of $147,000.

Cal., Exchequer—The Merced Irrigation District, Merced, has applied for permission to build a dam here for power purposes and to operate drainage pumps.

Cal., Los Angeles—J. Harvey Pierce, 4838 Elmwood Ave., has made application for permission to build 3 dams and 3 power houses for mining and lighting purposes.

Cal., San Francisco—J. G. Van Zandt, c/o W. L. Huber, First National Bank Bldg., has applied for preliminary permit to build a power house, reservoir, etc., at Bear and Santa Anna Creeks, here.

Ont., London—The Utilities Commrs. will have plans prepared for a 2 story, 45 x 70 ft. sub-station on Cabell St. and are in the market for transformers, generators, switches, etc. About $85,000. E. V. Buchanan, Hydro Offices, Engr.

CONTRACTS AWARDED

Mass., Charlestown—The Charlestown Gas & Electric Co., 27 Main St., has awarded the contract for a 1 story, 40 x 50 ft. substation on Salem St. to W. M. Bailey, 88 Broad St., Boston. Noted Nov. 23.

R. I., Woonsocket—The Enterprise Dye Wks., Inc., 229 1st Ave., has awarded the contract for a 1 story, 25 x 40 ft. boiler plant to the Eastern Constr. Co., 660 Winter St., at $15,000.

Conn., New Haven—The Sheldon Co., Congress Ave., has awarded the contract for a power house to J. N. Leonard & Co., 952 Chapel St., at $15,000.

N. Y., New York—The Baker & Williams Co., 126 Le Roy St., has awarded the contract for a 9 story, 75 x 100 ft. warehouse addition including a steam heating system at 110 Le Roy St. to Cauldwell-Wingate, 381-4 4th Ave.

Md., Baltimore—The Protestant Episcopal Cathedral of Incarnation, University Parkway, has awarded the contract for a 2 story, 50 x 140 x 70 ft. Synod Hall to Morrow Bros., 1201 Fidelity Bldg., at $270,000. A steam heating plant will be installed in same.

D. C., Washington—The Engineer's Office, War Dept., has awarded the contract for furnishing 4 sets of controller devices for 5-hp. motors to Cutler-Hammer Mfg. Co., 50 Church St., New York City, at $978.12.

W. Va., Beech Bottom (Wellsburg P. O.)—The West Penn Power Co., Hartje Block, Pittsburgh, Pa., has awarded the contract for a 1 story power storage building, here, to the Austin Co., Pittsburgh, Pa., at $40,000.

La., New Orleans—The Linde Air Products Company, 30 East 42nd St., New York City, will build a 1 story, 125 x 125 ft. oxygen factory including a steam heating system, here. About $300,000. Work will be done by day labor.

O., Dayton—The Miami Ice Delivery Co., Ludlow Bldg., has awarded the contract for a 1 story, 60 x 60 ft. ice plant to Blanchard Bldg. Co., at $50,000.

Wis., Milwaukee—The Standard Oil Co., Brumder Bldg., has awarded the contract for the foundation of a 4 story, 75 x 100 ft. office and service building on Sycamore St. to the Universal Constr. Co., 79 Wisconsin St., at $300,000.

Wis., Milwaukee—The Hercules Knitting Co., 1097 Greenbush St., has awarded the contract for a 1 story, 30 x 80, 30 x 40 ft. factory addition to Kroening Constr. Co., Majestic Bldg., at $45,000. Electric motors will be installed in same.

Wash., Seattle—The Pacific Telephone & Telegraph Co., 333 Grant St., San Francisco, Cal., has awarded the contract for a 10 story, 111 x 120 ft. exchange building here, to the Sound Constr. & Engr. Co., Lowman Bldg., Seattle, at $1,000,000. A steam heating system will be installed in same.

Cal., Mare Island—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., has awarded the contract for the installation of a heating system in the structural shop here, to Scott Co., 243 Minna St., San Francisco, at $41,380.

Ont., Ottawa—The Dept. Pub. Wks. has awarded the contract for additions to boiler room at the Printing Bureau to G. C. Graves Co., at $77,000.

POWER

Volume 52 New York, December 7, 1920 *Number* 23

Let's Go to Work

BUSINESS conditions always affect the engineer. If he is one who has charge of the operation and maintenance of a plant, the dull seasons, if not too long, are his busy ones. He finds opportunity to make much-needed repairs. If he is a consulting engineer general depressions bring slack periods in his own business. So perhaps some impressions on the business outlook in this trying period through which we are passing will bring a better appreciation of conditions and assist in the formulation of plans which may be in contemplation, for nearly everyone is planning in accordance with what he sees ahead for business.

America is not alone at this time in the throes of adjustment following a great war. The world over it is the same. People are but now, two years after the signing of the Armistice, sobering from the intoxication of that war. The purse strings have been pulled taut with the suddenness of a cable lifting a bucket from a coal barge.

This is the period of I-won't-buy. It is the morning after a riotously extravagant night.

When people stop buying for long, manufacturing must stop. There is a limit to the burden that all industries can stand. Orders must come in above some minimum volume to support the men and machines producing the commodities for sale. In many, if not most lines, that limit is reached. The burden that is fixed, the idle, or underworked machines, cannot be lightened. The labor charge can—men are therefore laid off. Employers believing their men overpaid, find it a good time to apply wage reduction on those they can keep working. The labor market is liquidated.

In many lines there are stocks of completed commodities, not large stocks, but some at least. In others there is a serious shortage. These stocks were made from high-priced materials with high-priced labor. Yet universally there is refusal to buy at present prices, which are, by and large, lower than they have been for a few years.

Commerce is crippled with buyers' inertia. There is cold and congestion in the pocketbook. The Stock Market shivers off several points.

How can it be sweated out? That is what every business man is asking. There are many qualified diagnosticians, but few Battle Creeks to effect a cure.

The incongruity of it all is that when the shelves of the world are bare we sit looking at them and weeping instead of sweating and working.

Now we are in this mess and we must get out of it. None of us believes we can get what we want without working for it. We are not hoboes.

The situation must be paid for by someone, though he who pays may not have created it any more than one creates the death of a man whose funeral expenses he pays.

Somebody has got to take the loss on goods, made from high-price materials, and somebody else has got to take a loss on similar raw materials to bring prices low enough to get people buying what they need. The loss will probably be no greater than the excess profit made when the low-cost goods and materials on hand before the rise were sold at inflated prices; so many will break even.

This inertia on the part of the buyer must be overcome. He won't overcome it. Not on his three-year overcoat he won't! And you cannot hunger-strike him into doing so because you are he.

Some manufactories are in far less favorable circumstances than others to meet this condition. They are those who delayed in increasing their prices, but who had and have good, honest reasons for doing so. Most of them are entitled to ride in the front coach, but it looks as though they have got to go to the funeral.

Let's go! Let us bury this corpse, weep as much as we have to, get back to the house, put on our jeans and go to work.

Let's go to work!

Salient Features of Large Gas-Fired Generating Station

Gas-Burning Central Station of 23,500-Kva. Capacity—Gas Piped Thirty Miles—Circulating-Water Cooling Tower to Handle Fifty Thousand Gallons Per Minute—Two Different Steam Pressures and Superheats Used in Plants

By R. C. Denny
Operating engineer, San Joaquin Light and Power Company

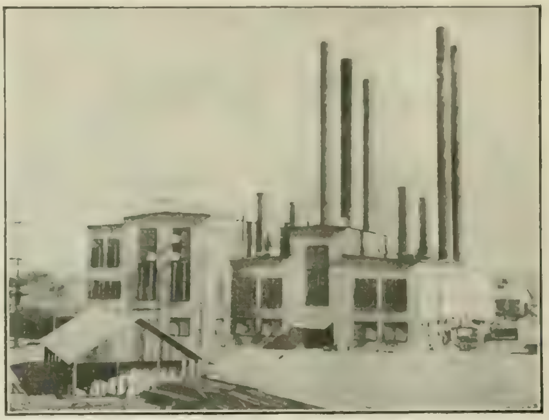
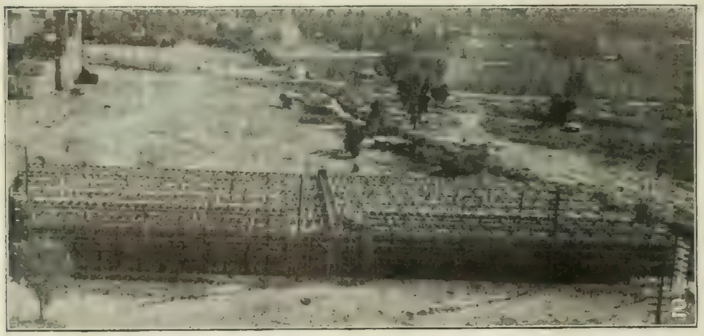
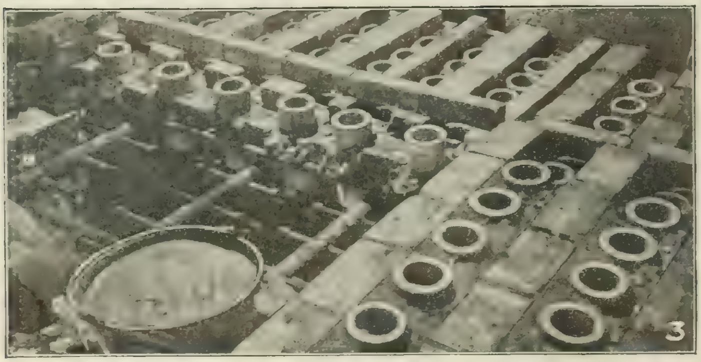


FIG. 1. EXTERIOR VIEW OF BAKERSFIELD PLANT

With the installation of a new 12,500-kva. turbo unit the Bakersfield steam plant (Fig. 1) of the San Joaquin Light and Power Corporation occupies a position unique in the annals of steam engineering as a natural-gas burning plant. The equipment now includes three 60-cycle, 2,300-volt, 1,800-r.p.m. turbo-alternators of 12,500-kva., 6,000-kva. and 5,000-kva. capacity respectively. Excitation is provided from a common bus at 125 volts, the exciter units being a 100-kw. motor-generator set, a 75-kw. 3,600-r.p.m. turbine set and a new 150-kw. 7,200- to 900-r.p.m. reduction-gear turbine set. Approximately 15,000,000 cu.ft. of gas per day are the fuel requirements. This enormous quantity of gas is piped in from two different fields through six-inch pipe lines a distance of thirty miles. Reaching the plant and passing through reducing valves, the gas is measured by orifice meters and passes on to the furnaces. The gas burners are made up of nipples of ordinary half-inch pipe, tapped out on each side of a two-inch main pipe (Fig. 6) every six inches along its length. These nipples are capped and near the end are drilled out $\frac{3}{16}$ in. on the top side. Above these holes and





FIGS. 2 TO 4. VIEWS OF VARIOUS PARTS OF STEAM PLANT
Fig. 2—Condenser circulating-water cooling tower. Fig. 3—How gas burners are arranged. Fig. 4—Interior of generating station

centered with them are placed fireclay tiles cemented in with asbestos cement. This constitutes a burner, of which there are six banks of thirty-four each under each boiler. (See construction, Fig. 3.)

Originally, fuel oil was burned, and the oil piping and burners were left in place ready for any emergency. There is at the plant an oil-storage reservoir having a capacity of 23,000 bbl., sufficient to tide over gas-line troubles for a week.

The two smaller turbo units are operated at 200 lb. pressure and 100 deg. superheat from eight 603-hp. water-tube boilers, while the large unit is operated from ten 822-hp. boilers of the same type at 250 lb. pressure and 125 deg. superheat. Two of the 822-hp. boilers are equipped with auxiliary relief valves so that they can be cut over to work with the 603-hp. boilers at 200 lb. pressure.

Natural draft is used, and the stacks are made of riveted steel 90 in. in diameter. There are, in all, nine stacks, five of them 165 ft. high, all cross-guyed to one another and to reinforced-concrete anchors.

A large cooling tower (Fig. 2) occupies one end of the property. This tower is built entirely of wood, is 24 ft. high and stands in a cemented reservoir 134 x 346 ft. surrounded by a 3½-ft. concrete wall. Fifty thousand gallons of water can be pumped over this tower per minute and cooled 25 deg. F.

Graphic meters are used throughout the plant, and a laboratory adjacent to the main building is proving a useful adjunct. Here are installed a calorimeter and a density balance. Several tests are made daily to determine the specific gravity of the gas and its B.t.u. values. This makes it possible to check each day's run for over-all plant efficiency. Tests are also made on the boiler-feed water so that proper treatment may be applied. Bailey boiler meters are used in connection with CO_2 recorders, Orsat apparatus and draft gages. Steam-flow meters are used on each of the main turbo-units to indicate and integrate the steam consumption. One man at the plant has all these meters under his supervision as well as the testing laboratory. He instructs the firemen and engineers so that all strive for efficiency in their methods.

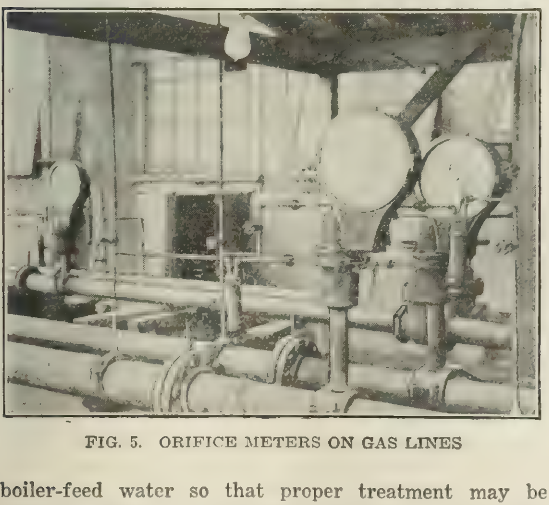


FIG. 5. ORIFICE METERS ON GAS LINES

Since the new unit has been in operation and the entire plant running at nearly 100 per cent capacity factor a great increase in efficiency has resulted. Especially since using gas only, the efficiency has attained the figure of 38 kw.-hr. per thousand feet of gas, or an increase expressed in equivalent oil of 55 kw.-hr. per barrel more than when burning both gas and oil and operating the two smaller units at 97 per cent capacity factor.

A weekly record is kept at the plant of all expenses incidental to operation, and from this, along with the labor, fuel and fixed charges, a kilowatt-hour cost slip is made up in the general superintendent's office. The segregations on this record are essentially for the information of the operating department. Similar records are kept on all generating plants of the system.

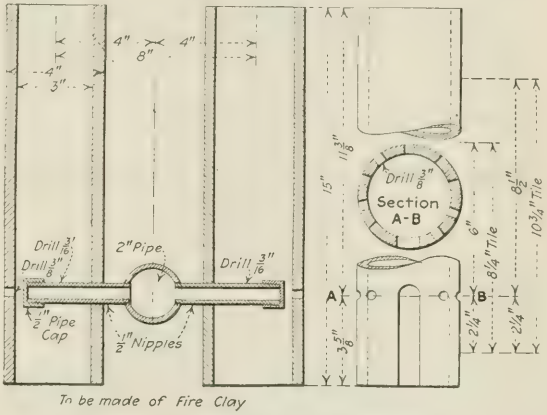


FIG. 6. DETAILS OF GAS BURNER

The new unit, with all its auxiliaries, was installed and put in service on schedule time despite transportation difficulties coming on the system in time for the peak period of the year. Some of the difficulties encountered which may be of interest are as follows:

The chief transportation difficulty at the time was the general strike of railway trainmen and the inability to get material in motion, due to strike and the freight embargo. The condenser for the unit, after being loaded on the car at Carteret, N. J., stood ten days at the factory and was finally shipped about May 12, after an appeal to the Interstate Commerce Commission. It was then lost track of for several weeks and after much tracing was located at Streeter, Ill., where the car had broken down. After some delay the apparatus was transferred to another car and again started on its westward journey about June 16. Some anxiety was felt about getting it through the tunnels in the Tehachapi Mountains except perhaps as a special, but this fear proved to be groundless as the car went through all right as a regular freight.

Arriving at Bakersfield on June 25, the car was shunted to the steam plant, where another difficulty, not anticipated, was presented. The track into the steam plant approached the door on a slight grade and apparently for this reason there was not sufficient headroom to get through the door, the shell only just wedging under. It was considered easier to lower the track to a level than to unload the equipment, so the track was lowered, but still there was not enough clearance. The top of the door was then torn out, and even then it was necessary to spring an I-beam that proved to be in the way. Once inside the building the condenser was put together and ready for try-out in five and one-half days, the men working in shifts night and day. This record was due largely to working three men in the condenser, one in each section, to guide the tubes into place.

Some of the other equipment was delayed until the last, such as a circulating pump and a large valve or two, but nothing of such consequence as the condenser. One could naturally expect transportation difficulties during a strike, and while there were inconveniences, the job was put through in good time by keeping at it day and night. The work was under the supervision of the company's general superintendent, E. A. Quinn, whose able management and tireless efforts were responsible in a large measure for the early completion of the work. July 17 was the date that the new unit was put into service for the first time to carry load, and its operation since has been very satisfactory.

Mean Effective Pressure of Ammonia Compressor

By D. H. Stokes

The mean effective pressure of any gas compressor is found by the formula,

$$M.E.P. = \frac{K}{K-1} P_1 \left[\left(\frac{P_2}{P_1} \right)^{\frac{K-1}{K}} - 1 \right] \qquad (1)$$

in which K is the ratio of the two specific heats of the gas, P_1 is the suction pressure, and P_2 is the delivery pressure.

When the indicated horsepower of a compressor is required, it is necessary first to obtain the mean effective pressure. This may be done by drawing a diagram with abscissas or vertical lines every tenth of the stroke, and calculating the pressure at those points by the formula,

$$Pressure\ required = \frac{P_1 V_1^k}{V_2^k} = P_1 \left(\frac{V_1}{V_2} \right)^k \qquad (2)$$

The points so obtained are then joined by a curve to make the usual diagram, which can be scaled to get the mean effective pressure. This method is necessary if it is desired for comparison with an indicator diagram taken from a compressor, but such a method of getting the m.e.p. for design or consideration work is far too laborious since a simpler one is available.

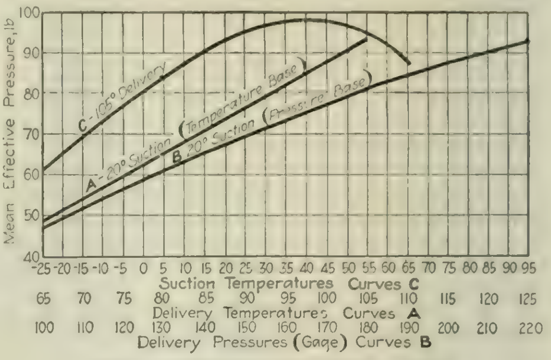
The same may be said of formula (1), and therefore the annexed table has been calculated, on the following basis:

$$K = 1.336 \qquad \frac{K}{K-1} = 3.9761 \qquad \frac{K-1}{K} = 0.25149$$

It will be noticed that the suction and delivery headings are given in temperatures. The refrigerating engineer always deals with these terminal points in temperatures when designing, and in the majority of cases steps of five degrees are quite sufficient for practical purposes.

However, to bridge the steps on the condensing side, it may be mentioned that as the m.e.p. has, at any given suction, an even increment for each degree rise of delivery temperature, a final column has been added giving that increment, and intermediate figures can readily be found.

The way to calculate these lines, say the 20-deg. suction line, is to use the formula (1) and calculate for 20-deg. suction and 105-deg. delivery, which gives a m.e.p. of 93.028 lb. per sq.in. Now, evidently 20-deg. suction and 20-deg. delivery would give a m.e.p. of 0 lb., therefore a rise of 105 — 20 deg. = 85 deg. gives the rise of m.e.p., and 93.028 ÷ 85 = 1.094447, which is the increment per degree referred to.

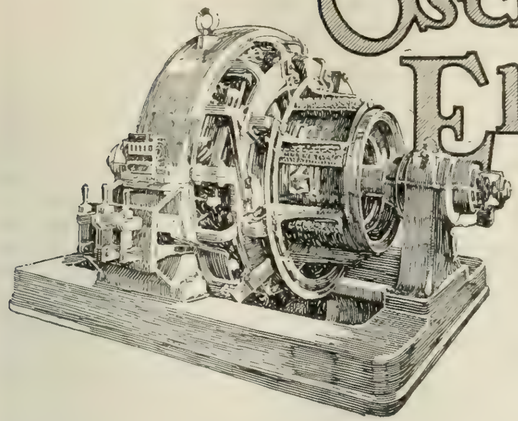


MEAN EFFECTIVE PRESSURE CURVE

The "curve," therefore, along any suction line on a temperature base is a straight line, and this fact has been used to check and correct the table, as shown at *A* in the diagram. The same line plotted on a pressure base is a curve, as shown at *B*. The curve *C* is that of the column headed 105 deg. delivery. These curves serve the useful purpose of conveying clearly to the mind the points referred to, as well as from curve *C* that there is a point of maximum m.e.p. which the table will locate and confirm. Further, it may be noted that the power rises, not with the pressure but with the temperature, which is therefore the true measure of the work done and the increment varies with the suction temperature used.

MEAN EFFECTIVE PRESSURES FOR AMMONIA COMPRESSORS

			Condenser Pressure, Lb.									
Suction or Refrigerator Pressure, Lb.		— Absolute Pressure, Lb. —	118.03	129.19	141.22	154.10	167.88	182.62	198.35	215.12	232.98	Increment in Lb. per 1 Deg. Rise in Temp. of Condense
		Gage Pressure, Lb.	103.33	114.49	126.52	139.4	153.18	167.92	183.65	200.42	218.28	
		Temp. F.°	65	70	75	80	85	90	95	100	105	
16.17	1.47	—25	42.558	44.919	47.283	49.647	52.011	54.375	56.739	59.104	61.468	0.47283
18.45	3.75	—20	44.508	47.126	49.744	52.362	54.980	57.598	60.216	62.834	65.452	0.5236192
20.99	6.29	—15	46.281	49.174	52.067	54.959	57.852	60.745	63.637	66.530	69.422	0.578523
23.80	9.10	—10	47.821	51.009	54.197	57.385	60.573	63.761	66.949	70.137	73.325	0.637609
26.92	12.22	— 5	49.091	52.598	56.104	59.611	63.117	66.623	70.130	73.637	77.143	0.701305
30.37	15.67	0	50.033	53.881	57.730	61.578	65.427	69.276	73.125	76.973	80.822	0.76973
34.16	19.64	5	50.582	54.798	59.013	63.228	67.443	71.658	75.874	80.089	84.304	0.84304
38.34	23.64	10	50.695	55.303	59.912	64.520	69.129	73.738	78.346	82.955	87.564	0.92172
42.94	28.24	15	50.328	55.361	60.394	65.427	70.460	75.492	80.525	85.558	90.591	1.006566
47.85	33.15	20	49.250	54.722	60.195	65.667	71.139	76.611	82.084	87.556	93.028	1.094447
53.43	38.73	25	47.611	53.563	59.514	65.466	71.417	77.368	83.320	89.271	95.223	1.190283
59.42	44.72	30	45.208	51.666	58.125	64.583	71.041	77.500	83.958	90.417	96.875	1.2916
65.92	51.22	35	41.977	48.974	55.970	62.966	69.962	76.959	83.955	90.951	97.948	1.39925
72.99	58.29	40	37.826	45.392	52.957	60.522	68.088	75.653	83.219	90.784	98.349	1.5130735
80.66	65.96	45	32.585	40.731	48.878	57.024	65.170	73.317	81.463	89.609	97.756	1.629266
88.96	74.26	50	26.428	35.237	44.047	52.856	61.665	70.474	79.284	88.093	96.903	1.7168727
97.92	83.22	55	18.972	28.457	37.943	47.429	56.915	66.401	75.886	85.372	94.858	1.89716
107.59	92.89	60	10.194	20.388	30.582	40.777	50.971	61.165	71.359	81.554	91.748	2.03885
118.03	103.33	65	. . .	10.934	21.868	32.801	43.735	54.669	65.603	76.536	87.471	2.18677



Oscillators on Electrical Machinery

By Clarence Lynn*

How oscillators came to be used on rotating electrical machinery. Different type of oscillators used. Proper method of staggering brushes to make commutator wear smooth. Oscillators are not required on modern type of rotary converters, and their use has been abandoned by one electrical manufacturing company.

PROBABLY the first use of oscillators on rotating electrical machinery was in connection with the operation of rotary converters in one of the substations of the Niagara Falls Power Co. in 1895. Generally the oscillator is thought of as belonging to the rotary converter, although its use has not been confined exclusively to such apparatus. In the days of non-commutating pole machines and before the development of the present types of brushes, the use of copper-leaf brushes on collector rings and of brushes of high resistance on the commutator was widespread. As current collection on the alternating-current end of a machine did not involve any electrical difficulties and as the copper-leaf brush was admirably suited, electrically, for this purpose, it was only natural that it should be used on the alternating-current end of rotary converters. On account of the high voltage per bar in the commutating zone, due to the lack of compensating devices, except the shifting of the brushes in the early types of direct-current machine, the use of a high-resistance brush on the commutator was imperative in order to limit the short-circuit current of the brush to such a value that successful commutation would result. A high-resistance carbon brush is usually a hard brush, and the result was that both the commutator and the collector rings became grooved with continual use of the machine.

In order to overcome the grooving effect, it was suggested that the rotating part be given a slight axial motion or oscillation so that the brushes would rub over the entire surface and thus do away with the grooving caused by the brushes dragging in one path continuously. It was found that under these conditions the oscillation of the armature did give some improvements.

There are two general classes of oscillators—one an electromagnetic type, which uses an electromagnet for pulling the shaft endwise, and the other a mechanical type, which makes use of mechanical devices of various sorts for giving the shaft a longitudinal motion in one direction. To give the shaft an axial motion in the reverse direction, the armature is so located, in respect to the field of the machine, that the operation of the oscillator moves the armature out of the magnetic center and the pull of the field moves it back to and past the center again, and thus the cycle is repeated.

The magnetic oscillator was first developed in a form in which the magnet was excited periodically by contacts located some distance from the rotary converter, the shaft being drawn toward the magnet when it was excited. As soon as the circuit was opened, the field poles would pull the armature in the other direction, and if the machine was properly installed, the armature would oscillate backward and forward several times and after a short interval of time the magnet would be energized again, thus repeating the operation. This type was improved by taking into consideration the natural period of oscillation of the armature, and the contact-making device was so constructed that it was actuated by the movement of the shaft and

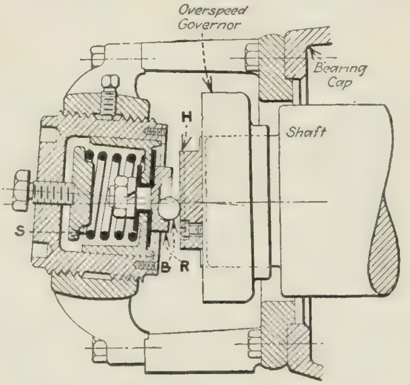


FIG. 1. SECTIONAL VIEW OF MECHANICAL OSCILLATOR

the magnet energized for each oscillation of the shaft. The chief difficulty with this type of oscillator is the trouble experienced with the contacts and in keeping them in permanent adjustment.

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*Power Engineering Department, Westinghouse Electric and Manufacturing Company.

Like the modified magnetic type, the mechanical oscillator imparts to the shaft an endwise thrust for each oscillation of the armature. Fig. 1 gives a sectional view of one type of mechanical oscillator. From the figure is can be seen that there is a hardened flat steel faceplate *H* fastened to the shaft and a hardened circular steel ball race *R* with a hardened-steel ball *B*, running in between the ball race and the faceplate. The circular ball race is inclined from the vertical and pushed toward the shaft by a compression spring *S*, the force of which is regulated by a screw in the rear of the oscillator sleeve. A circular ring stop limits the ball-race bushing in its motion toward the shaft. The oscillator sleeve is screwed into the bracket in such a manner that, should it become loose, the rotation of the shaft will tend to screw it away from the shaft and thus not pinch the latter up against the bearing.

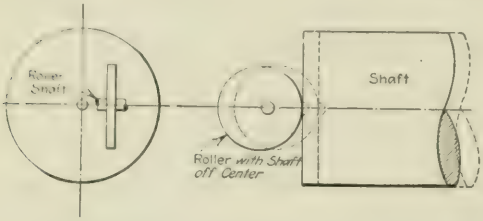

FIG. 2. ROLLER-TYPE OSCILLATOR. DOTTED LINES SHOW MECHANISM IN EXTREME POSITION TO THE RIGHT

As the shaft moves toward the oscillator, the hardened steel ball rotates upward in a circular path between the ball race and the faceplate compressing the spring. The reaction of the spring forces the shaft away from the oscillator, and the ball is caused to drop to the bottom of the ball race. In high-speed machines trouble was experienced at first with the ball, which would not drop to the bottom of the ball race as soon as the shaft was pushed away from it, but owing to its momentum it would continue to rotate in a circular path in the ball race and the shaft would sometimes come into contact with the ball when it was at the top of the race instead of at the bottom, thus giving the shaft no oscillation. If there was any shaft magnetism present, it would tend to help hold the ball in the race, but this is minimized by the use of insulating washers. The difficulty was overcome by the use of a small flexible wire placed between the ball race and the end plate of the shaft in such a manner that the ball, instead of continuing in a circular path after it had reached the top of its travel, would strike the spring wire and would drop to the bottom of the ball race in readiness for the next oscillation. In some cases the shaft of the machine is given a small inclination from the horizontal in a direction toward the oscillator end. This will assist the armature in returning toward the oscillator.

Another mechanical oscillator is the roller type, shown schematically in Fig. 2. This consists essentially of a disc roller with its axis off center and so mounted that it is rotated by friction drive with the end of the shaft of the rotary. The shaft of the converter would be pushed away from the shaft of the roller as the latter turned, as shown by the dotted lines of the figure. This type was never very extensively used. Both roller and ball oscillators were subjected to the difficulty of the roller and ball pitting if any current flowed in the shaft. However, this could be overcome by properly insulating parts of the oscillator.

There was another type of oscillator which differed radically from any mentioned so far, and this was the type which oscillated the entire brush rigging parallel to the shaft. It was designed primarily to be used where the oscillation of the shaft was impossible. A motor was used to drive the mechanism, and the rate of oscillation was extremely slow in comparison with the rate when the ordinary oscillator was used. The troubles attending the use of this oscillator were due to its complicated construction and the use of flexible leads connected to the brushes. If application was limited almost entirely to the engine-type direct-current generator, and it did not have a very wide use.

When the oscillator was first developed and for many years afterward, it really had a field of usefulness, but with the progress of the electrical art the need for it has disappeared owing to the overcoming of the obstacles which first necessitated its employment, although oscillators continue to be used apparently for no other reason than precedent. On such classes of electrical machinery as engine-type generators and geared units, where the use of an oscillator was attended with many complications, the absence of such a device has caused no particular hardship. By the elimination of the oscillator the troubles and difficulties attending its use have disappeared.

In stating the reason for the discontinuance of the use of the oscillator, both the electrical and mechanical reasons should be considered. On the direct-current end the use of commutating poles and in the case of high-speed motor-generator sets, compensating winding, has reduced the resultant volts per bar under the brush to such a value, that with a low-resistance brush excessive local or short-circuit currents will not flow in the brush. This means that a soft brush, generally with some lubricating qualities in it, can be used with less wearing away of the commutator. Besides the actual frictional wearing away of the commutator by the brushes, there is a burning action which takes place under the brush and which is more effective in wearing away and grooving the commutator than the actual brush friction. The

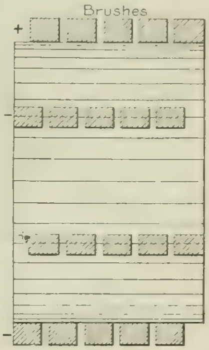

FIG. 3. BRUSHES INCORRECTLY STAGGERED ON COMMUTATOR

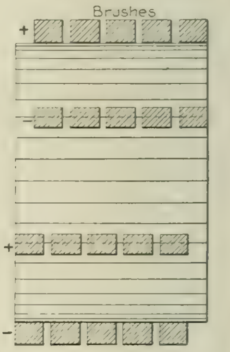

FIG. 4. BRUSHES CORRECTLY STAGGERED ON COMMUTATOR

burning effect under the positive brushes is different from that under the negative ones. This burning, like that of the ordinary arc, acts in such a manner that particles of material are carried in the direction of the current flow. Thus, in the case of the positive brush of a generator and the negative brush of a motor, copper of the commutator is "eaten away" and partly deposited upon the brush, and on the opposite polarity brushes the brush is eaten away. When the brushes are not staggered or all brushes of one polarity are staggered from all brushes of the other polarity, as in Fig. 3, the aforementioned action would tend to groove the commutator, especially under the brushes where the current flows from the commutator to the brushes. An oscillator was used to overcome this, but instead often made the action worse, since when the oscillator shifts the armature to one side, the brush, which in the normal position is running in the center of the groove, is caused to rise and rides on one edge only. This causes reduced contact between the brush and the commutator or collector ring, as the case may be, and excessive burning of these parts results. However, if the brush arms be staggered in pairs, as they should be (see Fig. 4), then the burning action will not be confined to definite paths, causing grooves, but will occur over the entire surface of the commutator; and if a brush of the right composition be used, the scouring action of the brushes will keep the commutator smooth and give it a good polish.

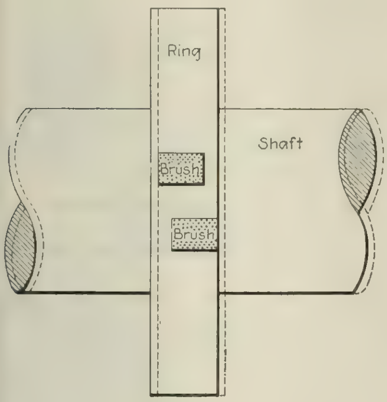

FIG. 5. STAGGERING OF BRUSHES ON COLLECTOR RING. DOTTED LINES SHOW RING AND SHAFT IN EXTREME POSITION TO THE RIGHT WHEN OSCILLATOR IS USED

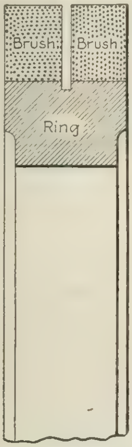

FIG. 6. LATEST TYPE OF UNDERCUT COLLECTOR RING WITH TWIN BRUSHES. NO OSCILLATOR

On the alternating-current end copper-leaf brushes have been superseded by composition brushes containing carbon, graphite and some metal, generally copper. As the capacities of rotary converters increased, it became impossible to get enough copper-leaf brushes on the collector rings to carry the current because of the angle at which they must run with the rings. By the use of the alloy brush the cutting of the rings and brush itself, which was a very objectionable feature with the copper-leaf brushes, was modified considerably. When alloy brushes were first used, they were staggered as shown in Fig. 5, so that when the ring moved sidewise, owing to the oscillation of the armature, its entire surface passed under some part of the brush. It can be readily seen that, because of this staggering, the central part of the ring is subjected to more wear than the outer edges, and even with the use of an oscillator the rings would become grooved in the center. If the brushes were not staggered, the central part would still become grooved as this part of the ring would always have part of the brush rubbing upon it when the oscillator pushed the armature to one side. If a single brush, wide enough to cover the ring and its movement due to oscillation, were used, the brush face would be worn to a concave shape which, with oscillation, would cause poor contact. Without the use of an oscillator a brush the same width of the ring can be used without difficulty with either ring or brush wear. In the case of large-capacity machines, the arrangement shown in Fig. 6 is used with a double ring and twin brushes and holders. This has been found desirable, as the use of several small brushes will give a better contact with the ring than the use of a lesser number of large ones. It has been found in actual practice with the brushes arranged as above and with no oscillator used, that the rings do not groove as much as if an oscillator were used.

Thus it appears that there is no more need for an oscillator on a rotary converter or a motor-generator set than there is for one on an induction motor or an ordinary engine-type direct-current generator and that there is more to be gained by its omission than with its use. The Westinghouse Electric and Manufacturing Co. has been supplying for over a year rotary converters and motor-generator sets without oscillators, even though some engineers and operators may still feel that a rotary converter is incomplete without an oscillator.

Moody Spiral Pump

A desirable feature in a pump is high speed, inasmuch as such a pump can be installed at less cost, because it can be made smaller and lighter in design and requires less floor space than a slow-speed pump.

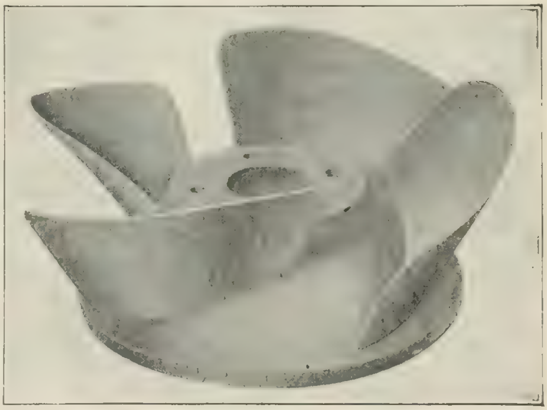

FIG. 1. DESIGN OF THE PUMP IMPELLER

A low- and medium-head high-speed pump has been designed by the I. P. Morris Department of the William Cramp & Sons Ship and Engine Building Co., Philadelphia, Pa. Fig. 1 shows the design of the impeller, and Fig. 2 shows a sectional elevation of the pump.

In design the spiral pump is simple. The impeller is of the single-suction type, and as it is overhung on the end of a shaft, but one bearing and one stuffing box are required. The openings between the impeller vanes are large, and an impeller of 18 in. outside diameter will pass a 3-in. cube through the smallest section. This feature of design decreases the danger of plugging the pump with foreign material.

The design of the pump also reduces the leakage that occurs at the seal of the impeller; therefore the clearance between the impeller and the stationary part may be made comparatively large, thus reducing the effect of wear and adding to the life of the pump. This pump is designed to deliver 12,000 gal. of water per minute against a head of 16.5 ft. at a speed of 672 revolutions per minute.

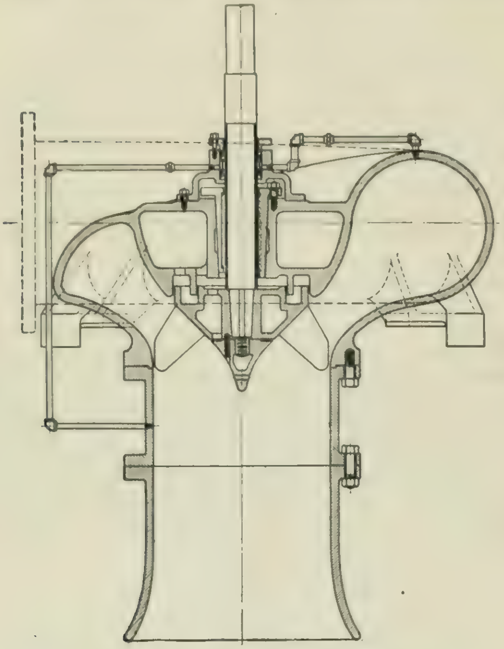

FIG. 2. SECTIONAL ELEVATION OF THE PUMP

Fuel-Oil Unloading Apparatus

Considerable information has appeared from time to time as to proper storage tanks for oil fuel. Little, however, has been mentioned as to the proper equipment to install for unloading purposes.

Either of two methods may be used, dependent upon the location of the plant storage tank and the topography of the land. If the storage tank is underground or below the level of the railroad siding, the underneath unloading apparatus is in many ways superior, being cheaper to install and requiring no pump to handle the oil. Fig. 1 shows this arrangement. The unloading piping is attached to the fuel line leading to the storage tank. The pipe line should be anchored, preferably to a concrete block, to prevent any displacement of the pipe line. The swinging joints may be any of several well-known makes. Undoubtedly, a ball-and-socket arrangement having a soft metallic gasket is the best. The two joints of pipe should be several feet longer than the distance to the center of the railroad track, as this allows connection without an exact placement of the car. The pipe is much superior to flexible hose. The pipe size may be as desired, although a diameter above two inches should be chosen. The tank coupling can be obtained from any supply house.

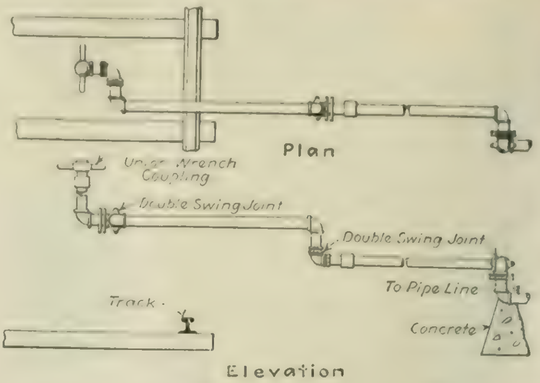

FIG. 1. UNDERNEATH UNLOADING APPARATUS

Where the storage tank is placed above the track level, the overhead unloading system is advisable. It has the advantage of providing ample clearance along the track. Furthermore, there is no danger of loss of oil due to defect in the unloading coupling. The platform should best be set at least eight feet from the near rail and should be ten to twelve feet above ground. Fig. 2 gives the various dimensions as recommended by the Bessemer Gas Engine Co. The drawing shows two unloading pipe lines, although one is sufficient. In the Northern states fuel oil often is very sluggish to handle and it becomes necessary to install a steam pipe line to the tank heater coils. This line can be placed on this unloading rack without interfering with the fuel oil.

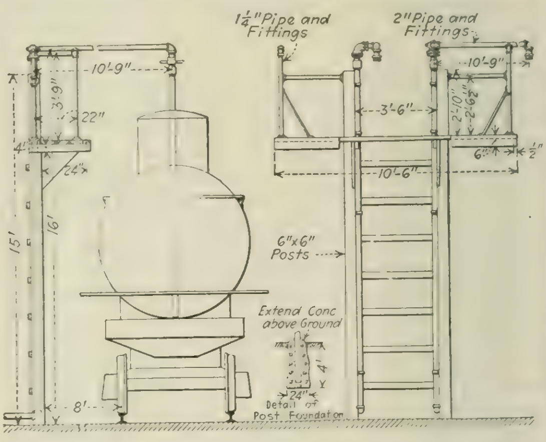

FIG. 2. OVERHEAD UNLOADING APPARATUS

The successful operation of a semi-Diesel oil engine depends more on the action of the fuel pump and atomizer than on all other factors. An operator should give close attention to these two details. Another detail of great importance is the cleanliness of the engine and engine room.

Latest Developments in Large Boilers for Central Stations

IN A recent issue of *Power* there was published an article on the Springdale Power Station[1] in which brief reference was made of the boilers, which were designed and built by the Babcock & Wilcox Co. These boilers represent one stage in the evolution of a new type which the company regards as one of the most important contributions it has made to the betterment of steam engineering. The history of this special type of boiler is about as follows:

About five years ago the late Henry G. Stott decided to use duplex furnaces under the boilers of a power station he was designing for the Buffalo General Electric Co., and the Babcock & Wilcox Co. designed in co-operation with him a type of boiler for 250 lb. pressure and 250 deg. superheat at the throttle. It was 11 tubes high, with the superheater placed, as usual, above the water tubes, and a large economizer supplemented each boiler unit.

For such heavy service as was expected from this plant, duplex furnaces burn coal more economically than single furnaces, for a given boiler output, because of their higher ratio of grate to heating surface. But the large volume of gases from duplex furnaces is at a very high temperature when the boiler is heavily loaded, and so the bottom baffling was placed above the bottom row of water tubes in order that these tubes, by absorbing heat from the gases, might aid in keeping the furnace temperature below the point where the brickwork is seriously affected. As is known, this boiler plant has been very efficient.

The Springdale installation represents the next step in the development of this type. These boilers are 16 tubes high, and the bottom two rows of tubes are below the bottom baffling. They were designed for 350 lb. working pressure and about 200 deg. superheat. Space has been provided for installing economizers later if load and fuel-cost conditions warrant their use.

The Babcock & Wilcox Co. next utilized the new methods of securing great capacity and flexibility in service in its designs for the boilers for the Colfax Power Station of the Duquesne Light Co.[2] Those boilers are 18 tubes high and were built for a working pressure of 275 lb. and about 250 deg. superheat. It is not planned to use economizers with them.

Early this year the company was asked to design boilers for 275 lb. working pressure and 225 deg. superheat for a large central station. After an exhaustive study of the conditions, it designed the boiler illustrated. Economizers are not provided, although space is left for them if an advance in the price of coal justifies their installation at some later date. The net efficiency of these boilers with economizers, estimated in the light of the best current economizer operating results, compared with the net efficiency of the boiler illustrated, without economizers, did not justify the investment in economizers with coal at the present prices. The company considers that this type of boiler will prove a coal-saving and efficiency-maintaining unit of unusual value for high or low load factors.

The notable increase in the load factor of central power stations resulting from the increased general use of electricity, coupled with the high cost of fuel, has forced consideration of more efficient distribution of the heating surface of boilers. The type developed as a result of exhaustive studies for several years along this line is shown in the accompanying illustration, and a short description follows.

The boiler, designed by the same company and of the cross-drum type, is divided into two decks with six tubes in the lower deck and fourteen in the upper, making twenty in total height, the tubes being 20 ft. long. The six tubes of the lower deck are exposed for their full length, without baffles, to the radiant heat of the furnace. This construction increases the total heat absorption through direct radiation and tends toward keeping the furnace temperature at a point where the upkeep of the brickwork is at a minimum.

Furthermore, the construction gives such a large and easy entrance for gases into the boiler-heating surface that the probability of slagging between tubes, where the gases are hottest, is remote even at the highest rates of combustion and with high-ash coals.

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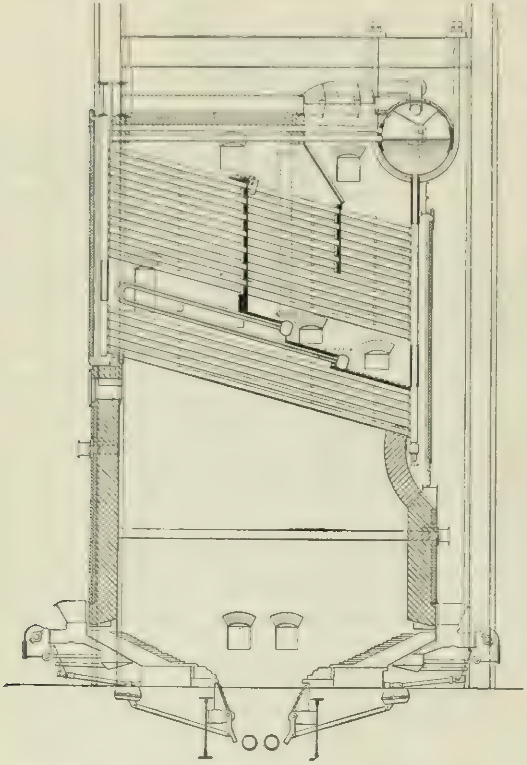
[1] Page 488, Sept. 28, 1920.

[2] A description of this plant will be published in a later issue.

The superheater is located immediately above the lower deck of boiler tubes. This location in the setting, where the gases have not been cooled to a point approaching that existing in what has come to be looked upon as standard superheater location in horizontal water-tube boilers, enables practically any desired degree of superheat to be obtained with a minimum amount of superheating surface and a corresponding minimum superheater cost.

The upper bank of fourteen tubes is baffled after the standard methods of the company. The great length of gas travel at the high gas velocity, following from the burning of sufficient fuel to give capacities per square foot of heating surface corresponding to those obtained in lower boilers, results is an increased rate of heat transfer for the design illustrated. This tends toward the lowest practicable exit-gas temperatures and hence the highest boiler efficiencies.



RECENT DEVELOPMENT OF THE TWO-DECK, CROSS-DRUM BABCOCK & WILCOX BOILER

The boiler is equipped with a duplex furnace of ample volume, such as was originated by the late H. G. Stott. With such a furnace, even at the highest boiler capacities, the combustion rate, expressed in pounds of coal per stoker retort per hour, will be at an efficient rate from the standpoint of stoker operation and upkeep.

The boiler, as illustrated, contains 452 sq.ft. of heating surface per section of width. At the present time the company is equipped to build units of this character up to and including 51 sections in width, which would give a total heating surface of 23,050 sq.ft. The heating surface will vary with the ultimate steam temperature required. Boilers of this general design would ordinarily be used in a base station where the load factor is high. The superheating surface installed would be such as to give the desired ultimate temperature at normal operating load.

With the setting height indicated in the illustration the furnace volume would be approximately 3.95 cu.ft. per so-called rated boiler-horsepower.

In the largest unit that could be built 32 retorts of underfeed stoker could be installed. If a chain-grate type of stoker were installed rather than underfeed, assuming the length of the chain grate to be 17 ft., the total grate surface would be 459 sq.ft., giving a ratio of 1:41.5.

Departures From "Accepted Designs"

By W. D. Forbes

THOSE who go about among machinery notice at once any departure from what are called "accepted designs." This I have observed almost always in men who have charge of steam engines. We are prone to stick to what has proved satisfactory in engine building. This is wise up to a certain point, and when it comes to engines, pumps, blowers, etc., which have to work about all the time, and where the supply house is miles away, men who have to care for machines are justified in being slow to try out new things.

In looking over my notes I came across some departures from the usual which may prove interesting to *Power* readers. The relief valves that are supplied with most engines are usually made in one of two ways; that is, those that scald you when they lift, if you are on duty, and those that are piped off so that you cannot be scalded. I have often seen relief valves so made as to be piped, but I cannot recall many cases where the piping has been done. Generally, the screwed opening is placed so as to do as little scalding as possible and it is let go at that.

The specifications for relief valves are usually rather "misty" and read about like this: "Relief valves shall be furnished of sufficient size to relieve any pressure in the cylinder caused by trapping water therein." Never but once have I seen anything regarding the increased clearance that relief valves might produce.

An Unusual Relief-Valve Idea

The first odd relief-valve I ever saw was on a German engine, made, I think, by a man named Maur. Both front and back cylinder heads were fitted with ground joints, and under the nuts of the studs holding the heads in place were spring washers, so that if water was trapped the entire head lifted. This was regarded as a very fine idea. It was several years later that I had to inspect some chocolate machinery in Holland, and there I found that same engine, but the spring washers were no more and in their place were the regular finished washers usually found on foreign engines under the stud nuts. So I do not think the system worked very well.

In another foreign make the builder of a very high-grade engine was proud indeed of his relief-valve system. In his piston there were four valves, two facing one way and two the other. The builder explained that if water was trapped in the cylinder the valves in the piston would open and the water would escape to the other side of the piston. He seemed "peeved" when I questioned the wisdom of dumping water that was not wanted on one side of the piston to the other side where it was not wanted either.

MEETING THE DEMANDS OF THE NAVY DEPARTMENT

I received an order for some engines from the United States Navy, Department of Steam Engineering, and when you build engines for that department you have to have all drawings approved before you start work or you will get into trouble. In the specifications for the engines there was a demand requiring the relief valves to have a certain area and to be so placed that the increased clearance would not exceed a certain percentage of the cylinder volume.

There was no trouble in meeting these demands on the head end, but as the engines were small, only 4½-in. bore, I struck trouble on the crank end. Admiral George Melville was then the Chief of the Bureau of Steam Engineering, and it was a pleasure to do business with him. I worked hard in getting the relief valves to suit and made several trips to Washington with drawings, but I could not quite reach the requirements as to reduced clearance. The Admiral at last said that he thought what I had was close enough to the demands and that he would approve my last design. Just at the end of the interview the whistle blew, so to speak, and I was obliged to leave to return next day.

On my way across La Fayette Square to my hotel I happened to remember the spring-washer idea of Maur's, and when I went to the Army and Navy Building the next day I had the relief valve for the crank end of my engines down to the requirements, much to the Admiral's delight. Shortly after I sent on finished drawings and built the engines with the head-end relief valves constructed this way.

Instead of having the cylinder head lift I made the entire stuffing box for the piston rod lift, acting as a relief valve. In fact, the crank end of the engine had its head cast solid. The stuffing box I made of composition, and I easily got the area wanted and kept the clearance below specifications. I know that this system worked well, as when the torpedo flotilla was taken out to the Philippines by Commander Cone he reported that "the Forbes blower engines were a delight." Now anybody who has been to sea and can say he has a blower engine that is a delight has met a rare bird or his head has been affected by the heat of the engine room. I was very proud of those engines, as I think I had the right to be.

DOPP RELIEF VALVE FOR LOCOMOTIVES

Out in Buffalo, N. Y., when Frank Wilder was master mechanic of the Western division of the Erie railroad, a man by the name of Dopp, I think, brought out a relief for locomotives, and Mr. Wilder put on several. This valve answered not only as a relief valve but also as a drain cock; in fact, it was an automatic drain cock, but if used it made the relief valve unnecessary, and that, in fact, was its idea. The body of the valve was T-shaped and was connected up with the outlet looking down, while the ends were piped up to the regular drain-cock holes. There were two seats in the body, one on each side of the opening. These two seats were closed by two cone-shaped hollow clappers, and the larger ends of the two clappers were ground to the two seats in the body, and between them was supplied a small bar of composition just long enough to push one of the valves off its seat when the other was seated; therefore both valves could never be closed at the same time. When the steam pressure struck the valves, say on the head end, it closed that valve and no steam could escape; when the steam came on the other end of the cylinder the other valve closed; the bar between them acted if necessary.

As the two clappers on the valves were cone-shaped, when the steam was off both ends of the cylinder the clappers lay on the bottoms of the body of the valve; therefore both seats were uncovered, giving a free passage for water. I could see but one objection to this arrangement, and that was that it might be costly in steam consumption. The Dopp valve, if I have the name right, was designed with the idea that if the cylinders could be always automatically drained relief valves would not be necessary, which is of course correct.

THE "BANGS" OIL CUP

I built several compound engines some years ago for marine use, and on one of them I was directed to put the "Bangs" oil cup on the crankpin end of the connecting rod. I ordered the cups, and Mr. Bangs brought two cups to fill my order and to explain them to me. Instead of having the usual hole in the bottom of the cup there was a rib cast on the inside which ran from the bottom to within ¼ in. of the top. In this rib a very small hole was drilled with about a No. 40 drill, and this small hole was connected with a hole drilled to meet it, reaching a somewhat larger hole in the stem of the cup. Just above the small hole in the rib was a spoon-shaped piece of metal set with the hollow facing the center of the cup. The cup had to be set in the rod so that the oil would throw against this spoon and it then ran down onto the top of the rib, which was countersunk just a little. When the engine was standing still no oil could feed, as is evident, and when in motion oil was thrown into the spoon.

I was not at all impressed with the system, as I thought the small hole would get plugged up, but I was assured by Mr. Bangs that if I drove a hickory peg into the small oil hole it would not stay there. I tried the experiment and Mr. Bangs was right; the peg would not stay in the hole. This cup saved a great amount of oil and yet oiled the crankpin perfectly. I think only about one-eighth the amount of oil was needed when this cup was fitted, yet I never saw a dozen of them in all my life. Now, why not? It was a good thing and a money saver, but so far as I know it was little used.

To scrape a Diesel bearing, the journal should be coated with lampblack. Placing the bearing on the shaft and giving it a rocking motion, the high spots in the bearing will be coated with black and can be scraped down. If commercial lampblack to use in scraping bearings is not obtainable, a good substitute can be made of soot from the exhaust mixed with lubrication oil.

The Baumé gravity has no direct bearing on the adaptability of a fuel oil. It happens, however, that most oils have a gravity fairly in proportion to their adaptability as a fuel oil. With Mexican untopped oil of 16 deg. Bé., enough gasoline is present to produce the primary ignition.

The Continuous Testing of the Power-House Plant

By A. S. TROLLIP

THE late P. W. Willans pointed out in his paper, "Steam Engine Trials,"[1] that if the steam consumption per hour of a constant-expansion or throttling engine be plotted against the horsepower, the result is an oblique straight line, as shown in Fig. 1.

The equation to the curve is represented by

$$Q = a + bP$$

in which Q equals the total weight of steam used per hour; P equals the horsepower; a equals the weight of steam used at zero mean pressure, depending on the extent of the back pressure and on the inherent losses of the engine; and b equals a constant, depending on the type of engine. It follows that this relation will hold for a turbine running with constant vacuum and constant speed.

Several engineers, among them R. H. Parsons, have shown that a power house, considered as an organic whole, follows the same law. The performance can be represented by two equations connecting the:

1. Coal consumption and water evaporated; which may be termed the boiler-house characteristic.
2. Steam consumption and kilowatt-hours generated; which may be termed the engine-room characteristic.

These two equations can be combined and again represented by a straight line connecting the coal consumption and the kilowatt-hours. This curve may be conveniently termed the power-house characteristic.

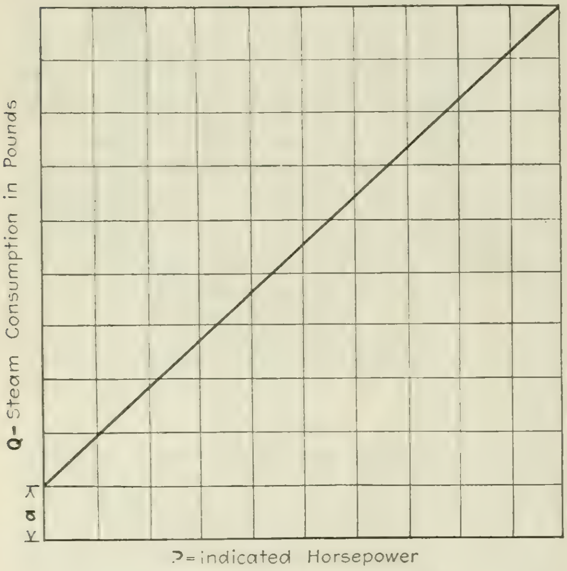


FIG. 1. WILLANS LINE: $Q = a + bP$

The writer has found from an analytical investigation of the financial figures for a power-supply company, that an equation can be obtained connecting the costs of whole of the supply undertaking with the units delivered to consumers. It can, as before, be represented by a straight line. This relation may be termed the financial characteristic.

To illustrate these most important characteristics, the equations for a turbo-generator station equipped with watertube boilers will be considered:

Let C equal weight of coal fired in pounds per shift; W equal weight of water evaporated in pounds per shift; A equal weight of steam losses; S equal weight of steam condensed per hour; and K equal output of units per shift.

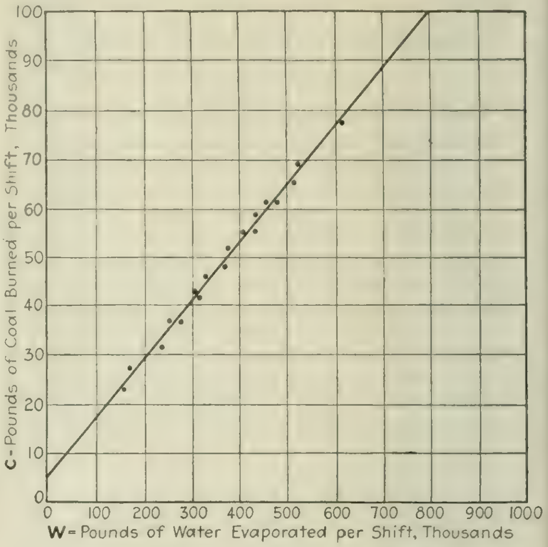


FIG. 2. BOILER-ROOM CHARACTERISTIC

BOILER-HOUSE CHARACTERISTIC

If the figures for the coal consumption in pounds and the water evaporated in pounds over a given period—an hour, a shift, twenty-four hours or a month—be plotted, it will be observed that the successive points lie approximately on a straight line.

In the example considered, Fig. 2, the readings have been taken over a period of a shift of eight hours. Readings taken over shorter periods are likely to give inaccurate results due to errors of water level and amount of fire on the grate.

An average line can be drawn through these points; it will be observed that the line cuts the ordinate axis at a point that represents the no-load losses.

This curve has an equation of the form $C = a + bW$; the values of a and b can be found by means of simultaneous equations.

The equation for the curve represented in Fig. 2 has the value

$$C = 4{,}620 + 0.12\,W \qquad (1)$$

Interpreted, this means that 4,620 lb. of coal is consumed per shift to provide the following losses: Radiation, steam leakage, banking fires, etc. After these losses have been met, there is an expenditure of 0.12 lb. of coal per pound of water evaporated.

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[1] *Proceedings* Inst. C. E., vol. cxiv, p. 2.

ENGINE-ROOM CHARACTERISTIC

Similarly if the steam consumption per shift be plotted against the output in kilowatt-hours, they, too, lie approximately along a straight line. (See Fig. 3.)

The equation to the curve for the station we have taken as an example is represented by

$$W = a_1 + b_1k$$
$$W = 34{,}833 + 15.k \qquad (2)$$

meaning that 34,833 lb. of steam is used every shift in supplying the losses due to leakage, condensation, etc.; 15 lb. of steam is supplied per kilowatt-hour generated.

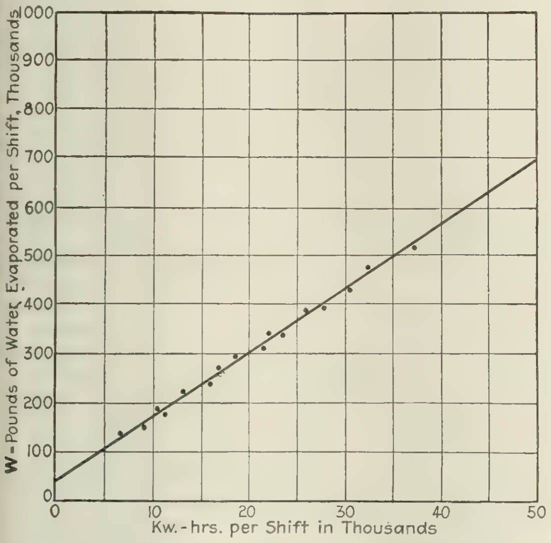

FIG. 3. ENGINE-ROOM CHARACTERISTIC

POWER-HOUSE CHARACTERISTIC

If the coal fired per shift be plotted against the units generated per shift, they will be found to lie on a straight line, Fig. 4, having the form

$$c = a_2 + b_1k \qquad (3)$$

The equation represented is made up of the boiler-house and engine-room characteristics and may be found from equations (1) and (2) as follows:

$$c = a + bw \qquad (1)$$
$$w = a_1 + bk \qquad (2)$$
$$c = a + b\ (a_1 + bk)$$
$$c = 4{,}620 + 0.12\ (34{,}833 + 15\ k)$$
$$c = 8{,}800 + 1.8\ k \qquad (3)$$

in which the total coal fired is made up of 8,800 lb. to cover losses due to radiation, blowoff, steam leakage, etc., and 1.8 lb. per kw.-hr. produced by the plant.

The characteristic for the individual units in a station connecting the steam consumption (s) and the kilowatt-hours generated (k) can be obtained in the same way. It is of the form $s = a + bk$. The performances of the individual units in the example under illustration are, unfortunately, not in the writer's possession. For a station that is now under analysis consisting of 6,000 kw. Curtis turbo-generators, the machine characteristic is represented by $s = 62{,}400 + 12$ kw. If we subtract the equation representing the machine characteristic from the equation representing the engine-room characteristic, we obtain $w - s$, the amount of water or steam lost by condensation, etc.

THE VALUE OF CONTINUOUS TESTING

Continuous testing permits of a continuous check on the coal and steam consumption. Losses are detected and localized during the shift in which they occur.

It also provides a means of comparing the performance of stations. The constant or no-load losses are chiefly dependent on design. The consumption of coal and water, which are proportioned to the load, are dependent upon the efficiency of the whole plant and on the efficiency of operation.

In practice these results are achieved by plotting the characteristics on squared paper. Upon the completion of a shift the engineer plots the several points on the chart. If the points are on or below the characteristic, all is well; if the point is above, a loss is signified, which, as was pointed out under the heading of division of losses, may be traced definitely to either the boiler house or the engine room.

The value of this method is great, for it provides not only a continuous check, but a means of testing the station as a whole.

The method provides a ready means whereby an equitable bonus system may be used. In most plants the bonus system is not applied because of the impossibility of securing the necessary data save at prohibitive cost. With the method under discussion, after the several constants of the plant have been secured, it requires but a few minutes' calculation at the end of a shift to determine the economies secured and the bonus earned.

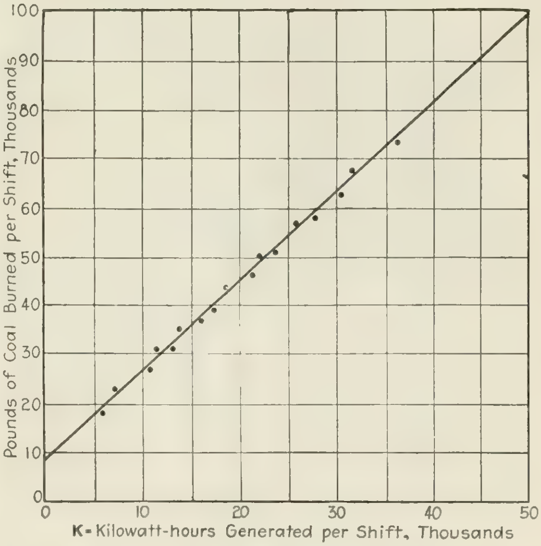

FIG. 4. POWER-PLANT CHARACTERISTIC

REQUIREMENTS FOR TESTING

As will be gathered, the following measurements are required: Coal fired, water evaporated, steam consumption of each turbine or other unit, units generated by each generator, and weight of the makeup feed water.

The coal is best weighed by an automatic coal-weighing machine. Volume measurement is crude. There are numerous methods of measuring the feed water, steam condensed, etc. Judging from the number of V-notch recorders in use, this method is giving good results.

FINANCIAL CHARACTERISTIC

This characteristic is obtained by plotting the monthly costs of the whole of the supply undertaking—namely, generation, distribution and management expenses—against the number of units sold to the consumer. The characteristic consists of two parts:

1. The costs incurred which are necessary for the system to be in a position to deliver to the customer. They include what are generally known as the fixed costs; namely, depreciation and amortization, and salaries, wages, cost of no-load losses of the station, etc.
2. The costs which are proportional to the load; namely, the greater proportion of coal, oil, waste, repairs, etc.

This characteristic is of extreme value to the management, who can at a glance compare costs of any month, without falling into the error of comparing costs per unit delivered to the consumer upon the basis of unequal production.

The Speed Limit of Ball Bearings

By W. J. A. LONDON

The maximum safe speed at which ball bearings can be operated is one of vital importance when considering the application of such bearings to high-speed machines. Unfortunately, the only formulas available, as published by the ball-bearings makers, are very ambiguous on this point. Again, the rating tables, as issued by the various makers, are, in the writer's experience, too idealistic to be followed indiscriminately in practice. The earlier formulas ignored speed altogether, while some of the later ones published introduce a *"k"* for speed correction.

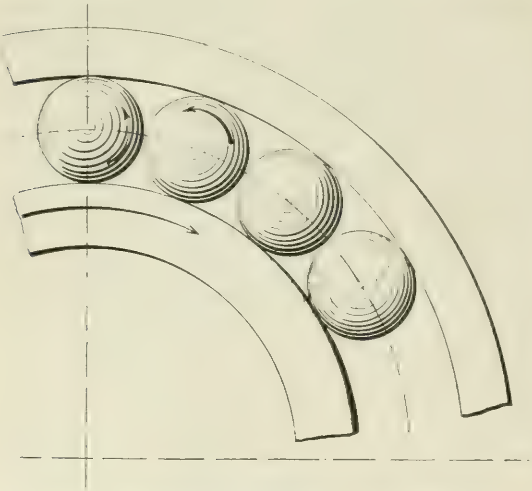

FIG. 1 ACTION OF A PERFECT BALL BEARING

The following arguments are advanced in criticism of all existing formulas in that they do not, in the writer's opinion, take into consideration the major factors that enter into this so-called safe speed limit.

In a theoretically perfect ball bearing, if it were possible to operate such a one, the actual speed limit would be reached when the specific journal load plus that due to the centrifugal force of the balls reached the breakdown point of the material in the balls and races. With the actual loads used in practice compared with the safe load standing still, and making calculations for the centrifugal force of the balls, it will be found that the speed limit is so high that it can rightly be ignored, as it is so far beyond any commercial requirements.

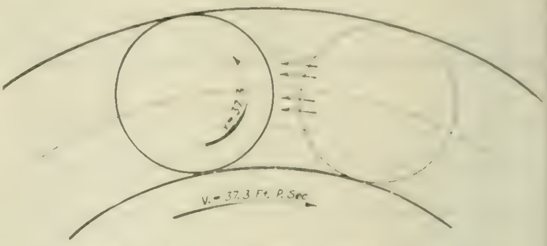

FIG. 2 VELOCITY OF BALLS AND RACE

Still considering the perfect bearing, no lubrication is necessary, as true rolling motion only is supposed to exist. A perfect ball bearing, however, cannot be operated, inasmuch as a retainer must be introduced to separate the balls, otherwise they would rub together in opposite directions as shown in Fig. 1; and experience has shown that a safe speed limit is reached long before the calculations of the perfect bearing indicates.

We can, therefore, in considering this subject from a practical standpoint, absolutely ignore the performance of the balls in the races and confine ourselves exclusively to the performance of the balls in the retainer. An analysis of what actually takes place in a bearing will, the writer believes, prove the correctness of the foregoing contention. Take, for instance, a ball bearing having a mean diameter of 3 in. with ⅝-in. balls operating at 3,600 r.p.m. The speed of the inner race will be 37.3 ft. per second, so that without slippage the peripheral speed of the balls will also be 37.3 ft. per second, as indicated in Fig. 2.

Any retainer must be built so that there is a bearing surface between any one ball and the adjacent section of the retainer. As the balls drive this retainer around, these contact surfaces are in reality a series of little sleeve bearings or shoes. Fig. 3 shows a typical ball bearing with a retainer ring. The surface speed with the example given has been shown to be 37.3 ft. per second. This in itself is considered a high speed in practical sleeve-bearing operation with ring lubrication. Furthermore, it must be borne in mind that no antifriction metal is introduced.

It may be contended that while the surface speed is high the load per unit area is apparently negligible. This, however, is by no means the case. There is, first of all, a small positive load due to driving a retainer of minimum weight and in perfect balance. This particular load will vary with the amount of oil in the bearing and the drag created thereby.

The serious loads, however, are those that may accrue from imperfections in the retainer and from conditions creating unbalanced forces of considerable magnitude. In operation the circumferential pitch of the balls is continually changing, so that it is reasonable to suppose that the whole load of the retainer is taken at any one time on one of the little sleeve bearings. With the same bearing previously cited, the speed of the inner race at 3,600 r.p.m. is 37.3 ft. per second, therefore the speed of the retainer around the axis is about 18.65 ft. per second corresponding to a speed of 1,430 r.p.m. The actual retainer of one type of bearing of the proportions given weighs about four ounces, and while it is next to impossible with retainers as now made to make any definite statement regarding the bearing surface actually employed, a careful inspection of several bearings has led the writer to adopt a figure of 0.030 sq.in. per section as being a fair average. This figure is at least sufficiently accurate to use as a basis for the arguments intended to bring out.

The centrifugal force created by one pound suspended at the radius of 1½ in. rotated at 1,430 r.p.m., is 87 lb. Reverting to sleeve-bearing practice, let us assume a load of 30 lb. per sq.in. as being within safe limits. The unbalanced force, therefore, necessary to create 30 lb. per sq.in. on a surface of 0.030 in. is 0.0135 lb., or 5.4 per cent of the weight of the retainer proper. If the retainer is initially perfectly balanced, it must be kept concentric during operation, otherwise unbalanced forces are produced in proportion to the eccentricity of operation. Where an uneven number of balls are used, the unbalanced forces due to eccentricity are accentuated.

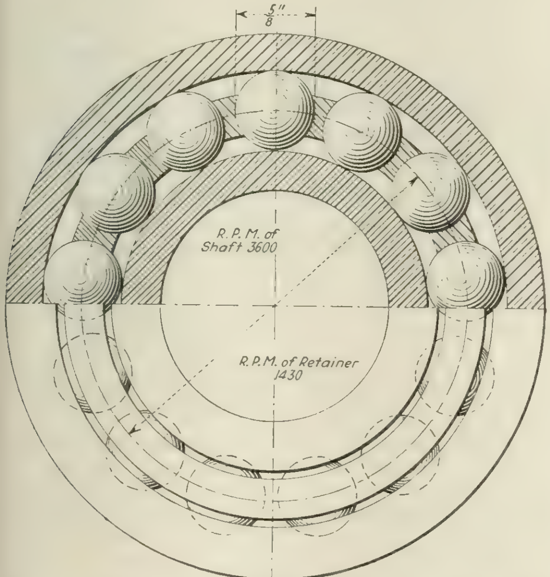

FIG. 3. TYPICAL BALL BEARING WITH RETAINER RING

Exception may be taken by ball-bearing makers to some of the figures used in the foregoing calculations, such as estimated bearing surface for example. The simple fact, however, remains that there is a practical limit at which ball bearings can actually be operated and, further, that this speed is considerably less than that published in the catalogs of ball-bearing makers and also considerably less than that derived from any of the existing formulas. When this practical limit is compared with that derived from a consideration of the balls in the races only, there is no relation between the two. There is, therefore, only one answer.

It is, of course, assumed in these arguments that rational engineering sense is used in the choice of the design of bearing, method of mounting, etc., and a proper grade of lubricant supplied.

A safe speed limit will be reached when the load between one ball and the adjacent bearing of the retainer is sufficient to break down the oil film at this point. This conclusion, then, brings to our attention the fact that the proper lubrication of such bearings is of much more importance than is generally believed. Ball-bearing manufacturers in general, in making recommendations as to the proper application of their product, almost entirely ignore this very important question. Moreover, the representatives and salesmen of such apparatus are responsible from time to time for making dangerously misleading statements as to the relative importance of this factor.

Considering the balls and races only, it has already been stated that no lubrication is necessary. Considering the balls in the retainer, we have a series of sleeve bearings the lubrication of which spells success or failure. This condition, therefore, calls for a retainer design that will permit the lubricant to enter properly the ingoing side of the bearing surface. In sleeve bearings it is just as important to lead the oil from the bearing as it is to the bearing. In like manner, then, a complete circulation through a ball bearing at high speed is essential. The general practice of partly filling a small chamber surrounding the bearing with oil prevents this important action.

There is no reason why ball bearings should not operate satisfactorily at high speed (say 3,000 to 4,000 r.p.m.) provided the foregoing considerations are properly taken into account, and experience extending over several hundred of such bearings has proved this contention. On the other hand, repeated failures with high-speed ball bearings has been in a great measure undoubtedly due to a lack of appreciation of the true internal workings of such bearings.

Extension of Power Contracts

An appellate court decision having an important bearing on power contracts which contain provisions for renewal for an additional term was handed down by the Montana Supreme Court in the case of Helena Light and Railway Co. vs. Northern Pacific Railway Co., 186 Pacific Reporter, 702.

The point in issue in this case was whether there had been a valid extension of a contract for the supply of electric current by plaintiff to defendant for use in operating pumps, etc. The original contract was to run for five years and provided that defendant should be entitled "to renew the same for an additional period of five years" on thirty days' notice in writing prior to expiration of the term of the original contract.

The court holds that giving of the written notice in proper time operated to extend the contract according to its original terms for an additional period of five years, without any action on the plaintiff's part and without the drawing up of a new agreement. But it is decided that the original contract was not renewed in the sense that before expiration of the additional term defendant could renew it for another additional term of five years. The provision for renewal must be interpreted as being limited to one renewal.

Operation and Adjustment of Turbine Machinery
XIII—Prevention of Oil Throwing at Bearings

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

Oil throwing is caused by one or both of two things—air currents and oil leaks. Oil vapor is sucked into the windings of a generator, and in time a heavy deposit of oil is formed. On account of the proximity of the generator to its bearings, together with suction fans and heavy currents of air, there is a strong tendency for oil throwing.

Leakage of oil from the bearing is caused by: Stoppage of discharge pipe; oil groove in the bearing being cut too deeply through to the end of the liner; excessive clearance in the bearing; excessive oil pressure; porous castings; improper adjustment of oil deflectors, etc.; air leaks due to leaking joints of air passages in the vicinity of the trouble; excess air carried in with the oil; oil level too high.

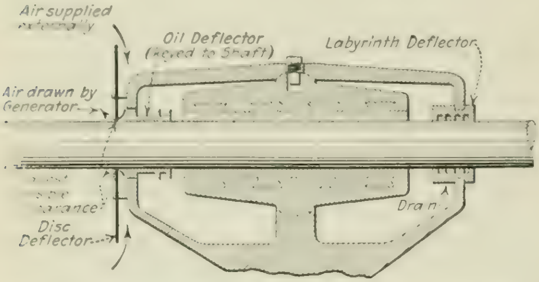

FIG. 1. DEFLECTORS PREVENT OIL BEING THROWN FROM THE BEARING HOUSING

If a bearing is mechanically correct but placed in such a position that air currents draw oil vapor from it the methods of prevention of oil throwing are as follows: Use of an oil deflector (Fig. 1) placed on the shaft inside bearing housing; labyrinth ring (Fig. 1) having close clearance to the shaft which is placed in the end of the bearing housing (this should have a drain where oil collected can be discharged); a ring of babbitt such as shown at the lower right, Fig. 2, with small clearance over shaft which, having a thread bored in it in such a direction that the rotation of the shaft will cause a draft in the bearing housing, may be put at the end of the housing; the suction fan (Fig. 2) is placed on the shaft just inside the housing, arranged to cause a current of air into the latter; a disc oil deflector (Fig. 1) placed outside of the bearing housing to prevent air suction acting on the end of it; an air-cell trap (Fig. 2) may be used for the same purpose; tight joints in the bearing; sometimes the use of a heavier grade of oil; breathers.

Figs. 1 and 2 show the use of these various devices on a bearing. In stopping oil throwing it is generally found that the disc deflector or air cell is the most convenient and effective remedy. With light air currents the reversed thread and suction fan and oil deflector are usually sufficient. Oil leaks should receive special attention. In locating oil leaks, particularly where oil vapor or particles of oil are carried by air currents, it is well to place strips of white paper in the path of the air currents; these will soon be spotted from the oil and by setting up such targets the path can be followed to the source of the trouble.

It sometimes happens that air passages, such as suction air paths for fans, are brought close to bearings. The joints of such casings often leak sufficiently so that the air sucked in will also carry oil vapor along and cause throwing. It is a good plan to make up such joints with heavy shellac and graphite. Targets, as described in the preceding paragraph, are useful in locating leaks when their sources cannot be readily found.

Some types of machines contain breathers placed on bearing housing (see Fig. 2). This is simply a pipe open to the atmosphere, which relieves the bearing housing of surplus air pressure caused by air being carried in with the oil and also allows oil vapor to be discharged where it can do no harm. These can sometimes be installed with good results and less expense than other methods of prevention.

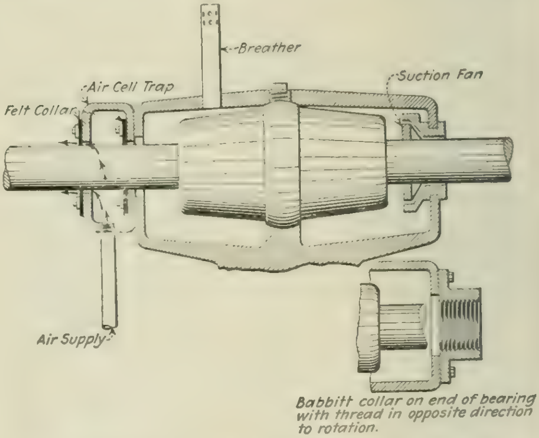
Breather
Suction Fan
Air Cell Trap
Felt Collar
Air Supply
Babbitt collar on end of bearing with thread in opposite direction to rotation.

FIG. 2. OTHER MEANS TO PREVENT OIL BEING THROWN FROM BEARINGS

Refrain from mixing two different grades or makes of oil. This procedure often results in foaming, emulsifying or other defects in the quality of the oil.

Examine the oil strainer at regular intervals. This often reveals troubles, such as cutting of thrust bearings, main bearings or gears, which would not otherwise be noticeable. Preventive measures can therefore be taken before serious trouble results.

Correct oil, which produces the best results, is a matter that requires great care in determining. The advice of oil manufacturers and turbine manufacturers should be considered and the final determination made by careful trial. Every plant has special operating conditions. The behavior of the oil in actual operation, together with proper handling, is the best way to determine its value.

Oil-pressure gages frequently give trouble and wear out rapidly because of vibration of the oil piping and fluctuations in the oil pressure. A good way to avoid the vibration trouble to which piping is susceptible is to mount the gage on a pillow block, bedplate or other equally solid casting and then connect the gage to the pressure line by means of capillary tubing or ⅛-in. copper pipe. Fluctuations of oil pressure can be partly eliminated by the usual method of throttling the valve placed below the gage.

In lubricating miscellaneous parts of a turbine a medium viscous oil usually gives best results on points of friction, such as valve gear, emergency trip gear, etc. This oil lasts longer and is not easily affected by high temperatures. Roller bearings or ball bearings which operate at low speed are also lubricated to best advantage with medium viscous oil or non-acid grease. High-speed bearings, such as governor-thrust bearings which contain ball races, should be supplied with a light grade of oil. Thrust bearings which contain no small balls when at high speed can be lubricated with heavy lubricants to advantage in cases of high temperature.

When using medium viscous oil or non-acid grease, make sure that the surplus or used lubricant does not find its way into the main oil system. Where a bearing requires a large supply of lubrication and drains into the main oil system the regular turbine oil should be used to prevent deterioration when mixing with the contents of the oiling system.

Graphite is furnished in many stages from pulverized dust to fairly large flakes. The finest and most impalpable grade is to be preferred for mixing with shellac.

Economic Value of Coal—I. A Comparison of Anthracite and Bituminous Coal

BY B. S. MURPHY*

The author points out the necessity of adapting the plans to the particular fuel obtainable. Study is made of the available coals. Comparisons of coals of different heat values are brought out.

THE greatest single material item in the generation of power is the cost of fuel. The fuel is used to produce useful work by means of a heat transfer. Consequently the amount of heat that may be removed from the fuel and converted into useful work is the controlling item in the cost of power production. Of necessity the amount of heat that can be so removed must depend to a very great extent upon the heat available in the fuel itself, or on the calorific value, and also on the behavior of this fuel during the reaction period. This is equally true of all fuels, but the following discussion will be limited to coal, and more especially anthracite.

RELATIVE IMPORTANCE OF COAL

In order to bring out the importance of the coal cost in power production Table I has been prepared, showing the relative power-station costs for a typical anthracite and a typical bituminous electric-power station for the whole year of 1910, the whole year of 1919 and the month of May, 1920.

TABLE I. MAKE-UP OF POWER COSTS

	1910		1919		May, 1920	
Station	A	B	A	B	A	B
Coal, per cent	42.0	77.2	58.5	64.8	62.0	65.2
Total operating material, per cent	48.2	80.9	60.5	69.6	64.0	69.0
Total operating labor, per cent	31.0	11.3	19.3	13.8	22.6	13.9
Total maintenance material, per cent	11.3	4.3	9.9	9.1		10.5
Total maintenance labor, per cent	9.5	3.5	10.3	7.5	9.5	6.6
Total cost, per cent	100	100	100	100	100	100
Price of coal per ton, per cent	100	100	228.0	195.0	240.0	233.0

Net kilowatts of output for both stations—over 3,000,000 per month.

Both of these stations are in the same city; the station marked "A" burns anthracite and the other, "B", bituminous coal. In 1910 the "A" station was hand-fired and the operating labor cost, even with the low wages paid at that time, was 31 per cent against 10.3 per cent for the stoker plant with bituminous coal. In 1919 the "A" plant was stoker-fired with a poor grade of "A" coal, and the cost was 19.3 per cent for operating labor, with very much higher wages than in 1910, against 13.8 per cent for the bituminous plant. The last line of the table gives the relative cost of coal, with the average cost for 1910 taken as 100 per cent, to show the increase in coal cost, and indicates that in May of this year it was necessary to pay nearly two and one-half times as much for the coal with no prospects of any betterment.

From this it is safe to assume that over 60 per cent of the cost of power generation is coal alone. Assume that the output of a station averaged 6,000,000 kw. per month, and for the sake of an even figure assume that the cost of power was $0.0125 per kilowatt-hour of output, then the cost for the year for this station would be $900,000. If the relative cost of the coal was 60 per cent the coal alone would cost $540,000 for the year.

RELATIVE COSTS OF ANTHRACITE AND BITUMINOUS COAL

Another very interesting feature that this table brings out is that in 1910 the relative cost of anthracite as a fuel was low as well as the actual cost per ton as compared to bituminous coal, but since that time has increased in cost proportionately more than the "B" coal until in the early part of this year there was relatively little difference. This is due to the greater demand, the diminishing supply and the falling off in quality. In using anthracite it is, of course, necessary to figure a considerably greater quantity per kilowatt of plant output, but the true comparison is the economic one, the cost of producing this kilowatt irrespective of the number of pounds of coal required to be fired. This will take into account all the different phases, such as the cost of handling this additional bulk of coal, the disposing of more ashes and soot and, in the case of hand-fired installations, the additional firemen required.

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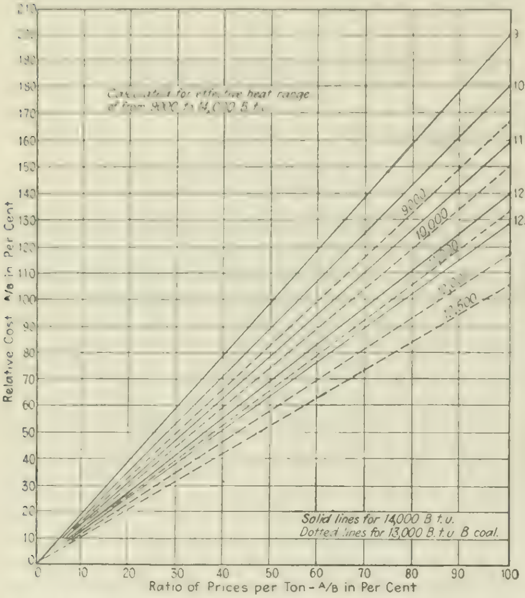
*Superintendant of Power, Hudson & Manhattan R.R.

During the war this was very noticeable; the price and impurity content went up while the calorific value went down. This happened to both anthracite and bituminous, but not in the same proportion, for though the cost of the hard coal was perhaps only about half of that of soft, it was actually more expensive to use.

It is seen, then, that if 60 per cent or over of our total power-production cost is coal, too much study and attention cannot be given it. Fuel is becoming more costly and more difficult to procure each year, and the day has passed when a plant could be located at any desired place, boilers purchased, and the operation started and continued blindly with the understanding that "coal is coal." It is necessary now to pre-plan your plant location to suit the available fuel supply for new installations, and for existing plants to adapt your facilities to what coal you can procure; for it is extremely difficult now to do the reverse, that is, grade your coal to suit original plant conditions.



RELATIVE COSTS OF ANTHRACITE AND BITUMINOUS COAL

In order to have a comprehensive knowledge of the coal analyses must be made, and the results of these analyses, in conjunction with known operating conditions, should be the governing factors in the selection of the coal if selection is possible, or in the adaptation of existing facilities to suit the coal available. These studies will soon show that the actual cost per ton at the mines or at the station will not necessarily be the controlling factor, for in certain cases the higher-priced coal may work out to the best advantage, while in another it will be the most expensive to use. In some instances a coal of high ash content may be made to give better results than one with less impurities if other conditions are available. And in some instances a low calorific-value coal may be made to give much better economy and operating results than one that ordinarily would be considered a much better coal from its chemical analysis.

It will be only a relatively short time until the small power station will be done away with completely excepting in cases where other factors, such as the utilization of waste heat, make it desirable to retain the plant. The practice of erecting the power station where the power is to be utilized will, for economic reasons, have to be abandoned, and the large distributing stations or super-power plants will be erected at the source of fuel and the power transmitted to the industries and centers of population. But in the meanwhile, for new projects or for existing plants, the first consideration is either the choice of fuel or the modification of existing facilities to suit the fuel available.

Investigation must first be made to see what coals are available in the quantities needed and what will presumably continue to be available for the next few years to come. In the East there is generally the choice of two kinds, anthracite and bituminous; so, if from a study of the coals available it is found that a continuous and ample supply of either can be anticipated, consideration must be given to the problem of which will best meet the requirements before going into the different grades of each.

To get the full benefits of any particular coal the whole boiler plant should be laid out with the requirements of this fuel in mind, for in the case of an existing station designed to use bituminous considerable changes would necessary to convert it to use anthracite. This conversion would be costly, depending on the size and other operating features of the station, so of course the interest charges on the necessary expenditure to make such changes would have to be considered against any gain anticipated by the changing of the fuel. In new projects the difference between the first costs of the layouts would in turn have to be considered in the same manner.

A HYPOTHETICAL CASE

To bring out these elements more forcefully a hypothetical station will be assumed and a comparison made of the fuel. Assume that it is reasonable to expect an adequate supply of either "A" or "B" coal and that the purchase price of 2,240 lb. delivered at the boiler room is: Anthracite, $5—11,100 B.t.u. as received; bituminous, $9—14,000 B.t.u. as received. A comparison of costs should next be made based on the total heat content in the coals; this appears in Table II.

TABLE II. ANTHRACITE AND BITUMINOUS
(Comparison on total heat basis)

	Anthracite	Bituminous
Cost per pound, dollars	0.00223	0.00402
Pounds of coal to make 14,000 B.t.u	1.26	1.00
Cost for 14,000 B.t.u., dollars	0.00281	0.00402

From this it would appear that with the price assumed we could expect to procure the same heat in the firebox with anthracite at a cost but 70 per cent of that for bituminous. However, this is not a true comparison on account of the ash, burning quality, etc., as will be more fully gone into later, but may be considered the very maximum difference that would exist between the use of the two coals.

In a later article it will be shown that the more correct way of approaching this subject is by a comparison of the useful range of heat and not by the total heat in the coal. For instance, when the freight charges on the anthracite are in the neighborhood of 40 per cent of the total cost of the fuel we must set a low limit for our heat content and say that it does not pay us to purchase coal with less than 9,000

B.t.u.; then the useful range would be between 9,000 and 14,000 B.t.u. or 5,000 B.t.u. The "A" coal containing 11,100 B.t.u. is 2,900 B.t.u. less than the "B" and lacks 58 per cent of the heat necessary. There would be required 1.58 times more coal for an equal heat content, or the cost would be $0.00352 for 14,000 B.t.u., or 88 per cent of the cost for an equal heat content in the "B" coal. This method is more nearly correct than a comparison of the total heat in the coal and will represent the maximum cost for the hard coal. It is only necessary to compare "A" and "B" coal of two different heat values to establish a curve which will determine the deficiency of heat for any coal. If we refer to Table I for 1919 we find the ratio of the coal cost is 90 per cent, while for May, 1920, it was 95 per cent, showing that the effective range method is not far out as other plant conditions, such as economy of prime movers, etc., will make up this difference.

RELATIVE VALUES OF DIFFERENT COALS

On the chart are plotted curves to show the relative values existing between bituminous and anthracite coals of different calorific values and different prices per ton, based on the effective heat range of 9,000 B.t.u. to 14,000 B.t.u. The horizontal scale is the ratio of cost per ton of the two coals, or the cost per ton of the hard coal divided by the cost per ton of the soft multiplied by 100. The vertical scale is the relative cost of the anthracite in per cent, the bituminous taken as standard, or 100 per cent. The solid lines give this ratio when the calorific value of the soft coal is assumed to remain constant at 14,000 B.t.u., and the calorific value of the hard coal varies as shown from a minimum of 9,000 B.t.u. to a maximum of 12,500 B.t.u. The dotted lines also give the relative ratios between the coals when the calorific value of the soft coal is constant at 13,000 B.t.u. For intermediate ratios, for coals of other calorific values than those given, we interpolate between the lines. For instance, if in our choice of coals we could anticipate a hard coal of 12,000 B.t.u. and a soft coal of 14,000 B.t.u. we can pay up to 73 per cent of the cost of the latter for the former. Or if the "B" coal was available at $8 per ton we could not afford to pay more than $5.94 per ton for anthracite; while if there was available another anthracite of, say, 11,000 B.t.u., we could pay only 63 per cent, or $5.04 per ton for it. On the other hand, if the soft coal contained only 13,000 B.t.u. and we still had to pay $8 for it we could use 11,000 B.t.u. anthracite and pay at the rate of $6.08 per ton. All of this is with the understanding that the coal is a fit one from an operating standpoint to meet the conditions under which the boilers are to be operated, for the calorific value is not the only controlling feature by any means. But this shows that but little dependence may be placed on the actual price per ton for any coal when this item is taken by itself as a comparative feature.

TABLE III. VARIATION IN RELATIVE COAL COSTS

Year	Bituminous Coal, Per Cent	Anthracite Coal, Per Cent
1911	100	77.8
1914	100	78.0
1919	100	119.0

It is is seen that the quality of the coal will have a great bearing on this subject in connection with the relative price. For instance, during the war the quality of all coal fell off and the price increased, but the anthracite suffered more in this respect than the bituminous. Basing the comparison of the effective range as above for one anthracite station the relative value comparisons were as given in Table III.

This showed that from 1911 to 1914 a saving in cost of fuel of about 22 per cent could be expected by the use of anthracite. This saving was cut down after 1914 gradually until in 1919 the hard coal was actually 19 per cent more expensive to use than the soft. This was due to a very serious falling off in the quality and a proportionately greater increase in the price per ton, but fortunately this condition is righting itself in that the coal is of somewhat better quality and also that the "B" coal has increased in cost per ton to a greater extent than the other, or rather the increase was slower for the bituminous and came along at a later date.

We will now return to our original assumption of an output of 6,000,000 kw. per month, and with the "B" coal a unit cost of power of $0.0125 and a total coal cost of $540,000. If we take the saving by the use of anthracite as 12 per cent based on a cost of $0.00352 for 14,000 B.t.u. of anthracite and $0.00402 for 14,000 B.t.u. of bituminous coal, this would represent $64,700 per annum, or the interest at 7 per cent on $925,000. Therefore, for a new station it would pay to put in considerable additional equipment, or in an old station, by extra blowers, changes to stokers, etc., to use this cheaper fuel, provided there was an assurance that the supply would be adequate, of the required quality and that there would not be a greater percentage increase in cost than the soft coal for, say, the economic life of the station, or fifteen years.

What Caused the Boiler Heads to Corrode?

An article describing the failure of the rear steam drum of a water-tube boiler at Newmarket, Ont., Canada, was published in *Power* July 8, 1919. The head of this boiler was in a weakened condition, the failure following the line of rivet holes below the water line and tearing through the solid metal well up in the bumped portion above the water line. The evidence was that the metal was brittle along the line of rivets. It was suggested that the explosion might have been caused by caustic soda which might have attacked the

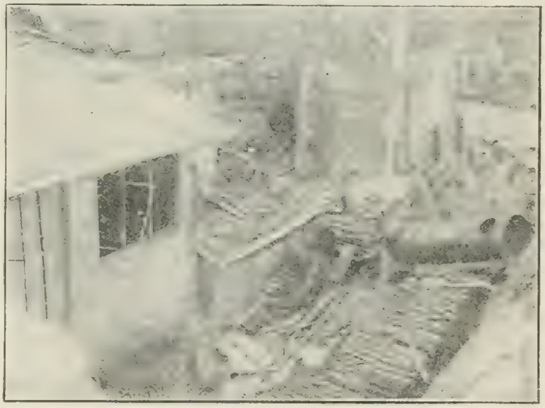


FIG. 1. WHERE A PORTION OF THE EXPLODED BOILER LANDED

metal, the liberated oxygen in turn affecting the properties of the metal and producing brittleness.

Attention has again been turned to the possible action of caustic soda by the recent report of an investigation regarding a disastrous boiler explosion last May at the municipal power house at Turku, Finland.

The boiler room of the power plant originally contained two Steinmuller water-tube boilers, each with a heating surface of 208 sq.m. (2,239 sq.ft.). In 1910 another Steinmuller boiler of 429 sq.m. (4,618 sq.ft.) heating surface was installed and a Babcock & Wilcox unit of 500 sq.m. (5,382 sq.ft.) heating surface in 1914. All four boilers were operated at a working pressure of 13 atmosphere (191 lb.) and were furnished with superheaters. In addition there was an economizer. The boilers were fed by four piston pumps, and in the forward end of the room there was an apparatus for purifying the feed water. No. 1 Steinmuller boiler was responsible for the explosion. The cylindrical drum was thrown over against a ledge. The front water leg was partly fastened to the drum, but the water leg and the connection between that and the drum were found about 25 meters (82 ft.) from the boiler house on the roof of an adjoining engine room. The rear head of the drum had been entirely torn off. The front head worked inward, loosening the joints. The tubes loosened from the superheater, and boiler No. 2 was moved about one meter (3.28 ft.) back from its foundation. The other boilers were evidently undamaged except for small breaks in the joints and setting.

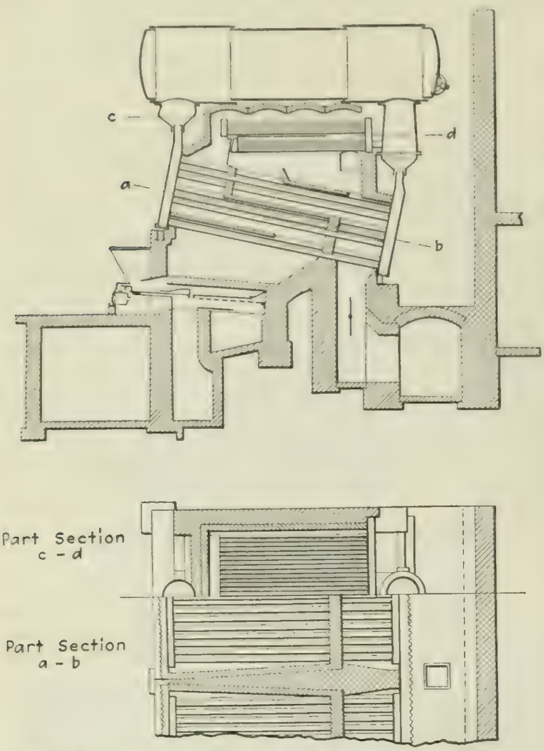


FIG. 2. SECTIONAL PLAN AND ELEVATION OF THE EXPLODED BOILER

No. 1 boiler had been inspected at regular intervals by a Government inspector, the last time being three years ago, when no flaw was found. Every time the boiler was cleaned the engineer at the plant went over the tubes and shell on the outside to see that everything was in good condition. Three weeks before the explosion occurred the engineer of the plant had the boiler cleaned and it was inspected as usual. At the same time a test was made at a pressure of 20 atmospheres (294 lb.), the plates showing no signs of weakness. Under the present boiler rules a test pressure of 20½ atmospheres (301 lb.) is necessary for a boiler to be run at 13 atmospheres (191 lb.); therefore the pressure was not exceeded in the test. At the time of the accident the gages showed a pressure of 11 atmospheres (162 pounds).

In the past the feed water was never found to contain anything that might cause the corrosion of the plates.

A careful inspection was made of the pieces of the exploded boiler. The loosened rear head and the shell of the drum were examined to ascertain the depth of any possible corrosion, and it was found that on the lower half of the shell, below the water line, the plate had been eaten so deep that only about two or three mm. (0.08 or 0.12 in.) of pure metal was left. The corrosion had started exactly at the water line on both sides of the shells and heads. When the front head was inspected it was seen that below the water line a similar corrosion had taken place as in the rear head.

It was at first thought that the corrosion of the heads was due to some chemical contained in the feed water, which had reacted with the metal. But on the other hand it was noticed that the corrosion took place only below the water line and all other parts of the boiler were clean and without flaw. It also seemed impossible that electrolysis could have caused the corrosion of the plate. It was hinted that there might possibly have been some flaw in the workmanship of the shell, but the plate had given way below the water line and there was no sign of tearing in the steam part of the drum. Fig. 2 shows the large diameter of the drum and the comparatively small dishing in the heads, and the small radius at the upturn of the flange.

Why the corrosion took place only below the water line remains a mystery. A chemical test of the water and plate might show, if it were possible, that while the plate was under a strain such as would take place with varying pressure, the corrosion had been more rapid. Believing that a like condition might exist in other units the second Steinmuller boiler was opened up and a slight corrosion was found to have taken place, similar to that in the exploded boiler. The corrosion here was not nearly so wide, but it could be easily seen if its presence was looked for.

Boiler No. 3 had not started to corrode, but the color of the plate had changed suspiciously at a point just below the water line. The Babcock & Wilcox boiler showed no signs of corrosion.

Any semi-Diesel oil engine should have a lubricating-oil consumption not to exceed one gallon per 500 horsepower hours. The oil taken from the crankcase is a mixture of lubricating and fuel oil. It seldom can be used on the engine again, but will do for lineshaft bearings. If a heavy-bodied oil is purchased and the engine refuses to burn it, mixing with kerosene will eliminate the trouble, although the bulb will carbonize. The kerosene tends to separate from the crude if it stands any length of time.

Checking Direct-Current Switchboard Shunt Ammeters

By H. C. Yeaton

It often becomes necessary to check a direct-current switchboard ammeter used with a shunt, in order to ascertain its accuracy. Ammeter shunts are constructed so that there is a certain voltage drop across their terminals when the full current at which they are rated is flowing through them. Direct-current switchboard ammeters are connected to the terminals on the shunt by means of leads. These leads are not interchangeable, as they are of a certain resistance and they are calibrated together with the shunt and ammeter. Any change in the resistance of the leads will affect the accuracy of the measurement.

On the switchboard ammeter the scale is usually marked in primary amperes; that is, the actual amperes flowing in the line. The voltage drop across the shunt is proportional to the current that is flowing, and the switchboard instrument is calibrated so as to indicate full scale when the rated current is flowing through the shunt.

There is usually a voltage drop across a switchboard shunt of approximately 50 or 60 millivolts when the rated current is flowing; therefore, ammeters are usually calibrated with 50 or 60 millivolts impressed across the ends of the leads, for full scale deflection. If there is any doubt about the shunt drop, it is advisable to write to the manufacturer for information.

A switchboard ammeter, which is used with a shunt, is usually checked with a portable millivoltmeter and is connected as shown in Fig. 1. As heretofore stated, the voltage drop across the terminals on the shunt is proportional to the amount of current flowing, and as the scale of the switchboard ammeter is proportional to the voltage drop across the shunt, it is obvious that by checking the shunt drop with a portable millivoltmeter, the accuracy of the switchboard instrument may be determined.

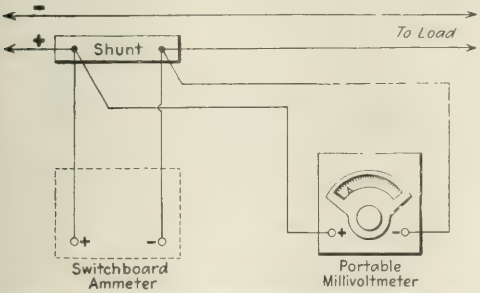


FIG. 1. CHECKING AMMETER WITH PLANT LOAD

Suppose that the shunt shown in Fig. 1 is rated at 100-amperes, 60-millivolts, and the switchboard ammeter used with the shunt has a scale of 100 amperes. To check the ammeter, connect a portable millivoltmeter of at least 60 millivolts range across the terminals of the shunt as in Fig. 1. The correct leads should be used with the millivoltmeter; that is, the leads which the instrument was calibrated with and which were furnished with it by the manufacturer; otherwise the readings will be in error.

Now suppose that the ammeter indicates 75 amperes. Then, since the drop across the shunt is proportional to the current, the millivoltmeter will read, if the ammeter reading is correct, (*Ammeter reading, in this case 75*, times *drop across shunt at rated load)* divided by *full scale rating of ammeter*, or in this problem, (75 × 60) ÷ 100 = 45 millivolts. If the ammeter reading is in error, the correct amperes may be calculated from the millivoltmeter reading. Suppose in the foregoing the millivoltmeter showed a reading of 48. Then since the reading of the ammeter is proportional to the drop across the shunt its reading should equal (*millivolt drop across the shunt* times *full scale rating of the ammeter*) divided by *drop across shunt at rated load*, or in this problem the ammeter reading should be (48 × 100) ÷ 60 = 80 amperes. However, if the ammeter indicates only 75, it is reading 5 amperes low. When checking the instrument with the normal load on the circuit, it may be found difficult to take readings at periods when the load remains constant for any length of time, but by taking the readings of the two instruments simultaneously, accurate results can be obtained. As the load on the circuit varies during the day, several points on the ammeter's scale may be checked for accuracy.

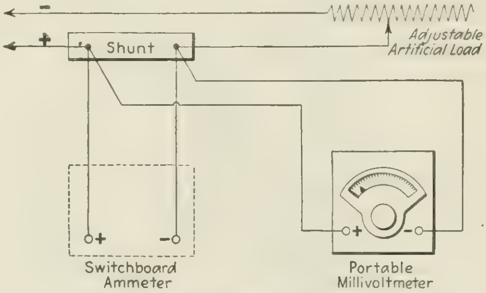


FIG. 2. CHECKING AMMETER WITH ARTIFICIAL LOAD

Fig. 2 shows the connections with an adjustable artificial load connected in the circuit, so that by varying the load any point on the ammeter's scale can be checked. If it is required to check the points at 20, 40, 60, 80 and 100 amperes, the voltage drop across the shunt would be proportional to the scale readings on the switchboard ammeter, and the following calibrating table is obtained by taking readings and making calculations as indicated in the foregoing:

Switchboard Ammeter Reading	Millivolt Drop Across Shunt	Portable Millivoltmeter Reading
20	12	12
40	24	24
60	36	36
80	48	48
100	60	60

Other points on the ammeter can be checked in like manner, but four or five should be sufficient to determine the accuracy of a switchboard instrument.

Bolivia in its present stage of development is a country of mines, though other resources exist. There are only three or four towns of any importance and population, and the present field for street-railroad and power-transmission material is restricted. The greatest hydro-electric resources are those in the vicinity of La Paz, Tres Cruces and Colquechaca, and plans for their exploitation have been made. The three initial power plants will entail an expenditure of $10,000,000 and will require large quantities of other machinery and electrical accessories in addition.

Making a Difficult but Rapid Repair to an Ammonia Pump

By D. L. Fagnan

Our 7 x 3 x 10-in. aqua ammonia pump, a sectional view of which is shown in Fig. 1, had been gradually failing of late, and although new hard-rubber valves had been installed and the piston rings found in good condition, the writer at last located the trouble in the valve seats. A section through the valve chamber is shown in Fig. 2. The suction-valve seats were scored to a depth of 0.003 in. in several places; that is, practically eroded away in narrow ridges. The discharge-valve seats were found to be in decidedly worse condition.

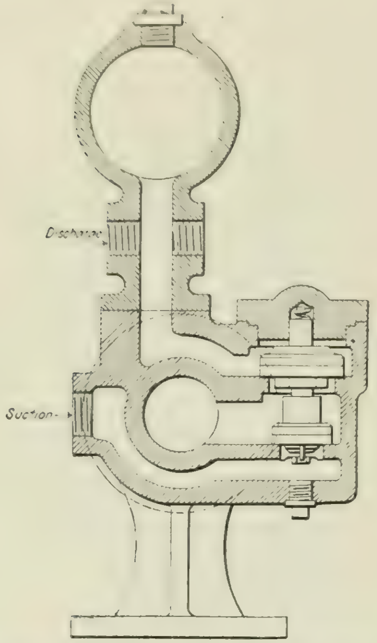


FIG. 1. END SECTION OF THE PUMP, SHOWING VALVES

We immediately communicated with the pump builders, advising them of the conditions and asking them to furnish a valve-seat refacer or other machine for the work. But they had nothing of the kind and suggested that the ammonia end of the pump be brought to their shops where they would reface the seat in the lathe. But as the pump is needed in the plant every day in the year excepting in zero weather, dismantling was out of the question, and we so advised them. Near-by we could find nothing that would allow of properly centering the cutters, as the top of the pump was found to have no studs but instead was fitted with only a large screwed cover.

It occurred to us that the valves themselves could be used to regrind the seats true. We went to the pump builders and got in touch with the foreman of their shops, an excellent mechanic, and together we evolved a plan.

A full set of blank castings of the suction and discharge valves were on hand, and we planned to make them as shown in Figs. 3 and 4. Fig. 5 shows the rods as made to use as a ratchet brace. Fig. 6 shows the emery and carborundum cloths as cut into rings. A ream of each number was ordered, and by using a wooden templet and marking the circles on the smooth side of cloth with pencil, the templets were readily shifted to obtain the greatest number of circles possible from each sheet to avoid waste. A pair of shears were used to cut the larger circles, and a cast-iron flange containing $\frac{5}{8}$-in. holes and a ball-peen hammer to cut the holes through the center for capscrew openings.

We then had the pump drained and ventilated. Next we attached the discs of cloth between the cast-iron disc 2 and valve 1. The 9-in. rod is attached to the suction-valve casting. A few drops of oil was put on the emery cloth, which was rotated back and forth 50 or 60 times on the seat. The coarsest cloths were used first until a fairly good seat was made, then cloths of fine grade down to No. 0 were used. After an hour's work on each of the suction valve seats, an excellently polished and true seat was obtained. Notice that the opening in the bottom of the discharge valve seat is 3 in. and valve seat 4 in. By using a 3-in. disc to clamp the emery cloth, the disc forms a well-fitting guide for the discharge valve.

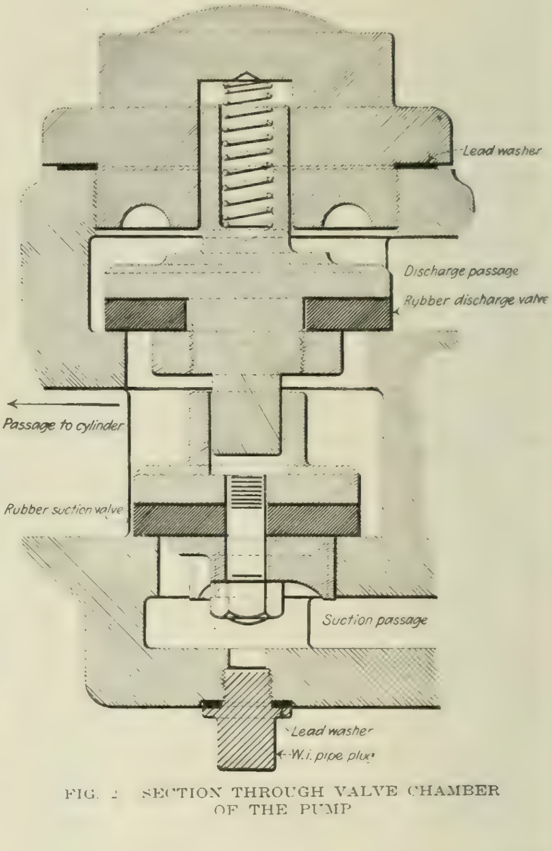


FIG. 2. SECTION THROUGH VALVE CHAMBER OF THE PUMP

No tilting or canting can possibly occur; therefore, a true seat is obtained by grinding if reasonable care is observed in using the brace. Also the hole in the suction-valve seat is 2 in. and the valve 3 in., therefore a 2-in. disc was used as a clamp for the suction valve, and in this case also no canting occurred. The discharge valves took longer, 3½ hours on each one, but an excellent seat was obtained on each. Then the seats and passages were thoroughly cleaned, using a magnet made from an old file and cloths to get out all grit. The hard-rubber valves were then ground on their seats with emery and oil until they seated like new.

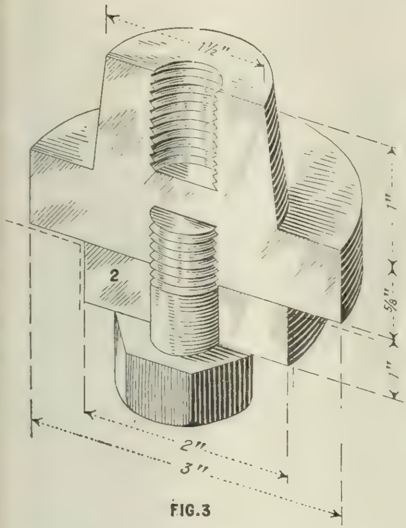


FIG. 3

SUCTION VALVE CASTING MACHINED FOR REGRINDING SEAT

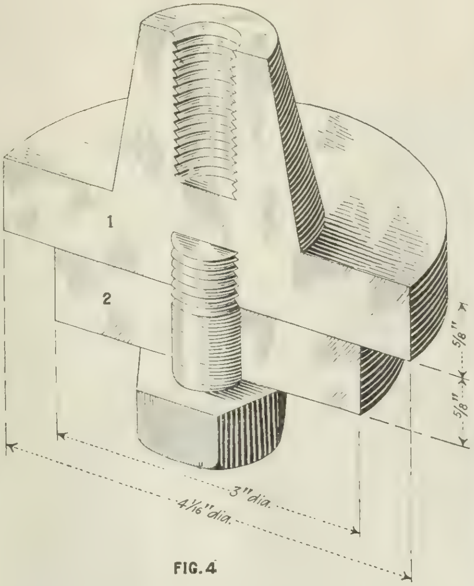


FIG. 4

DISCHARGE VALVE CASTING MACHINED FOR REGRINDING SEAT

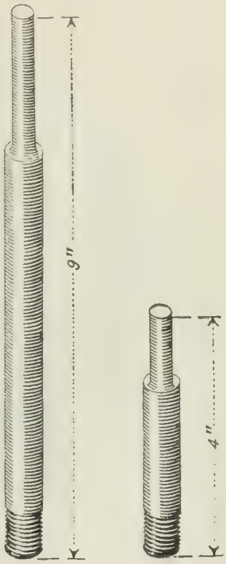


FIG. 5

RODS TURNED DOWN TO USE RATCHET BRACE

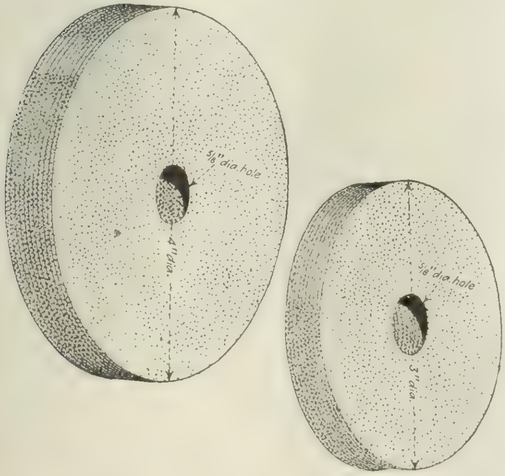
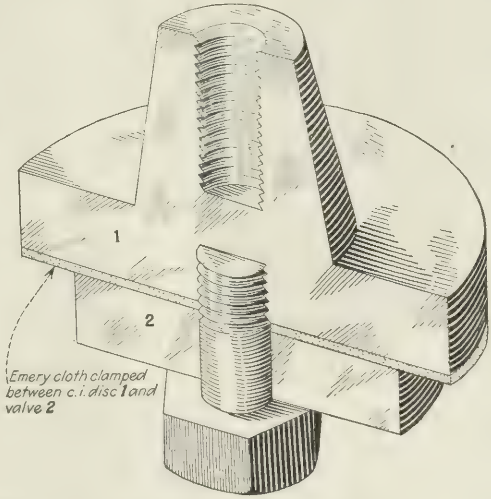


FIG. 6. EMERY CLOTH DISCS USED FOR DRESSING VALVE SEATS



Emery cloth clamped between c.i. disc 1 and valve 2

FIG. 7. SHOWING APPLICATION OF EMERY CLOTH DISC BETWEEN VALVE DISC AND SEAT

The pump ran fine after the valves had been ground. The outlay in money to do the job was $12. This included machining, the blank valve castings and making the rods, supplying capscrews, etc., with disc machined both sides, allowing about 0.004 in. clearance on the disks. That is, they were respectively 3 in. minus 0.004 in. in diameter, 2 in. minus 0.004 in. in diameter; holes for the guides were reamed true to size. The emery cloth for making the discs cost five dollars.

When a vacuum was needed on an absorber, it was almost impossible to get a good one before repairing the pump. The pump slip was excessive. When the pump was idle the leakage back through the exchanger from the generator worked back into the aqua receiver and through it into the absorbers, causing a considerable rise in pressure and making the pump gasbound. Now, with tight valves and seats, all this trouble is eliminated.

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EDITORIALS

Advancement in Central Station Boiler Design

IT IS but a few years ago that a five-hundred horsepower boiler was considered of large capacity; now it is looked upon as a small unit. Likewise a pressure of one hundred and twenty-five pounds was considered high; now one hundred and seventy-five pounds is common practice, three hundred pounds is fast becoming so, and recently boilers have been installed that were designed for three hundred and fifty pounds working pressure. Such a boiler would be fifty-one sections wide, each of four hundred and fifty-two square feet of heating surface. Formerly five thousand square feet of heating surface represented the large units; today boilers are being designed with twenty-three thousand and fifty square feet of heating surface. Allowing ten square feet per boiler horsepower, these boilers will have a normal rating of two thousand three hundred and five horsepower.

On another page of this issue it is shown that builders are ready to manufacture units of these large capacities to carry high pressure and high superheat. These double-decked boilers permit of increased total heat absorption through direct radiation, the six rows of tubes of the lower deck being exposed without baffles to the radiant heat of the furnace.

By locating the superheater immediately above the lower deck of the boiler tube, the desired degree of superheat may be obtained with a minimum amount of superheater surface, consequently a corresponding minimum superheater cost.

Naturally, such sizes of boilers will be equipped with duplex furnaces and a furnace volume supplied of approximately three and ninety-five hundredths cubic feet per rated horsepower.

Such boilers clearly show the trend as regards modern power-station practice. Large units and higher pressures are necessary to meet the increase in the load factors of the present-day central station.

Conservative Guarantees

IT IS not necessary to make impossible guarantees to sell goods. A conservative guarantee, whether of efficiency or capacity, will carry more weight and have more respect shown for it than will wild, irresponsible claims of impossible figures such as sometimes are made by over-enthusiastic salesmen. Power-plant apparatus is not always sold by engineers, but sometimes by men who are primarily salesmen and who are sent out to get the business. If it becomes necessary in keen competition to outbid someone else in efficiency or capacity they will do it and take a chance on the results. Coal salesmen sometimes bid on contracts, making B.t.u. guarantees that they know cannot be met, the bid being accompanied by a schedule of penalties for coal that does not come up to the specifications. This is simply another way of cutting the price and gets by in the coal business.

When selling power-plant apparatus, however, it is a more serious matter. Large amounts of capital are invested in boilers, generators and other equipment on certain guarantees. If these guarantees are not met when the installation is completed it is an expensive and unsatisfactory process to alter the apparatus to make good, and usually it is not satisfactory to make an adjustment in the price to meet the conditions. Boilers, for instance, are installed in many places where floor space is at a premium and it is necessary to get the greatest steam capacity possible in this space. Simply deducting a percentage of the purchase price, if such capacity is not realized on test, does not meet the situation, because throughout its life the plant is penalized by a lower capacity per unit of floor space than was originally intended when the installation was laid out. The same reasoning applies to efficiency guarantees for an engine, turbine or other power-plant machinery. The penalty that it would be possible to inflict will never cover the loss that will be continuous throughout the life of the equipment.

It is much better to quote conservative guarantees that are rather certain of being exceeded. Purchasers who know anything about power-plant affairs will have more confidence in a firm following this practice, and in the long run both seller and buyer will be better served.

Speculation in Anthracite

ALTHOUGH conditions in the bituminous markets have recently shown improvement the anthracite industry is still a pawn in the hands of the speculator, with retail prices outrageously high, in spite of a slight drop during the past few days, evidently as a result of the constant agitation that has been going on.

The anthracite industry, unlike the bituminous, is not a competitive field and from seventy to seventy-five per cent of the output is in the hands of a few large operators who claim to be selling at a normal profit and are listing their prices. They claim further that the high retail price is due to the independents taking advantage of the shortage resulting from the strike which occurred in September.

The local dealer, on the other hand, claims his selling price is arrived at by pooling his costs and that the high average is due to having to purchase the bulk of his coal from the independents.

If the bulk of the anthracite produced is being sold by the large operators at the listed prices, then why is the local dealer not able to secure the bulk of his supply at these prices? Either this coal is first passing through the hands of the speculator or the dealers are hoodwinking the public.

It is incredible that the large operators are unknowingly diverting their production to the speculator, and the statement by Senator Calder that there has been connivance between some of the operators and these speculative middlemen seems suspiciously true in spite of the many denials.

Again, why is it that some of the large wholesalers, while professing a desire to assist in a reduction in price to the consumer, invariably invoke the legal machinery of the courts whenever the investigating authorities endeavor to gain access to their books. It must be most disheartening to the prosecuting officers to constantly have their efforts thwarted by the technicalities of the law.

A ray of hope lies in the threat by Senators Calder and Edge, of the Senate Coal Investigating Committee, to introduce at the new session of Congress, a bill that will put teeth into the law and minimize the opportunity for speculation in coal. Until then we must expect anthracite prices to run riot, unless, indeed, the prospect of Governmental supervision has a steadying effect on the industry before that time.

Germany and the United States Making the Same Experiment

ON ANOTHER page appears a report from our Berlin correspondent on the coal situation in Germany. An interesting feature of this report is the proposal of Stinnes, the principal German "coal baron," to form trusts of related industries, in which procuring of the raw material, its manufacture into a finished product and the production of power used in the process will be under one organization. There is now a very similar proposition under way in this country; the plan is being tried at the River Rouge plant of Henry Ford. Mr. Ford already mines his own coal and transports it to his plant, and it is his further intention to bring iron ore to this new plant and produce all his own steel and iron as well as power.

This fits closely the description of Stinnes' plan, except for the representation of consumers on a governing board. The latter provision, however, savors more of bait than of an integral part of the astute German's proposal. It should be interesting to watch the progress of the movement in the two countries and to make comparisons of results. It should be of especial interest, because nearer home, to watch Henry Ford's venture; it is a radical step not only in engineering, but in economics as well.

It is hard to conceive of an enterprise sponsored by Mr. Ford becoming oppressive to other business, for his effort has always been to help the other fellow rather than to fight him. But suppose his plan works out well and is adopted by others? Would its tendency be good, and would it, perhaps, afford a solution of our difficulties? Or would it be perverted—would it give the profiteer a tighter grip on the throat of industry than he has today?

Cinders in Stack Gases

CINDERS as applied to stationary power-plant engineering have been of little importance except in a few instances where low-grade anthracite has been burned at high rates of combustion with forced draft. In such cases elaborate means have been taken to reduce the discharge of solid material from the stack, the problem being complicated by the presence of sulphur in the gases of combustion and the desire to keep the temperature as high as possible for the sake of good operating conditions.

Although they have a definite fuel value, cinders represent a small loss, and they are not so much of a nuisance as smoke or soot, as they do not form an insulating covering on the heating surface of the boiler and do not have the damaging action familiar to a smoky atmosphere. However, when taken to mean any of the non-gaseous products of combustion which are discharged from the stack, the term takes on new importance. Many plants operating without smoke are discharging into the atmosphere a considerable amount of finely divided material which can be classed as combustion dust. When viewed under a microscope, much of this material is seen to have the characteristics of true cinders, consisting of a considerable amount of combustible material mixed with fused silica, ash, slag, etcetera. This substance, although spread over a great area, finally reaches the ground and in industrial communities represents annually hundreds of tons of precipitate per acre.

Two influences are now at work that will bring the cinder question more prominently to the front. The first is the growing insistence on burning the lowest grades of anthracite, introducing, as it does, forced draft; the second is the increasing use of powdered coal in the boiler room.

Theoretically at least, powdered coal will find its best application in burning the high-ash low-grade coals, and this emphasizes the question of disposal of the solid products of combustion. While there is a small amount of combustible material in the cinder, there is a large proportion of objectionable matter which it will be advisable to eliminate if possible. Luckily, the draft necessary in the burning of powdered coal is low. This condition lends itself to the introduction of deflectors, dust catchers, cyclone separators or other devices that may help to solve this problem.

Marine Oil-Engine Situation

IT IS customary to expect engineers to be ever ready to adopt improved machinery. In view of the intense interest displayed by the lay public in the matter of the merchant marine and the oil engine, it is somewhat surprising that no paper on this or kindred subjects was presented at the annual meeting of the Society of Naval Architects and Marine Engineers in New York City in November.

The motor ship is here to stay, and the naval architects can do much to encourage the general adoption of this economical power. The problem of adapting the Diesel to marine service is by no means so difficult of solution as was that of the steam turbine, neither are the operating difficulties of such magnitude; while the economies that can be secured by the oil engine are so great that the naval architects and engineers will do well to give considerable study to this important subject.

In reply to his message of congratulation to James Harkness, past president of the society, just elected governor of Vermont, Secretary Rice of the American Society of Mechanical Engineers has received the following:

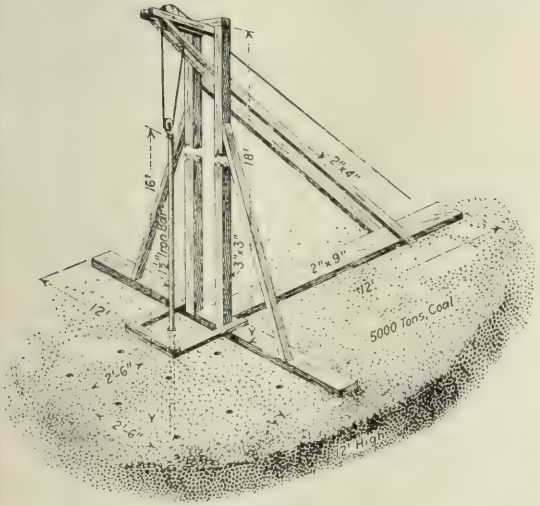
> Delighted to receive your message of congratulations. Tell my fellow engineers who are looking over the sea of politics to come on in. The water's fine!
>
> JAMES HARTNESS.

If more engineers would take a similar plunge, it would be good for politics.

CORRESPONDENCE

Ventilation of Coal in Storage

I read with interest the article on page 618 of the Oct. 19 issue of *Power* on "Ventilation of Coal in Storage." When I took charge of my present plant, seven years ago, I found a coal-storage fire in full blast and we lost considerable fuel. Coal is received in cars, and it is unloaded by a swing derrick. When the pile is about seven feet high, we cut the pyramid down by shoveling to make it level and to mix the lump coal with the fine so as to reduce the air space; we do this for every four feet in height or three times before we reach the twelve-foot level. When we have enough area on the top to work on, we pull up our homemade "pile driver," made similar to that shown in the sketch.



PILE DRIVER FOR MAKING VENTILATING HOLES

It is light enough for three men to handle and is made from two 2 x 9-in. planks and two 3 x 3-in. posts with 2 x 3-in. braces. One single block with half-inch cotton rope is used to handle the 1½-in. diameter iron bar which can be driven through the coal in less than a minute. When the bar reaches the bottom, it is shaken sideways so as to pack the loose coal around the bar. Before pulling the bar up, it is necessary to make a casing of 10-oz. roof paper around the bar, coming just level with the surface of the coal. This is to prevent loose coal from falling into the holes when the bar is removed. We punch a hole for each 2.5 or 3 sq.ft. area. Three men are able to make about twenty-five to thirty holes in one hour. We store 5,000 to 7,000 tons of coal every year.

The pile is easy to check for temperature by lowering a thermometer in each hole. **Joseph Esiszter.**

Berthierville, Canada.

Judging from my personal experiences with stored coal, I would say that in most cases it has been found that the coarser the coal is put on the bottom of a pile and covered with finer sizes, the worse it seems to heat.

Extinguishing a fire in a coal pile has always been successful when the water was applied to the bottom of the pile. This is accomplished by applying a nozzle to the top of the pile and pushing it down as far as the force of water will permit it to go.

Where coal is not piled over ten feet high, the bottom of the pile can be reached with the ordinary nozzle. If the pile is higher an extension pipe must be attached. From fifty to seventy pounds pressure is sufficient to penetrate the general run of nut and screenings, and a ⅝- to ¾-in. diameter nozzle is large enough where the fire has not spread too much. I cannot say how this will work on lump and run-of-mine coals, as the lumps might prevent working the nozzle down. Screening and nut are the only kinds I have dealt with.

By moving about on a pile at spaces of from three to six feet apart, it is possible to cover any fire under the pile. Sometimes a pile will need several applications of water before all trace of the fire is gone.

Pouring water on the top of a pile of hot coal is like pouring water on a duck's back, as it will go down but a small distance. It means either work through the top or in on the sides of the pile. It is surprising how much water a pile of screenings will absorb when applied as described. The fires always seem to start at the bottom of the pile.

The ventilating pipes, as shown in Fig. 7 on page 619 of the Oct. 19 issue, would be a good method of applying water in advance of any fire, thus cooling the pile and not giving the coal a chance to start heating.

Capping the pipes would stop ventilation if it were considered detrimental.

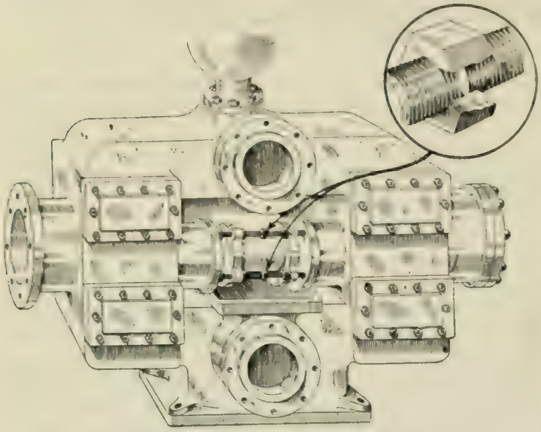
I have known screenings to be stored for two years and longer without taking fire; then again, other coals would not be in storage two months without a fire starting. Contrary to the common belief, the old coal showed, by actual analysis, very little depreciation from long storage. The foregoing applies only to coal fires in the incipient stage. **E. G. Hoppe.**

Cairo, Ill.

A Quick Pump Repair

A single-acting, center-packed boiler-feed pump that supplies water for two 150-hp. return-tubular boilers recently gave the operating engineer a chance to do some quick thinking. This pump is the only means for feeding the boilers, except when the pressure is lowered to 40 lb., when the city supply can be turned on. The plant operates six days a week, and twenty-four hours a day.

The engineer had instructed the fireman to pack the water end on Sunday. When he packed the pump, he filled the stuffing boxes so full that he could not enter the glands by shoving them in by hand, so he put the nuts on and pulled the glands up with a wrench; the packing used was made of a composition of rubber and duck.



EMERGENCY STUFFING-BOX REPAIR

The pump was started on Monday morning as usual and ran until about 9 o'clock, when the four ¾-in. gland studs on the end toward the steam cylinder pulled out of the casting, because of the pressure and the packing swelling.

The engineer procured eight ¾ x 4-in. studs and sixteen hexagon nuts, and after screwing out the four studs on the opposite end, he put the studs and nuts in place in the form of a jackscrew, as shown in the sketch. It took one hour and five minutes to make this repair, repack the pump and have it forcing water into the boilers. C. J. MILLER.

North Tonawanda, N. Y.

Boiler Drum Pitted

In answer to Mr. Carter's letter, page 675 of the Oct. 26 issue, relative to pitting of boiler drums, I am of the opinion that it is caused by the carbonic acid and air that are present in the feed waters—in some more than in others. It is known that when water is heated it releases most of the air it contains and the temperature of dissociation begins at about 140 deg. F. If the circulation is poor, the air and carbonic acid adhere to the rough surface of the drum.

Strohmeyer says that feeding one ton of water per hour is capable of a wasting of six pounds of iron in twenty-four hours, assuming that all the water would come in contact with the iron. The drum of which Mr. Carter speaks may just be at the right dissociation temperature. I believe that every closed heater should have an air valve in the feed pipe just outside the heater. JOHN D. DESMOND.

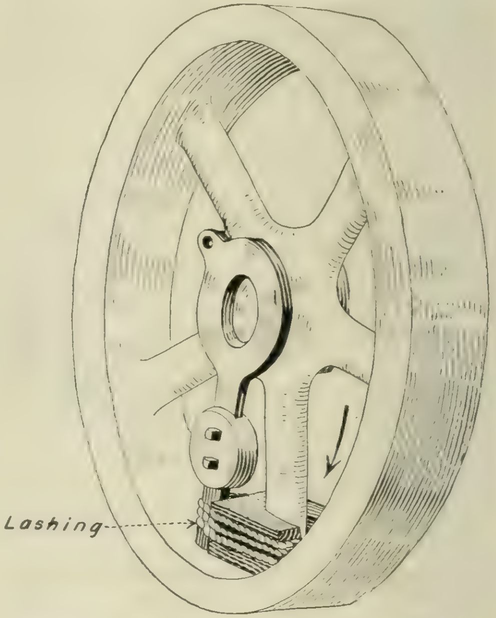
Milwaukee, Wis.

Carrying the Load with the Governor Disabled

We were running along one night, in a power house where I was chief engineer, with a 700-kw. load on a 500-kw. vertical turbine and an 800-kw. load on a revolving-field alternator directly connected to a 1,500-hp. vertical cross-compound engine with a 500-kw. direct-current generator on the other end of the shaft. This direct-current machine had no load.

The two alternators were in parallel when the governor spring on the engine broke and caused the engine to drop its load. This happened about 6:30 p.m., just before Christmas, when our peak load was on. This engine was controlled by a shaft governor which operated the admission valves on the high-pressure side; all the other valves were operated by eccentrics. As we did not have time to fit up another spring, I had the men lash the governor weight back against the stop as illustrated.

We started, with one man at the throttle, one at the condenser and one at the switchboard. The man at the throttle was given orders to obey signals from myself as to opening and closing the throttle. The machine was brought up to speed, synchronized and put on the bus. We put the engine in on the condenser and opened up the throttle until the engine had its part of the load, the turbine doing the governing for both units. As the load fell, we closed the throttle of the engine so as to make the turbine do the governing. This goes to show that a governor is required on but one of the prime movers when the machines are operated in parallel.



WEIGHT ARM LOCKED TO FLYWHEEL SPOKE

East St. Louis, Ill. E. LITTLEFIELD.

Methods of Calculating Flue-Gas Losses

I recently chanced to leaf through an issue of *Power* (April 27, 1920) and found an article by F. D. Harger, entitled "Calculations from a Flue-Gas Analysis of Loss Due to Incomplete Combustion." Now this is not intended to take issue with Mr. Harger, but let it be said in passing that rarely, in my experience, has any CH_4 been found in the analysis of flue gas taken from the breeching of furnaces where the gases have had a chance to travel any of the usual distances through a boiler setting before they leave the heat-absorbing surfaces and pass to the stack. In fact, CH_4 is rarely found even in the first pass of any boiler where anything like ordinary combustion conditions are maintained. Then too, using an accurately calibrated 100-c.c. water Orsat equipped with a good bubbling pipette containing well-prepared ammoniacal cuprous chloride, all the CO that is ordinarily found in flue gas can be absorbed in three to four passes. The whole operation requires only about a minute and a half. A sample of pure CO can be absorbed in less than three minutes by this method. However, if an ordinary absorption pipette with vertical glass tubes is used, the rate of absorption will be much slower owing to the low viscosity of the CU_2CL_2 solution. If something could be found to thicken this solution, it might be used successfully in an ordinary pipette. Continuous analysis for CO is hardly worth while since conditions causing an appreciable amount of CO ought to be detected by the eye and remedied at once. Bulletin No. 135, United States Bureau of Mines, "Combustion of Coal and Design of Furnaces," shows a series of tables compiled over a long series of tests.

These tables trace the progress of combustion throughout a furnace, showing that CH_4 is confined to an area just above the fuel bed. Most of it is found at the surface or not more than 11 in. above. Beyond this point the CH_4 is almost entirely burned, and it is only a little farther on that the CO content materially decreases until by the time the uptake is reached there is only a few tenths of one per cent, if any.

But to return to Mr. Harger's reference to H. B. Brayton: An article by this author in *Power* (Feb. 17, 1920), "Calculations from a Flue-Gas Analysis," though substantially correct in most details, is by far more complicated than need be for the average boiler-room operator. An assumed analysis of coal given was: Carbon, 82.73; hydrogen, 4.63; oxygen, 4.42; nitrogen, 1.31; total, 93.09 per cent. Calculated calorific value, 14,480 B.t.u. The difference between this total and 100 per cent is presumed to be ash, sulphur and moisture, if the analysis were made on a "wet" basis. Fifty per cent excess air was assumed and average flue-gas temperature was given at 550 deg. F. outside air, 50 deg.

Now, instead of calculating heat losses from atomic weights and using a different value of specific heat for each gas, it is much simpler to start with a known flue-gas analysis. Since 50 per cent excess air was assumed, let us find an analysis that will give us that figure. With 12 per cent CO_2 and 6 per cent oxygen we have just 50 per cent excess air. This may be checked by using the formula for air required and air supplied:

$$11.5\,C + 34.5\left(H - \frac{O}{8}\right) = \textit{lb. of air required per pound of carbon.}$$

Submitting in the formula the values of carbon, hydrogen and oxygen found in the ultimate analysis of the coal, we find that 11.33 lb. of air is required. The formula for the amount of air supplied with 12 per cent CO_2 and 6 per cent oxygen is

$$3.036\left(\frac{N}{CO_2 + CO}\right) \times C =$$

$$3.036\left(\frac{82}{12}\right) \times 0.8273 = —\ 17.16 \textit{ lb. of air supplied.}$$

$$11.33 \div 17.16 = 66 \textit{ per cent excess air.}$$

With the flue-gas analysis given, the dry-gas loss may be easily computed from this formula:

$$Loss = W \times 0.24\ (T - t)$$

where

$W = \left(\dfrac{4\,CO_2 + O_2 + 700}{3\,(CO_2 + CO)}\right) C$ (C = per cent carbon in fuel);

0.24 = Mean specific heat of flue gases;

T = Stack temperature;

t = Temperature of outside air;

$W = \dfrac{48 + 6 + 700}{36} \times 0.8273 = 17.32$ lb. of gas per lb. of carbon.

$$Loss = 17.32 \times 0.24 \times 500 = 2078.4 \textit{ B.t.u.}$$

$$2078.4 \div 14{,}480 = 14.3 \textit{ per cent loss.}$$

In computing the hydrogen loss the following formula is used:

$$9H\ [(212 - t) + 970.4 + 0.47\ (T - 212)]$$

where

H = Per cent of hydrogen in fuel;

T = Stack temperature;

t = Temperature of outside air;

970.4 = Heat of vaporization of water;

0.47 = Specific heat of superheated steam at atmospheric pressure and at temperature of escaping gases.

If any moisture value for the coal had been given, this value, expressed in per cent, could be added to the value of $9H$ and computation made. Substituting values in the formula, we have:

$$Loss = 0.4167\ (212 - 50) + 970.4 + (0.47 \times 338)$$

$$H \text{ loss} = 538.07 \textit{ B.t.u.}$$

$$538.07 \div 14{,}480 = 3.7 \textit{ per cent loss.}$$

Since no particular kind of furnace is specified, 10 per cent is probably high for an average radiation loss and a nearer figure would be 6 per cent or under.

$$868 \div 14{,}480 = 6 \textit{ per cent radiation loss.}$$

Totaling the various losses, we find an efficiency of 76 per cent.

HEAT BALANCE

	B.t.u.	Per Cent
Dry-gas loss	2,078.40	14.3
Hydrogen loss	538 07	3.7
Radiation loss	868.00	6.0
Heat utilized	10,995 53	76.0
	14,480 00	100.00

Mr. Brayton obtained an efficiency of 75 per cent, but he did not obtain a high enough value for the hydrogen loss, as he only accounted for the heat lost in superheating the steam formed. This amounts to less than 100 B.t.u., whereas there are over 400 B.t.u. lost in raising the temperature of the water formed from the temperature of outside air to the boiling point and then evaporating it. The factors, 0.47 for the specific heat of superheated steam and 0.24 for the mean specific heat of flue gases, are those used universally in computing heat losses.

Mr. Brayton did not account for any moisture in the coal nor any combustible in the ash, two factors that are sure to be present and together will cause a further loss of at least 3 or 4 per cent.

The simple formulas for computing dry-gas loss and hydrogen and moisture loss are the same as given in all standard textbooks on combustion. Bulletin No. 97, United States Bureau of Mines, "Sampling and Analyzing Flue Gases," has all the merits of any treatise on the subject and may be had for the asking. For plain, concise statement of facts, no better article has ever been written and every engineer, whether technically trained or not, will do well to read this bulletin.

East Chicago, Ind. J. R. DARNELL.

Ash Removal from City Plant

The editorial, "Ash Removal from City Plants," page 590 of the Oct. 12 issue, calls to attention a condition that is becoming serious in the large plants of the great cities. While ashes are now regarded as something of a nuisance, they may in time become, as have other waste materials, a valuable byproduct.

Analysis of coal ashes show them to be composed principally of the oxides of sulphur, silicon, iron, aluminum and calcium. Nearly all these compounds are necessary to the manufacture of portland cement and are found in varying proportions in both limestone and shale from which the cement is usually made.

In some cement plants the ashes from the boiler room are used in the raw-material mix. While this amount of ashes is small compared with the total mix, it is possible to use a great deal more without serious complications. In fact, it may be possible to replace the shale or clay entirely with ashes. This would, of course, give a mix of much higher iron and sulphur and a lower alumina content than is the usual practice. The immediate result would be a clinker that is easily burned, but because of the large iron content, is very hard to grind to the requisite fineness. It would also be very dark in color and heavier than normal cement. High-iron cement withstands the action of sea water better than the standard cement.

A thousand-barrel cement plant (which is a small one as cement plants go) will, if ashes supply the entire "argillaceous-material" requirement, take the ashes from a boiler plant of about 11,000 horsepower.

The economic considerations are the relative costs of quarrying the shale and of hauling the ashes coupled with the added expense of using them. In this connection the value of the 20 to 40 per cent combustible in the ashes should not be overlooked. This fuel becomes available in the rotary kiln which, of course, is the only type considered.

The ratio of dead to live load in concrete structures is very high as compared with structures of steel or wood, therefore, could a material be found that possessed the strength and enduring qualities of sand and stone and which was of much less weight, it should make a particular appeal to builders. Recently, concrete ships and freight cars have been introduced, and weight has been found a factor of considerable importance.

While the quality of light weight of cinders has been well known for many years, its use where the advantage of light weight is most desirable (in reinforced-concrete buildings) has been very limited because of the danger of corrosion of the reinforcing steel; and to free cinders of the unburned coal to the extent of making them safe for use in reinforced concrete would probably cost more than anyone would care to pay for the advantage gained.

By subjecting ashes to a high temperature in a rotary kiln, the combustible will be burned out and the noncombustible may be vitrified. The resulting clinker may then be crushed and screened and will become a very good, light-weight aggregate, suitable for concrete. This material will have all the good qualities of the untreated ashes and will be free from the liability of corrosive action on the reinforcing steel. A concrete aggregate that has the strength of sand and stone and about half their weight should, if the prices compare favorably, find a ready market.

In discussing the economics of this ash-treating plant, it should be credited with the cost of ash removal as formerly practiced. Also, it will be found that the fuel content of the ashes is nearly sufficient to produce the desired effect, so that the fuel charge will be comparatively small. C. O. SANDSTROM.

Kansas City, Mo.

Don't Blame the Fireman

The poor firemen get little consideration from the hands of contributing engineers, who in most cases find them ignorant and prone to do the necessary work of the plant in the easiest way possible, regardless of the waste of fuel.

It has been said that the greatest gain in economy in power-plant operation will, in the future, be made in the boiler room, but no owner has a right to expect very much in the way of material gain if he does not do his part. It is unfair to expect the fireman to make much improvement in boiler operation if the owner does not provide the instruments necessary to guide him in his work.

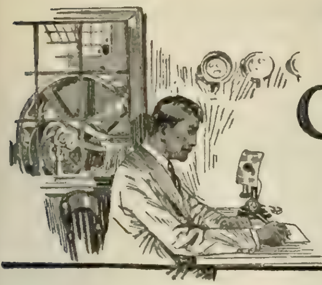
High boiler efficiency will be secured only when the fuel is properly fired, the heating surfaces kept free from scale, soot and ash deposit, the boiler setting free from air leaks and the gas passages unobstructed. All but the matter of gas-passage obstruction are under the control of the fireman. There is something more that governs the efficient operation of the boiler plant; that is, the fuel must be burned within the furnace, and to do this properly the right volume of air must be supplied to the burning fuel. If not, incomplete combustion results, producing a lower CO_2 and the temperature of the chimney gases is increased.

But how is a fireman to know how hot the flue gases are or whether excess air is being supplied to the furnace if the proper instruments are not provided for his guidance. If a plant is suitably equipped with the necessary instruments, the operation should be a continuous boiler test and then results can be expected.

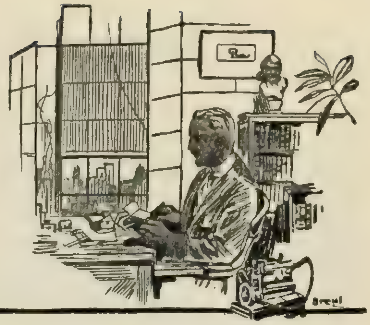
The best fireman on earth cannot get the best boiler-room results unless he has means of knowing what he is doing. Firing boilers by rule of thumb will not get the best results, although that is the way many boilers are operated. This is not because the fireman would not do better if he could, but because he is doing the only thing he can do with what he has to work with.

Do not condemn the fireman until he shows that he does not try for better results when proper instruments have been supplied for his guidance.

St. Louis, Mo. O. B. BASSETT.



INQUIRIES OF GENERAL INTEREST



Use of Loop or Siphon for Connecting Steam Gage—Why is a loop used in connecting a steam gage to a boiler? R. N.

A loop or siphon is placed in the connection between the boiler and the gage to trap water of condensation in the connecting pipe, so that steam will not enter the gage tube and affect its stiffness.

Necessity of Auxiliary Steam Valve on Single Pumps.—On a single-cylinder steam pump, why is it necessary to have an auxiliary steam valve? W. C.

If the main valve of the pump were mechanically connected to the piston rod of the pump, the steam port would be covered slowly toward the end of a stroke, the stroke would not be completed and the valve would not reverse. Therefore an auxiliary valve is necessary to operate the main valve.

Increasing Length of Bearing May Reduce Friction—Does increasing the length of a bearing add to the power required to overcome friction? W. A.

For the same materials and finish and same lubrication, up to the point of cutting or abrasion of one surface or the other, the loss of power by friction is directly as the total pressure and independent of the area of the rubbing surfaces. Therefore increasing the length of a bearing does not add to the power required to overcome friction, but on the other hand may reduce the resistance by prevention of cutting or permitting of better lubrication from reduction of the pressure per unit of area of the rubbing surfaces.

Changing from Natural Gas to Producer Gas—The natural gas for our gas engine will shortly be shut off. Is it possible to use producer gas without any great change to the engine? What will be the fuel consumption? G. E.

Producer gas may be used, and all that is necessary is to install a producer. The engine will require no alteration beyond a possible change in the compression and in the proportions of gas and air passing through the throttle valve. Any of the well-known producers will deliver enough gas from anthracite coal to allow the engine to develop a brake horsepower on 1¼ lb. of anthracite pea or buckwheat coal.

Increasing Power Developed by Engine—In how many ways can the horsepower of a non-condensing engine be increased? C. W. M.

Assuming that all bearings and working parts are adapted to the changed conditions, the indicated power of an engine is increased for a given m.e.p. by increasing its speed, or by increasing the m.e.p., and the actual or brake horsepower developed for a given indicated power can be increased by reducing the friction of the engine. The m.e.p. can be increased principally by supplying steam of higher initial pressure, by obtaining later and sharper cutoff, by obtaining release later in the stroke, by increasing the percentage of clearance (provided the steam does not follow full stroke), reducing the losses due to cylinder condensation by using a non-conducting lagging or steam jacketing, or by heating the cylinder without raising the temperature of the exhaust; reducing the back pressure by a freer exhaust or by condensing; and by improving the tightness of the piston, the steam and the exhaust valves. But under some conditions the increase of friction for reduction of leakage may be so great that the actual power will not be increased as much as the indicated.

Inside Lap for "Cushioning on the Exhaust."—What is meant by inside lap of an engine valve and what is its effect in the operation of an engine? R. G. L.

The lap of a valve is the distance its edge overlaps the port when the valve is in the middle of its travel. The term inside lap, when applied to a D slide valve, refers to the distance the exhaust edge of the valve overlaps the exhaust port when the valve is in the central position. Inside or exhaust lap therefore results in closure of the exhaust port before the piston reaches the end of its stroke. The exhaust steam then remaining in the cylinder is thereby compressed and acts like a cushion for gradually arresting the piston as it approaches the end of the stroke, and hence the operation is commonly referred to as "cushioning on the exhaust."

Purpose of Dash-Relief Valves on Pump—Why are dash-relief valves placed on the steam end of a pump, and do they make any difference in the regulation of the stroke of a pump? W. H. C.

Dash-relief valves are used to control the amount of opening of a communication between the exhaust passage and the regular live-steam passage, which is near the end of the cylinder and which remains covered by the main steam valve until it reverses. The communication between the passages with its adjustable valve is simply a controlled leak to regulate the amount of cushioning and useful in slightly lengthening the stroke in case of excessive cushioning after the piston has covered the exhaust passage, especially when the pump is working slowly and with a heavy load.

Size of Safety Valve for Compressed-Air System—What is the largest safety valve permissible on an air compressor? L. W. R.

For safety there would be no limitation of the maximum size. There is, however, a limitation of minimum capacity. The Massachusetts Air-Tank Regulations, which were carefully prepared, specify (a) that the maximum commercial rating sea-level pressure and 60 deg. F. of any air compressor shall be the piston displacement in cubic feet per minute at the maximum speed as given in the catalog of the manufacturers, and (b) the safety valve connected to an air-compressor system shall have, when adjusted to give the maximum discharge area for satisfactory operation, a capacity capable of discharging a quantity of air at least equal to 25 per cent excess of the maximum rating of the air compressors operating on said system, without the air pressure rising over 5 per cent of the allowable pressure.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Service Experience with Condensers*

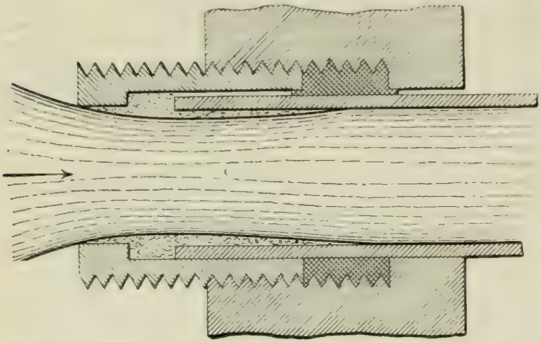
By Engineer Lieutenant-Commander G. B. Allen, R.N.

IN THE early days of low powers and comparatively high ratio of machinery weight in war vessels, a high standard of purity of feed water was not absolutely essential, and owing to its protective qualities a certain amount of boiler scale was not particularly objectionable. Under these circumstances the boilers were frequently worked with a slight density, and the admission of small amounts of salt water to the feed was a matter of no great moment, and indeed would not ordinarily be detected.

The demands for maximum power on a minimum weight necessitated the development of the water-tube boiler, which in its present form is peculiarly sensitive to the quality of feed supplied, and a condenser defect which formerly would have been regarded as of little importance is now attended by results out of all proportion to the magnitude of the defect itself.

Among the immediate results following upon such a defect as a small perforation are:

1. A rise in the density of the boiler water followed by priming (that is, the passage of water with the steam through the system), with consequent possible damage to fast-running reciprocating auxiliaries and undue wear (erosion) of turbine nozzles in modern vessels; and unless the evaporation is considerably eased and the engines either slowed down or stopped, the mechanical damage caused by the water passed over may be considerable.



FLOW OF WATER INTO CONDENSER TUBE

2. The deposition of scale upon the heating surfaces.

3. The beginning of serious corrosive action in the system, including both boilers and turbines, the first named being particularly severe in the highly forced boilers of the present day.

It is on these grounds, both of reliability and durability, that the importance of maintaining a pure "feed" rests.

Fortunately, the proportion of defective tubes compared with the number of tubes on service is extremely low and is not greater than 50 in 1,000,000 per annum; but if it be realized that in a large vessel fitted with some 48,000 tubes of a total length approximating to 115 miles, such a small defect as a $\frac{1}{16}$ in. diameter pin hole or one cracked tube may render the vessel unmanageable in a moment of great stress, it will be evident that it is a matter of great importance to secure immunity from such defects, and, moreover, one that requires considerable investigation and joint coöperation between the manufacturer, the metallurgist and the user.

Many of the early difficulties experienced were found to be due to faulty design and manufacture, but these, which concerned accuracy of fitting rather than faults in the tubes themselves, have been gradually eliminated. Defects of this nature may be summarized as follows: insufficient support of tubes between the tube plates; holes in diaphragm plates too large; holes in tube plates too large or too small; unsuitable packing; slackness of ferrules in tube plates; steam or drain orifices unsuitably placed, allowing steam and hot water, sometimes contaminated with oils, to impinge on certain tubes.

Insufficient Support of Tubes

Insufficient support led to undue vibration of the tubes, and although this has been largely rectified by the provision of suitable and unequally spaced diaphragm plates and by limiting the diameters of the tubes and the holes through which they pass, a certain clearance must of necessity be allowed; and the effect of vibration, more especially in high-speed vessels, cannot be ignored.

Experience has shown the necessity of adhering to rigidly defined limits in regard to the tolerances of tubes and holes in tube plates, both on the score of guarding against the fit being too close, with consequent abnormal strain thrown on the tubes when screwing up the glands, and also of guarding against too loose a fit, resulting in the packing being forced between tube and tube plate and probable leakage. Similarly, the exact concentricity of ferrules and tubes within narrow limits is of importance. Since the adoption of limiting clearances, defects of this character have to all intents and purposes been eliminated.

Opinions concerning the suitability of packing materials vary, and outside the service there appears to be little uniformity of practice. Experience in naval vessels shows that the linen gromet made to present Admiralty specification gives every satisfaction, and with ferrules and their stuffing boxes screwed to correct gage, difficulties due to gland leakage may be regarded as having been coped with successfully.

Investigations into the general problem of the nature of the underlying causes of corrosion within the alloy itself have resulted in various theories, none of which has as yet met with general acceptance, and in the present stage the most we are able to do is to endeavor to trace each defect to its immediate observable source.

The information available at the Admiralty is derived from reports forwarded by ships as failures occur. The following statement has been deduced to show the present causes of failure in the proportion in which they have occurred:

		Per Cent of Total Failure
(*a*)	Deterioration at inlet ends	18
(*b*)	Perforation due to local pitting	14.8
(*c*)	Perforation due to obstruction	14.8
(*d*)	Perforation due to steam impingement	5.4
(*e*)	Crushed ends	5.4
(*f*)	Splitting	10.8
(*g*)	Perforation due to contaminated circulating water	1.0
(*h*)	General corrosion	29.8

The large proportion of failures due to deterioration at the inlet ends of the tubes is noteworthy. Generally speaking, there is a marked thinning away at the ends of the tubes (not infrequently accompanied by wear of ferrules) culminating in perforation at from one to three inches from the end.

Air a Contributory Factor to Deterioration

In many cases where the greatest intensity of the deterioration occurs at the upper inside surface of the tube, the presence of air has been held to be the chief contributory factor, and under such circumstances the provision of air-releasing devices at the highest point of the circulating-water system has proved of marked benefit. However, with all such mechanical precautions the evacuation (before entry to the tubes) of air which is necessarily in suspension in the circulating water is at the best only partial. This is more especially the case in high-speed shallow draft vessels, and as will be evident from an examination of the sketch, the sharp edges both of ferrule and tube, assisted to some extent by the possibility that the tube and ferrule may not always lie perfectly concentrically, tend to break the flow of water and to form pockets of an unstable nature where air may be reasonably expected to accumulate.

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*Abstract of a paper before the Institute of Metals, Barrow-in-Furness, England.

This type of defect has been particularly noticeable in vessels serving in shallow waters containing a considerable proportion of solid matter, for example, sand, chalk, etc., and this, together with the comparatively high water velocity through the tubes, points to the influence of erosion or the abrasive action of gritty particles as being of considerable importance. The presence of such gritty matter cannot, of course, be avoided on service, and it appears that investigations with regard to the elimination of this type of defect must take the lines of endeavoring to obtain a metal whose surface is better able to withstand this abrasive action.

PERFORATIONS DUE TO LOCAL DEFECTS

Whereas in the cases of tube-end deterioration the number of tubes affected in any condenser (apart from those which actually fail) may be considerable; cases of local pitting are rarely evident in more than one or two tubes in the condenser concerned, and when once a failure has occurred and the tube plugged or replaced, little further trouble is experienced. In these cases perforation occurs at isolated spots, and the failure has been generally considered to be due to some local defect, for example, a spill or lamination. To quote the author of a previous paper on this subject, "The importance of spills cannot be exaggerated,"[1] and the elimination of defects of this character is entirely a question of the manufacture of the mechanically perfect tube, which desirable result can be attained only by the drawing down of a mechanically perfect cast shell. The practice of turning and boring each shell, even if regarded as merely for purposes of exploration of the metal immediately beneath the surface skins, has a considerable safeguarding effect toward the reduction in the number of such surface irregularities, as may be discovered on sighting.

Perforations, the cause of which has been directly traced to obstructions, were particularly prevalent in coal-burning ships where the ashes were discharged beneath the waterline, and though it is possible to nullify the effect of a vessel's own refuse by suitably placing the ash shoots and by the adoption of oil-fuel firing, yet such obstruction of tubes by cinders, etc., may still be caused by refuse from other vessels.

The recorded cases where failure has occurred through the impingement of steam and water directly on a limited area of the outer surface of certain tubes are few, and in general have been confined to condensers other than those of Admiralty design. Such failures should not occur, provided orifices are suitably placed and baffled.

FAILURES DUE TO CRUSHING

The proportionate number of failures due to crushing is small, and these may be regarded as isolated cases. In no case has it been established that over-tightening of screwed glands has been resorted to, and the fact that crushing sometimes does occur, serves to emphasize the importance of the tubes being sufficiently hard to stand a reasonable margin of pressure due to tightening up above that absolutely necessary to secure watertightness, though it may be remarked that crushing is sometimes observed as a natural result of the weakening of tubes which have been attacked internally by corrosion of a general nature.

There is some divergence of opinion as concerning the most desirable degree of purity of the 70 : 29 : 1 alloy, but investigation has shown that a large proportion of the tubes which have failed from splitting have been manufactured from materials of a lower standard of purity than that required by the Admiralty specification.

Apart from the question of purity of constituents, the internal condition of stress in the finished tube must have considerable bearing on the liability to season cracking and splitting. The work done during the final draw (which must be such as to leave the tubes sufficiently hard to stand the test of grometing) of necessity leaves the material of the tube in an indeterminate condition of internal stress, and anything that can be done which will eliminate this internal stress, while at the same time allowing the tube to retain the requisite hardness, will be of great benefit in minimizing defects from this source.

The case in which failure has been directly ascribed to the use of unsatisfactory circulating water is exceptional, but it certainly gives weight to a widely held opinion that the conditions under which many condensers are worked in the early stages of their life (for example, in comparatively stagnant fitting-out basins contaminated by various kinds of refuse) are conceivably of importance as a primary cause of tube decay. On the occasion referred to the vessel had been anchored in waters contaminated by sewage, and the case is quoted as emphasizing that materials for marine usage should be able to resist corrosion under varying conditions which do not allow of the selection of particular materials to suit particular waters. The deleterious effect of vegetable oils has already been described before this Institute,[2] but the writer is not aware of any experiments having been carried out to determine the effect of oil fuel in regard to the acceleration of corrosion; though it may be remarked that in one of H.M. vessels which reported a considerable number of defective tubes within two months of entering into service, no definite cause could be traced beyond that extended basin trials had been carried out in comparatively stagnant water contaminated by a considerable leak from one of the ship's tanks.

FAILURES CAUSED BY GENERAL CORROSION

The proportionate number of recorded failures due to general corrosion does not adequately express the importance of this class, these being cases of actual failure only, that is, general corrosion culminating in perforation; whereas the great majority of cases in which general corrosion is present are not recorded, and it is the possibility of failure at an unknown moment which gives this matter so serious an aspect.

Leakage from electric circuits has been put forward as being a contributory cause of corrosion, but though no evidence of a positive character has been obtained in support of this contention, it has been observed that failures have occurred shortly after the discovery of "grounds" and it is probable that the effect, if any, is one of acceleration rather than a primary cause.

The general problem of corrosion of condenser tubes may be conveniently regarded from four different standpoints:

1. The arrest or prevention of corrosion in condensers as at present constructed.
2. The treatment of tubes of accepted composition.
3. The general design of condensers.
4. The utilization of more suitable alloys than those at present in use.

The provision of steel protector plates and cast-iron water-ends has proved satisfactory in checking the rate of deterioration provided that good conditions are secured, but at the same time considerable wear of the cast-iron ends takes place, and this wear if excessive is an undesirable feature. The present Admiralty practice is to make the tubes and tube plates of as nearly the same composition as is practicable and to secure steel slabs direct to the tube plates, but from the foregoing remarks it cannot be said that this practice is entirely effective.

THE CUMBERLAND PROCESS

The Cumberland process has been fitted in certain vessels, but beyond the fact that it has been found that this process has not arrested decay where such decay has been in evidence before the process has been installed, the experience gained has not been sufficient to allow of any reliable conclusions being drawn.

With regard to the treatment of working tubes, the Admiralty (acting on a well-known and successful practice of coating corroded copper pipes with a film of pitch and marine glue) have experimented with resistant varnishes. In the first vessel treated, although a certain degree of protection was obtained, it was found that, probably as a result of the erosive action of the water (but possibly on account of the difficulty of forming a film of even thickness and of satisfactory drying), the varnish became washed away in places, thus exposing portions of the bare metallic surface to the action of the water. Experience with a second vessel has not been extensive, but it is understood that general corrosion which formerly resulted in comparatively frequent failures has been entirely arrested. In these cases the varnish has been applied to the tubes "in place" and dried by the admission of steam to the condenser, and it is probable that such a process carried out on tubes before being fitted would be of considerable value, provided that the surfaces formed withstand the work of fitting in place and prove sufficiently resistant to abrasive influences.

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[1] Bruhl, *Journal of the Institute of Metals*, 1911, Vol. VI, p. 304.

[2] Bruhl, *Journal of the Institute of Metals*, 1911, Vol. VI, p. 291.

The protective value of an oxide film has been suggested by a former report of the Corrosion Committee, and the Admiralty have under observation a vessel fitted with tubes on which such a film has been formed. Unfortunately, this vessel has done little steaming and no useful data have as yet been obtained.

In regard to the elimination of failures caused by surface defects, for example, spills, a vessel has been fitted with compound tubes made on the lines suggested by Sir Charles Parsons,[3] but here again owing to post-war conditions it has not been possible to obtain any conclusive results.

The Admiralty have from time to time experimented with tubes of various compositions, but experience to date has shown that the tubes made to Admiralty specification have proved the most satisfactory under the varying conditions imposed by naval service.

Germany May Take Over Coal Mines

What to do with the coal mines is one of the biggest questions in Germany today, and there is a popular clamor for nationalization of the entire coal industry, fostered principally by the radical classes. Responsible politicians and business men, however, are in many cases taking the same stand, not only because of the necessity of making some concession to the socialistic doctrines of the working classes, but also on account of the glaring faults of the present system, under which the country's coal resources are largely in the hands of a few men. These men have achieved tremendous wealth and influence; in fact, some of their coal companies in the last business year made net profits which exceeded their whole capital.

Some time ago, the government was forced to organize a committee to study the subject and make recommendations. This committee has not yet presented any feasible solution and is now being urged to take decisive action. It is composed of members of the National Economic Council and the National Coal Council, and of representatives of employers and employees.

The supporters of the nationalization of coal mines may be divided into two groups, according to the methods which they propose. One is headed by Professor Lederer, National Economist of the University of Heidelberg, and Rathenau, general manager of the A. E. G. concern, while the other group is represented by Stinnes, the German coal king. Professor Lederer and Rathenau agree that the total coal production shall at once be taken over by the government. Professor Lederer, whose proposal is the official one, believes that the mines themselves should be taken over by the state, and the owners divested of all proprietorship against payment of bonds corresponding to the value of the mines, whereas Rathenau proposes to leave the mines in the hands of the present owners for thirty years. In this case, however, the mine owners would be compelled to give up the total production of their mines at cost price plus an adequate profit, providing for a premium on increased production as a stimulus in this direction. In other words, one wants operation by the government itself, and the other wants operation by the owners simply as agents of the government.

The second group is totally opposed to either of these ideas. It is headed by Stinnes, probably the wealthiest and most astute business man of present-day Germany. His opinion is that the government would be utterly unable successfully to operate the mines, and that under government operation individual ambition, initiative and reward would be entirely lacking. His idea is that of co-operation, as opposed to nationalization. His plan is to make co-operative combines of large coal consumers like gas works, electricity works, water works, and a corresponding number of coal mines sufficient for their supply. The largest works, however, would merge with coal mines independent of other works. Each group would have a board which would regulate prices and distribution, and in this the consumers would have the majority. He believes also that the consumers should gradually assume control of the coal mines by buying up their stock against their own stock.

It is expected that these combines would consist not only of coal mines, but also of iron- and steel-works, with a corresponding number of manufacturers of finished articles; the idea being that the great amount of energy now wasted by all manufacturers in procuring fuel and raw material can be saved by linking together the chain of production from the producer to the manufacturer. This proposition is being strongly advocated among prominent industrial leaders; in fact, quite a number of them are acting upon it without awaiting the conclusion of the nationalization problem. Several of these combinations, or trusts, have been formed lately; the largest of them was the work of Stinnes himself.

Public opinion seems to be inclined towards Rathenau's proposal for state-controlled private operation rather than Stinnes's ideas of amalgamation. It is feared in many quarters that although his plan is to put the consumers in control of each trust, the coal producers, being in the strongest position, would assume control of the finishing stages and therefore of the entire combination. It is impossible to foresee at present which party will ultimately win; it seems likely that the final result will be a compromise.

Employment Conference Held in Chicago

A conference on employment and education, which was sponsored by the American Association of Engineers, was held in Chicago recently. This conference had for its purpose the stimulation of thought and discussion on the problem of educating the man and placing him in the right job. It was attended by educators, employment managers, engineers, experts on vocational and industrial education, character analysis, and others interested in education and employment.

Two resolutions were passed, one of which is exceedingly interesting in that it indicates that employment methods are already recognized as desirable in higher education. This resolution read: "Resolved, That personnel work is necessary in engineering schools, and should be provided wherever possible." Probably no other thought was so well-defined among those present as that there must be better selection of the wheat from the chaff in engineering education.

The other resolution read: "Resolved, That it is the sense of the educational delegates that the best teachers in the schools, training engineers, should be placed in charge of the more elementary work." Both resolutions were introduced by Dean E. J. McCaustland of the University of Missouri.

The conference was not intended to concern itself entirely with engineering education, nor did it; but the presence of some engineers on the program gave an engineering flavor to the subject matter of the addresses.

The engineering educators and the practicing engineers had a battle royal over the efficacy of a college education. R. O. Kramer, manager of the mechanical department of Montgomery Ward & Co., advocated the establishment of courses in management in the technical schools with a view to providing engineers with the preparation for their truest and best field of service—executive positions in the industrial and business world. Dean A. A. Potter of Purdue University upheld the work of the engineering schools with the remark that the technical world demanded a specialized product to a certain extent, but that the aim of the schools was to give a broad fundamental training which would adapt the graduate-engineer to any field of work he might enter.

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[3] *Journal of the Institute of Metals*, 1911, Vol. VI, p. 305.

J. H. Libberton, of Chicago, manager of the service bureau of the Universal Portland Cement Co., urged that the student be started out right in college by first being interviewed by a vocational advisor. He disagreed with the statement regarding college activities made by E. Davenport in an article in *The Saturday Evening Post* for Nov. 13 and urged the participation of the student in such activities to develop his initiative and imagination. He also recommended the securing of the best possible talent for teachers, who should be encouraged to engage in the practice of their profession.

John B. Densmore, director-general of the United States Employment Service, advocated a national clearance system of employment, operated very closely with the educational systems of the country. He deplored the present-day education by age instead of according to native ability and the lack of scientific methods of measuring abilities in the schools and colleges. A national clearance system would reduce the present duplication of expense of engaging men and women incurred by employers and the expense of finding positions for graduates incurred by educational institutions.

Professor A. F. Payne, of the department of trade and industrial education in the University of Minnesota, in speaking on "Vocational Analysis and the Engineer," said that "very few of our engineering colleges have as yet realized that most of their students eventually become administrators and executives, and in the vast majority of cases are managers in more or less degree." Inasmuch as the engineer is usually the only man in industry who has been scientifically trained in a scientific manner, the responsibilities of vocational analysis fall upon him. Mr. Payne outlined the methods of vocational analysis and determination of mental capacities. He strongly advocated a scientific selection of workers into proper vocations as a means of increasing prosperity and happiness.

Chicago Section A. S. M. E. Celebrates Fortieth Anniversary of Society

The Chicago Section of the American Society of Mechanical Engineers celebrated the fortieth anniversary of the society on the evening of Nov. 22. Souvenirs consisting of photostat copies of autographs of all members attending the first annual meeting held in New York City in 1880 were distributed. A similar record of autographs of Chicago members present at the Fortieth Anniversary meeting was made to be forwarded to New York for historical record. Anniversary speeches by Fred J. Miller, president of the society, and Dr. I. N. Hollis, president of Worcester Polytechnic Institute, were reproduced on the phonograph. During a short business meeting telegrams of congratulation were read from a number of prominent men, including Harding, Coolidge, Hoover, Gompers and others.

In a few introductory remarks Prof. Herbert S. Philbrick, chairman of the section, called attention to the fact that the greatest development in mechanical engineering has taken place during the last forty years and has been almost coincident with the upbuilding of the A. S. M. E. To be convinced of the progress made and the importance of the work done by the society, he remarked that it was only necessary to read over the list of presidents, all noted men in the mechanical field. It was his view that the future is as attractive now as it was forty years ago, and it was his hope that the progress of the society in the next forty years would be as great as the advancement it has made so far.

Captain Robert W. Hunt gave early recollections of the society that was nearest to his heart. He was not one of the founders, but had joined the society in its first year in 1880. His associations with prominent members at that time were recalled, and mention was made of some of the early presidents. He felt that in the continued progress of the society the secretary was of first importance, and that in this connection credit must be given to Frederick Hutton, to whom, more than to any other man, the wonderful success of the organization had been due.

A short summary of the first meeting of the American Engineering Council of the Federated American Engineering Societies, held in Washington from Nov. 18 to 20, was given by Arthur L. Rice.

The speaker of the evening was Dr. G. O. Smith, director of the United States Geological Survey. Speaking on "Industry's Supply of Energy," he gave a great deal of interesting data on the various sources of energy, including coal, water power, oil and natural gas, the estimated quantities available of each, the length of time that they should last at the present increasing rate of consumption and the primary horsepower installed.

Refrigerating Engineers Holding Annual Meeting

The American Society of Refrigerating Engineers is holding its sixteenth annual convention this week at the Hotel Astor, New York City. Meetings will be held on Dec. 6, 7 and 8. The program follows:

Monday, Dec. 6—Morning session, 10 o'clock: Routine business. Afternoon session, 1:30 o'clock: Discussion of Revised Refrigeration Code. "Refrigeration in Russia, and America's Participation in Its Future Development," Prof. N. A. Borodin, Russian Committee on Refrigeration. "National Department of Public Works," J. Parke Channing, Chairman of Engineering Council. New Refrigeration Data. (Members and others having engineering data, which have not been previously published, are requested to present them.) Evening Session, 8 o'clock: Paper and progress reports by members of the staff of the National Bureau of Standards, Washington, D. C.; "Specific Heat and Specific Volume of Superheated Anhydrous Ammonia Vapor." "Table of Properties of Anhydrous Ammonia in the Saturation Region." "A Clearance Volume Meter," H. C. Dickinson, National Bureau of Standards. "Total Heat Diagrams," E. F. Mueller and C. H. Meyers, National Bureau of Standards. "Pressure Relief Diaphragms," H. F. Stimson, National Bureau of Standards.

Tuesday, Dec. 7.—Morning Session, 9.30 o'clock: "Transportation Economies of the Refrigerator Car," H. C. Newlean, Chicago, Ill. "Concrete Brine Tanks," Lieut. Col. H. C. Boyden, Chicago, Ill. "The Isometrics of the Superheat and the Vapor Pressure of Liquid Ammonia," F. G. Keyes, Cambridge, Mass. Afternoon session, 1.30 o'clock: "Thermit Welded Pipe Joints," R. L. Browne, Boston, Mass. "Oxyacetylene Welding of Refrigeration Apparatus," Fred E. Rogers, Jersey City, N. J. "Resistance Welding and Its Application to Refrigeration Machinery," J. H. Gravell, New York, N. Y. "Electric Arc Welding of Refrigeration Equipment," H. C. Unland, Schenectady, N. Y. Evening, 7 o'clock: The annual dinner, at Hotel Astor, Broadway and Forty-Fourth Street, New York; informal dress; ladies invited; subscription, $5 per cover. Addresses: United States Army, Col. Raymond Sheldon, Assistant Chief of Staff for Military Intelligence. Motion Pictures, Showing the Manufacture of Wrought Iron Pipe, Wyman Howell, New York City. Motion Pictures of Spanish Scenes.

Wednesday, Dec. 8.—Morning Session, 9.30 o'clock: "Control of Corrosion in Refrigerating Systems," F. N. Speller, Pittsburgh, Pa. "The Use of Refrigeration in Air Conditioning," Lee Nusbaum, Philadelphia, Pa. "Safety Devices for Household Refrigerating Machines," H. E. Willsie, Darien, Conn. Afternoon Session, 1.30 o'clock: "Modern Propellers for Brine Circulation," E. A. Burrows, Chicago,, Ill. "Electric Current Rates for Refrigerating and Ice Making Plants," S. Bennis, New York, N. Y. "The Unaflow Steam Engine," Robert Cramer, Chicago, Ill.

The Board of Trade of Alberta, Canada, has appointed a committee to investigate the possibilities of the waste coal from the mines in the generation of electricity in a large central plant and of the proper distribution of this power to manufacturers and municipalities nearby. The fuel, which is very low in price, is being tested with a view to increasing its efficiency by pulverizing.—*Valve World.*

Some Opinions on the Petroleum Outlook from the American Petroleum Institute

The American Petroleum Institute has been very active lately in seeking light on problems of oil supply, both present and future. Excerpts from two speeches which were presented at its annual meeting held in Washington recently are presented herewith, together with an abstract of the memorandum prepared by the secretary of the institute for the Federal Trade Commission.

The Dyer resolution requires the Federal Trade Commission to make "inquiry and investigation into the causes of the recent advances in the price of fuel oil, kerosene, gasoline and other petroleum products." The American Petroleum Institute in its memorandum takes the stand that these increases are due simply to the great extent of consumption over production and not to any combination or any sort of collusion. Production in 1919 was greater than consumption by 2,160,000 bbl., but that condition did not hold true throughout the year. A radical change took place about Aug. 1st, 1919, for from that time on consumption has exceeded production at the rate of 33,717,240 bbl. annually. As it was just about this time that prices began to rise so noticeably, the inevitable inference is that the change in the relation between consumption and production was, and is, the cause of higher prices.

This condition is not due to any decrease in production, for there has been a considerable increase in the past year; it is, instead, the result of an enormously increased demand. The revival of industries, the increase of shipping and the shortage of coal have all had their part in bringing it about. But the greatest demand is, of course, for gasoline. From 1911 to Jan. 1, 1920, the number of automobiles increased 979 per cent, while the production of crude oil increased only 71 per cent.

Competition as it exists in the oil industry makes impossible any combination or trust. The very size of the industry precludes the possibility of a corner in the ownership of producing properties. There are more than 16,000 individuals and corporations engaged in the business of producing petroleum in the United States. The average oil field is a checkerboard of ownerships, and values have become so high that the capital necessary to buy or to control production is not available to any company or group of companies. The oil produced in the United States in 1911 was worth $134,044,752; it will be worth in 1920 about $1,260,000,000. Contrary to the popular idea, the Standard Oil Company of New Jersey and its former subsidiaries do not control the ownership of production in the United States; the production owned by these companies amounts to but 17 per cent. of the total volume in the country.

In spite of the alarm over the petroleum situation felt by many, this report is optimistic; it concludes:

> The oil business has ever met every public and private demand, and we are confident that it will continue to do so through: Conservation of petroleum and its products; increased production; increased importations; increased efficiency in the construction of automobile engines (a great change in this respect is probable); and increased efficiency in refining; that is, getting more gasoline and other valuable products out of each barrel of crude.
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> To attain these ends, it will be necessary for the petroleum industry to have the co-operation of the public and the Government of the United States, both at home and in foreign lands.

MR. TEAGLE DISCUSSES FOREIGN RELATIONS

W. C. Teagle, president of the Standard Oil Company of New Jersey and chairman of the committee on foreign relations of the American Petroleum Institute, in his address before the society, discussed "The World's Petroleum Problem." He felt this problem to be one of the few really big questions on which thinking men the world over are spending a good deal of energy.

Mr. Teagle stressed the point that the United States has been drawing upon its reserves to supply Europe's needs, and that now that our own demand has become so great, we should demand the opportunity of developing oil in foreign lands on an equal basis with other nations. He brought up the question of whether such development should be undertaken by the Government or by individuals, and pointing out the failure of the nationalization of oil lands in France, England and Russia, he declared emphatically that the oil business should be privately conducted and given a free rein, as has been successfully done in this country.

> On the other hand, many foreign governments are deliberately placing obstacles in the way of those who would like to assist in the development of new sources of supply. This condition appears to exist in Mesopotamia, Turkey, Asia, Japan, Dutch East Indies and very markedly in Mexico.
>
> If foreign governments insist on pursuing the policy of nationalizing oil lands and reserving subsoil rights to be held under government direction; if they persist in attempting to keep all their own petroleum products for their own future benefit, while relying upon the United States for a large share of their present-day needs, then, and in that event, this nation will have no alternative but to take cognizance of the attitude of foreign governments and, as a matter of necessary self-protection, to consider the adoption of measures reciprocally to conserve its petroleum resources for its own people.
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> With its position in world trade and the economic and financial weapons ready to hand, the United States could undoubtedly compel a new allotment of foreign oil territory so as to give it a share of what other nations are now proposing to keep for themselves. But we do not propose this. Might never makes right, and the smaller countries without similar means of forcing their way into such a division deserve better treatment at our hands.
>
> Moreover, we do not believe any such measures will be necessary. The world is too anxious for petroleum. This it can obtain only if there be maintained everywhere a free and fair field to all with special governmental favor to none.

MR. O'DONNELL TAKES OPTIMISTIC VIEW

Thomas A. O'Donnell, president of the American Petroleum Institute, took an unusually cheerful view in his address, "Future Production of Petroleum." He minimized the danger of exhaustion of oil, declaring that if the economic law of supply and demand be given a free opportunity to assert itself, the petroleum available will be sufficient to meet the requirements in all parts of the world for many generations to come. There are vast areas in all parts of the world that have scarcely been "scratched." Frequently, in the past there have been predictions that the source of supply was exhausted and there never again would be sufficient oil to supply the demand, and in every instance these predictions have been wrong. Increased prices have always resulted in increased activity of the wildcatter, which in turn has resulted not only in producing sufficient oil to meet the demand, but usually in overproduction. The present shortage has not been caused by any serious exhaustion of the petroleum deposits, but by extraordinary increased consumption.

Nature has supplied a sufficient quantity to meet the requirements. It is unbelievable that so many governments have established restrictive rules and regulations, and in those countries not yet affected there is much agitation for restrictive legislation and regulation, which will be very effective in discouraging necessary activity. A return to a "free and open-door policy" by many governments of the world is the most important factor in an assured future supply. Unless this is done, there is no doubt that a serious shortage is confronting the world. In conclusion, Mr. O'Donnell said:

> I have no apprehension as to the future petroleum supply of either this country or the world at large; the danger now confronting us, which is really serious, is not caused by exhaustion, but is likely to occur through the foolishness of men in permitting restrictions caused by too much government. In addition to our known petroleum deposits and the new discoveries that are sure to be made, we have enormous shale deposits in the western part of the United States as a reserve in case of need; but a proper, active development throughout the world will produce our petroleum requirements so much cheaper than is possible by operating the shale beds, that I do not anticipate any important development in the use of shale during this generation.

A. S. M. E. Annual Meeting Is Here

The forty-first annual meeting of the American Society of Mechanical Engineers will be held from Tuesday, Dec. 7, to Friday, Dec. 10.

As transportation will be the timely keynote of the meeting, there will be addresses by prominent men who are recognized authorities in this field. Other subjects will be treated of, however, for papers are to be read on fuels, forest products, machine-shop work, management, railroads, design, research, textiles and power. The detailed program follows:

Monday Morning, Dec. 6—Conference of local sections' delegates; meeting of committee on power test code.

Tuesday Afternoon (simultaneous sessions)—Fuel Section: "Fuel Supply of the World," L. P. Breckenridge; "Low-Temperature Distillation of Coal," O. P. Hood; "Fuel Conservation; The Need for a Definite Policy and Its Requirements," D. M. Myers; "Form Value of Energy in Relation to Its Production, Transportation and Application," Chester G. Gilbert and Joseph E. Pogue. Forest Products: "A Photographic Study of the Wood-working Industry," F. F. Murray; "Engineering in Furniture Factories," B. A. Parks; "Use of Wood in Freight-Car Construction," H. S. Sackett; "Machining Railroad Cross-Ties," D. W. Edwards; "Creosoted Wood-Block Factory Floors," L. T. Ericson; "Processes and Equipment Used in Wood Preservation," E. S. Park and J. M. Weber; "Electrically Driven Sawmills," A. E. Hall. Machine-Shop Section: "Side-Cutting of Thread-Milling Hobs," Earl Buckingham; "Cylindrical Grinding in 1920," W. H. Chapman; "Mechanical Engraving and Die-Sinking," J. F. Keller.

Tuesday Evening—Report of tellers of election and introduction of president-elect; presidential address; conferring of six honorary memberships; presidential reception and dance.

Wednesday Morning—Business meeting: Amendments to the constitution, reports of standing committees, committee on code of ethics, industrial relations, education, feed-water-heater standardization, subcommittee on bearing metals.

Wednesday Afternoon (simultaneous sessions) — Maagement Section: "Mr. Gantt's Contribution to Industry," Fred J. Miller; "Mr. Gantt's Contribution to Shipbuilding, Ship Operation, Ordnance and Aircraft," Marshall Evans; "Life Work of H. L. Gantt," E. A. Lucey; "H. L. Gantt," J. F. Butterworth; "Principles of Industrial Philosophy," W. N. Polakov. Railroad Section: "Static Adjustment of Trucks on Curves," R. Eksergian; "Increasing Capacity of Old Locomotives," C. B. Smith; "Modernizing Locomotive Terminals," George W. Rink. Design—I: "Rational Design of Hoisting Drums," E. O. Waters; "Tests on Rear-Axle Worm Drives for Trucks," K. Heindlhofer; "Foundations for Machinery," N. W. Akimoff. Research—I: "Calibration of Nozzles for the Measurement of Air Flowing Into a Vacuum," W. L. de Baufre; "The Heat-Insulating Properties of Cork and Lith Board," A. A. Potter, J. P. Calderwood, A. S. Mack and L. S. Hobbs; "The Constitution and Properties of Boiler Tubes," A. E. White. Meeting of committee of standardization of plain limit gages.

Wednesday Evening—Brashear Memorial: Oration on the life and work of the late Dr. John A. Brashear, past-president, A. S. M. E., will be delivered by Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching.

Thursday Morning—Keynote session on transportation: "Railroads," Daniel E. Willard, president Baltimore & Ohio R.R.; "Railroad Feeders," Charles A. Morse, chief engineer, Chicago, Rock Island & Pacific R.R.; "Waterways," General Frank T. Hines; "Motor-Truck Transportation," Francis W. Davis, engineer, Pierce-Arrow Motor Car Co. Meeting of committee on standardization of shafting.

Thursday Afternoon — Keynote session (continued): "Terminals," Colonel William Barclay Parsons, consulting engineer, of New York City; "The New York Terminal Problem," Gustav Lindenthal, consulting engineer, of New York City. Professional session, Research—II: "Effect of Fittings on Flow of Fluids Through Pipe Lines," D. E. Foster; "Steam Formulas," R. C. H. Heck. Organization meeting of the Ordnance Section: Ladies' tea and dance.

Friday Morning (simultaneous sessions) — Design—II: "Experiences with Large Center-Crank Shafts," Louis Illmer; "Design of Flywheels for Reciprocating Machinery Connected to Synchronous Generators and Motors," R. E. Doherty and R. F. Franklin. General session: "The Armor-Plate and Gun-Forging Plant of the U. S. Navy at S. Charleston, W. Va.," Roger M. Freeman; "Principles of the Gyro-Compass," George B. Crouse. Textile Section: "Textile Dye Houses," A. W. Benoit; "Power Applications to Cotton Finishing Plants," Leo Loeb; "Textile Fabrics for Mechanical Purposes," J. W. Cox. Power Section: The subject of the session will be "Future Power Development." Papers will be presented on: "The Policy of Future Power Development," "Effect of Load Factors on Cost," "Effect of Size of Plant on Cost," "Financial and Legal Aspects of Future Power Development."

Bureau of Welding Reorganized

The American Bureau of Welding was reorganized at a meeting held in the Engineering Societies Building on Nov. 22, as a joint advisory board of the Division of Engineering of the National Research Council and the American Welding Society, with the purpose of promoting welding research and standardization.

This advisory board, or bureau, is made up of representatives from the American Welding Society, other interested engineering and scientific societies and organizations, Government departments, and certain members at large selected because of their special fitness and ability in welding matters.

At the first meeting of the bureau, by-laws were adopted and the following officers elected: Director, C. A. Adams; first vice-director, H. M. Hobart; second vice-director, A. S. Kinsey; secretary, W. Spraragen.

The bureau voted to create the following research committees to advance welding research and standardization: Electric Arc Welding, Gas Welding, Training of Operators, Welding Wire Specifications, Welding Conference Committee, Specifications of Steel To Be Welded, Thermit Welding, Resistance Welding.

Water-Power Applications

Applications for water-power permits, or licenses, were received by the Federal Power Commission during the week ended Nov. 20, as follows:

Garland Hydro-Electric Power Co., 113 Fulk Building, Little Rock, Ark.; Ouachita River, Garland County, Ark.; use, public utility.

Frank G. Baum, 1901 Hobart Building, San Francisco; Little Colorado River at Grand Falls, Ariz.; use not stated.

Frank G. Baum, 1901 Hobart Building, San Francisco, Black River, Ariz.; use not stated.

W. H. Shrader, 21 East Gonzalez St., Pensacola, Fla.; U. S. dam on Sunflower River, Washington County, Miss.; use not stated.

R. L. Weeks, U. S. Army Recruiting station, 4th and Main Sts., Los Angeles; Shrimp Bay, Tongas National Forest, Alaska; use, power for pulp mill.

Alaskan-American Paper Corporation, 23 East 26th St., New York City; Orchard Lake outlet to Shrimp Bay, Tongas National Forest, Alaska; use, power for pulp mill.

* * *

The New Zealand Government is still assisting private interests in prospecting for petroleum in this dominion, and has subsidized a company that has put down a bore near Hawkes Bay to the depth of 3,660 ft. It is proposed to go much deeper, for the indications are that oil may be found in that locality. During 1919 the New Zealand government paid $21,656 in subsidies for prospecting work and will expend more this year.

* * *

The Bolivian government has been for some time contemplating the electrification of all railways and has declared as public domain the waters of such rivers as are capable of being used for the development of power. The Jafe de la Seccion de Ferrocarriles del Ministerio de Fomento has charge of these projects.

Fuels of the Future

That either oil or gas is to be the ultimate fuel was the prediction of S. W. Parr, professor of applied chemistry at the University of Illinois, in an address before the Gas Engineering Section of the Western Society of Engineers recently. Mr. Parr said that the whole question of fuel nowadays is going through a transition state. The world is demanding a fuel that has the property of mobility, that can easily be conveyed to the spot where it is wanted. This demand is to a large extent due to the development of the automobile. For steam generation there has been increasing use of liquid fuel, particularly on seagoing vessels, where all the advantages are with a fuel in liquid form. A ship the size of the "Mauretania" requires about 200 stokers when burning coal, while with oil fuel only 17 men are needed. There are other advantages, such as less storage space and greater steaming radius, so that it is evident that oil fuel is here to stay.

As the country is now using more gasoline than it is able to make, the question arises, Where will the greater supply that will be needed come from? This is a task for the chemist to determine. Of the annual yield of petroleum, approximating 350,000,000 bbl., only 12 per cent is now made into gasoline. Increasing this percentage is the big task of the chemist, and even a small gain of 2 or 3 per cent would mean a large increase in the total output. It was the speaker's belief that the chemist would succeed in increasing the yield of gasoline and that the liquid fuel of the future would be a mixture with gasoline as the base.

As to alcohol the potential yield is almost without limit. It has less heat value per pound than gasoline, but burns more completely, so that the relative merits stand in the ratio of approximately five to four in favor of gasoline. Used alone it is not a good fuel for internal-combustion engines, but gives excellent service when mixed with ether or other volatile fuel.

Although the use of gas has formerly been for lighting, its ultimate use will be principally that of a fuel. The most judicious thing to do with coal is to convert it into gas or gas and coke; it should not be burned raw. Siemmens made this statement years ago, and the truth of it is now being realized. The time is rapidly approaching when gas will begin to take the place of solid fuel for numerous purposes where it has been thought only solid fuel could be used. In the gas industry the sum total of development for the last hundred years has been in the mechanical field. The chemist is now entering the field, and many changes are to be expected. The gas produced averages about 550 B.t.u. per cu.ft., as compared to 800 B.t.u. for the gas coming directly from the coal, before the secondary reaction has taken place. It is the chemist's work to retain the higher heat value.

The University of Illinois has been interested in establishing a laboratory where investigations could be made on the manufacture of gas and the complete utilization of coal. Since 1902 they have been interested in the question as to whether it is possible to take smoke out of Illinois coal, and they are now of the opinion that it is possible to make smokeless fuel from this coal. During the process 25 to 30 gal. of liquid fuel is obtained, approximately one-half barrel per ton of coal. The gas is of the high-grade variety and averages about 750 B.t.u. per cu.ft., while the residue, coke, may be used as smokeless fuel. Burning coke, however, to generate electrical energy results in an efficiency of only 10 to 12 per cent. With the same fuel converted into gas an efficiency of 30 per cent is quite feasible, so that there is a wide margin to work upon. The better proposition, then, is to make the coke into water gas, thus converting all the coal into liquid or gaseous fuel and not burning any of it in the solid state.

Samples of coke from Illinois and West Virginia coals were presented for inspection, and it was scarcely possible to tell from which coal the coke originated. As a material for the manufacture of water gas coke from Illinois coal was considered ideal. It gives a gas containing approximately 500 B.t.u., and if the richer gas from the earlier distillation is turned into it an excellent gas of about 750 B.t.u. per cu.ft. is obtained. There are great opportunities to develop fuels of the liquid or gaseous type, using the proper chemical combinations and seeing that none of the heat is dissipated before the gas is delivered for use.

Discussion turned to the quality of coke from Illinois coal and its adaptability for blast furnace and domestic use. For the former purpose the coke should contain about 4 per cent volatile, but when burned in the home it gives better results with 10 per cent volatile. There is little doubt that coke from Illinois coal would stand up in the blast furnace. Whether all of this gas should be made at the mouth of the mine and transmitted to the point of use or whether the coal should be transported to the place where the gas is required was a question raised, and there was considerable discussion upon the use of alcohol and its production from sugar cane, potatoes containing an unusual quantity of starch, corn and other vegetable products.

The Old Hickory Powder Plant at Jacksonville, Tenn., has been sold by the United States Government to the Nashville Industrial Corporation, which is composed of business men of Nashville. Old Hickory was the largest Government manufacturing undertaking of the war; its total cost was over $87,000,000. It occupies 5,100 acres of land, has a water-filtration system capable of supplying a city the size of Boston, one of the largest steam-power plants in the world, a double-track railroad connecting with trunk lines, 35 miles of industrial track connecting manufacturing buildings, an immense refrigeration system, complete waterworks, sewerage system, fire departments and concrete and macadam roads. The village had a population of 35,000 when the plant was closed in 1918, and is now completely equipped with all necessary public utilities, schools, banks and clubhouses. The purpose of the Nashville people is to develop this war project into a large manufacturing center, having available immense housing and manufacturing buildings and facilities.

New Publications

A COURSE IN ELECTRICAL ENGINEERING, VOL. 1. By Chester L. Dawes, S B. Published by McGraw-Hill Book Co., Inc., New York, 1920. Cloth; 5½ x 8 in.; 496 pages; 364 illustrations. Price, $4.

This is Volume 1 of two to be used as a text on electrical engineering and deals with direct current. The work begins with the most elementary conception of magnetism and the flow of current and advances to a discussion of the many types of direct-current machinery. This book and its forthcoming companion volume are intended as a stepping stone to the more advanced works on electrical engineering. In preparation of the material the needs of students taking industrial courses in electrical engineering have been carefully considered, and as a result a liberal use of illustration and illustrative problems has been made, also frequent discussions of the methods of making measurements in laboratory tests are included. Like all textbooks on the subject mathematics is used freely. However, this treatment has been limited to simple arithmetic and elementary algebra. Wherever possible an attempt has been made to apply the theory to the solution of practical problems.

Although the book is intended as a text for use in classrooms, the treatment is such as to be easily mastered by the home student. In this respect the value of the work would be considerably enhanced if the answers had been given to the several hundred electrical problems included in the work.

LESSONS IN HEAT. By Franklin and MacNutt. Published by Franklin & Charles, Bethlehem, Pa. 144 pages; 41 illustrations. Price, $2.

This volume, which was prepared for use as a college textbook, has many features to commend it, especially the explanation of the Second Law of Thermodynamics This is usually a stumbling block to the student. In most instances a college textbook is of little worth to those whose mathematical training has been limited. In the volume under discussion the treatment is so simple that it should be of benefit to all who wish to gain a fair understanding of heat.

Obituary

William Krouse, chief engineer of the Paterson Parchment Co. for more than thirty-six years, died Nov. 20, at his home in Clinton, N. J. He was one of the early members of the National Association of Stationary Engineers, served as its state president for New Jersey, and is known to many members of the craft all over the country through his attendance at the national conventions.

Personals

J. Grady Rollow has resigned his position with E. I. duPont de Nemours & Co., and is now consulting engineer with the Los Angeles Gas and Electric Corporation.

C. C. Lance, formerly shop engineer for the Seaboard Air Line Railway Co., is now with the National Boiler Washing Co., Chicago, Ill.

A. H. Berchen has left the A. S. Cameron Steam Pump Works, of New York City, to accept a position with the Charles F. Ames Co. Ltd., 90 West St., as sales manager in this vicinity.

Lucien Buck, who was general manager of the Parana Paper Co., Inc., Parana, Brazil, S. A., has returned to the States and is now with the B. F. Sturtevant Co., Boston, Mass.

E. H. Whitney has recently joined forces with the Westinghouse Lamp Co. as district illuminating engineer of its New England office at Boston, Mass.

Dean L. A. Scipio, formerly of Robert College, of Constantinople, is now acting director of the Research Bureau of the American Society of Heating and Ventilating Engineers, in place of the late Professor Allen, with whom he had been associated.

Victor J. Azbee, consulting engineer, of St. Louis, is establishing a laboratory which will be equipped for chemical analysis and physical tests having to do with power-plant economy. It will enable him to test solid, liquid and gaseous fuels, boiler-feed water, boiler scale, etc.

S. S. Garrett has recently been advanced from the position of assistant professor in Cornell University to that of professor of mechanical engineering, having received one of the eight professionships recently established in memory of the university's students who gave their lives in the World War.

Fritz J. Frank, vice president of the Iron Age Publishing Co., has been elected president of that company, following the resignation of William H. Taylor, who had been president and general manager for more than ten years. Mr. Taylor resigned because of ill health and has retired from active connection with the company. He was for a time vice president of the McGraw Publishing Co., and, later, president of the Taylor Publishing Co., of Chicago, which consolidated the "Engineer" and "Steam Engineering." Mr. Frank has been with the Iron Age Publishing Co. since 1916, after an active association with other trade publications, among them *Colliery Engineer* and the *Mining and Scientific Press*.

Society Affairs

The American Society of Refrigerating Engineers is holding its sixteenth annual meeting at the Hotel Astor, New York City, on Dec. 6, 7 and 8. The program is given in full on another page.

The American Society of Mechanical Engineers will hold its forty-first annual meeting in the Engineering Societies Building, New York City, from Dec. 7 to 10. The full program is given on another page.

The Chicago Section of the Association of Iron and Steel Electrical Engineers will hear an address on Dec. 11 on "Switching Equipment for Steel Mill Power Houses and Sub-Stations," by J. P. Wilson, switchboard engineer with the Westinghouse Electric and Manufacturing Co.

Columbus Section, A. S. M. E., will meet on Dec. 10. Dean E. A. Hitchcock, of the Engineering College, Ohio State University, will speak on "Emergency Work in Power Plant Operation." Motion pictures will be shown of the manufacture of A. M. Byers genuine wrought-iron pipe.

The Cleveland Section of the Association of Iron and Steel Electrical Engineers will meet on Dec. 13 to hear an address by L. M. Adams, electrical engineer with the General Electric Co., on the subject of "Continuous Rated or 50 Degree Rise Motors." The meeting will be preceded by an informal dinner at 6:30 p.m.

The Philadelphia Section of the A. S. M. E. will hold a joint meeting with the A. I. E. E. and the Engineer's Club of Philadelphia on Dec. 13 in the Bellevue-Stratford Hotel. W. S. Murray will speak on "The Super-Power Survey." The meeting will be at 8 o'clock, and will be preceded by an informal dinner at 6:30.

The National Association of Practical Refrigerating Engineers will hold its annual convention at Chicago on Dec. 13, 14, 15 and 16, four days later than was originally planned. Arrangements are being made by the Chicago Subordinate. **Papers** will be presented by prominent men in the refrigerating industry; the program will be entirely educational and will amount, in fact, to an intensive course of instruction. All refrigerating engineers, whether members or not, are invited to attend.

Business Items

The Hagan Corporation has expanded its New York City organization, and has taken new offices at 110 West 34th St.

The Philadelphia Belting Co. announces that its New York Office is now under the management of Harry F. Wooden, a transmission engineer and packing expert. Problems of a technical character are solicited.

The Illinois Stoker Co., Alton, Ill., manufacturer of forced and natural draft chain-grate stokers, announces the appointment of the Ernest E. Lee Co. as district representatives for Iowa, Wisconsin, Michigan, Northern Indiana, and Northern Illinois with offices at 115 South Dearborn St., Chicago.

Trade Catalogs

Gillis & Geoghegan, 529 West Broadway, New York City, have just issued a booklet showing the labor-saving uses of G. & G. Hoists in factory buildings. Special prominence has been given a new electric model which consumes only half the amount of current that the former one used. Installations in machine shops, automotive buildings, chemical plants, railroad and other shops are shown.

The Graton & Knight Manufacturing Co., Worcester, Mass., has put out a new 96-page, 5 x 8-in. catalog on "Standardized Leather Belting for Power Transmission." The book is attractively bound and contains not only specifications of the company's product, but also some very handy and practical information on belt problems, which should be of value to millwrights and others having to do with belts.

COAL PRICES

Bituminous—The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

	Nov., 1919*	Aug. 5, 1920	Dec. 2, 1920†
Pittsburgh steam..	$2 30	$10.00	**$5.00**
Pittsburgh gas.......	2 30	12 00	*5.50*
Hocking..	2 50	9 00	**4.50**
Franklin, Ill.........	2.35	6.50	5.00
Indiana 4th vein...	2 35	7 50	*4.00*
Eastern Ohio, No. 8..	2.35	10.50	5.00
Fairmont...........	2.50	13.50	4.75
Kanawha...........	2.60	14 00	4.75
S. E. Kentucky......	3.00	10.50	**5.25**
Western Kentucky...	2.35	5.25	4.25
Clearfield...........	2.95	12.00	5.00
Cambria and Somerset	2.95	13.50	6.00
New River.......	2 70		
Pocahontas.........	2.35	14.00	**5.25**

* Government prices.

† Advances over the previous week shown in **heavy type**, declines in *italics*.

New Construction

PROPOSED WORK

Mass., Boston—The Schoolhouse Dept. will soon receive bids for a 4 story, 220 x 250 ft. Latin school including a steam heating system on Louis Pasteur Ave. About $1,000,000. J. E. McLaughlin, 88 Tremont St., Archt.

Mass., Roxbury (Boston P. O.)—The Children's Hospital, 300 Longwood Ave., plans to build a 3 story nurses' home including a steam heating system. About $600,000. Coolidge & Shattuck, 122 Ames Bldg., Boston, Archts.

Mass., Worcester—The Holy Cross College will soon award the contract for a 49 x 100 ft. chapel including a steam heating system. About $300,000. Rev. J. J. Carlin, Pres. Sheehan & Colleary, 120 Boylston St., Boston, Archts.

Conn., New Haven—The United Illuminating Co., 84 Temple St., had plans prepared for a 40 x 60 ft. plant extension on Grand Ave. Westcott & Mapes, Inc., 207 Orange St., Archts. and Engrs.

Conn., Storrs (Eagleville P. O.—The Connecticut Agricultural College, c/o Building Com., will receive bids until Dec. 14 for a 3 story, 110 x 186 x 53 ft. dormitory including a steam heating system. About $335,000. D. K. Perry, 27 West Main St., Archt.

Conn., Waterbury—The Connecticut Military Emergency Bd., State Armory, Hartford, will select new architect and receive bids soon for a 4 story armory including a steam heating system on Field St. About $400,000. Noted July 27.

Conn., West Haven—The Union School Dist., Orange, will receive bids early in January for a 3 story high school here, including a steam heating plant. Cost, between $350,000 and $400,000. R. W. Foote, 185 Church St., New Haven, Archt.

N. Y., New York—Marc Klaw, Inc., 1451 B'way, had sketches prepared for 2 theaters including a steam heating system at 46th St. near 8th Ave. About $650,000. DeRosa & Pereira, 110 West 40th St., Archts. and Engrs.

N. Y., New York—The Society for Prevention of Cruelty to Children, 83 Irving Place, had sketches prepared for an institution including a steam heating system on 5th Ave. About $3,000,000. Maynicke & Franke, 25 East 26th St., Archts. and Engrs.

N. Y., New York—Figge & Hutwelker, 627 West 40th St., are having plans prepared for a tank house including a steam heating system. About $500,000. Henshein & McLaren, 37 West Van Buren St., Chicago, Ill., Archts.

N. Y., New York—The Bowery Savings Bank, Bowery and Grand St., plans to build a 20 story, 105 x 200 ft. bank and office building including a steam heating system on 42d St. Archt. and Engr. not selected.

N. Y., Ossining—Chas. S. Ratigan, Supt. of Prisons, received bids for the installation of a heating system for additional accommodations at Sing Sing Prison from A. B. Barr & Co., 6 River St., Yonkers, $21,500; Globe Heating Co., 209 Washington Ave., Philadelphia, Pa., $22,150; Miller & Brady, 210 East 38th St., New York City, $23,760.

N. Y., Rochester—The Chocolate Shoppe, 11½ North Clinton Ave., is in the market for a 12-in. a.c., 110-volt blower. A. Callis, Pur. Agt.

Pa., Philadelphia—The Bd. Educ., 19th and Chestnut Sts., had plans prepared for a 3 story, 145 x 170 ft. school including a steam heating system on 7th and Norris Sts.

Md., Baltimore—The Immaculate Conception R. C. Church plans to build a church, school, rectory and sisters' house at Liberty Heights Ave. and Hilton St. About $500,000. Rev. G. V. McKinney, 532 Mosher St., Pastor. F. Baldwin, 328 North Charles St., Archt.

Md., Baltimore—The Duraflex Co., 409 Continental Bldg., is in the market for a 50 hp. boiler and 35 to 50 hp. motors. J. F. Nachod, Gen. Mgr.

D. C., Washington—The Catholic University, Brookland, here, is having plans prepared for a 100 x 600 ft. church at the university grounds. About $5,000,000. Maginnis & Walsh, 100 Boylston St., Boston, Mass., Archts.

N. C., Canton—The Champion Fiber Co. plans to build a 140 ft. paper mill and a 92 x 400 ft. board mill. About $750,000.

N. C., Kinston—The city will soon award the contract for power plant and pumping station buildings. W. C. Olsen, Engr. Noted Nov. 30.

N. C., Raleigh—The Raleigh Ice & Cold Storage Co., c/o J. L. Dorminy, plans to build a wholesale ice-manufacturing plant and cold storage house to be electrically operated, on West Hargett St. About $100,000. Archt. and Engr. not selected.

Fla., Tampa—C. H. Brown, 510½ Franklin St. and F. Hensley plan to build a 90 x 105 ft., 12 to 15 story, office building Archt. not selected.

O., Cleveland—The Cleveland Bar Assn., c/o J. J. Sullivan, Williamson Bldg., plans to build a 12 story office building including a steam heating system. About $1,500,000. Archt. not selected.

O., Lakewood (Cleveland P. O.)—The Bd. Educ., G. W. Grill, Clk., Warren Rd., will receive bids until Dec. 13 for a 3 story, [illegible] x 144 ft. high school including a steam heating system on Jackson Ave. About $[illegible]. C. W. Hopkinson, Rose Bldg., Cleveland, Archt.

O., Lorain—The Bd. Educ., East 6th St. and Washington Ave., is having plans prepared for a 2 story high school including a steam heating system at East 20th St. and Oakdale Ave. About $350,000. F. C. Warren, Hippodrome Annex Bldg., Cleveland, Archt.

O., Marietta—The Peoples' Banking & Trust Co. will receive bids until Jan. 1 for an 11 story, 51 x 114 ft. bank and office building including a high pressure steam heating plant. Weary & Alford, 1732 South Michigan Blvd., Chicago, Ill., Archts.

Ind., Linton—The city is having plans prepared for a 70 x 100 ft. light plant and will soon award the contract for equipment. About $100,000. Shrouds Stoner Co., Tribune Bldg., Terre Haute, Archts.

Ind., Richmond—W. Stevens, City Clk., will receive bids until Dec. 15 for a 75 x [illegible] ft. light plant and the contract will soon be awarded for equipment. J. D. Lyon, 2513 Union Central Bldg., Cincinnati, Ohio, Engr.

Ind., Thorntown—The Bd. Educ. will purchase two smokeless fire-box boilers, vacuum pumps, etc.

Ind., Wabash—The Wabash National Bank will receive bids until Dec. 15 for a bank building including a steam heating system. About $250,000. Weary & Alford, 1732 South Michigan Blvd., Chicago, Ill., Archts.

Mich., Benton Harbor—The Washington Hotel & Mineral Baths plans to build a 3 story, 200 x 300 ft. hotel including a steam heating system. Bennett & Gibb, 117 North Dearborn St., Chicago, Ill., Archts.

Mich., Detroit—The Zenith Foundry Co., Miller Ave., will receive bids until Dec. 10, for a 1 story, 90 x 200 ft. foundry including electric motors for power. G. W. Grave, 43 John R. St., Archt.

Mich., Detroit—The Bd. Educ., 50 B'way Ave., will receive bids until Dec. 21 for a 5 and 7 story, 250 x 350 ft. addition to the technical high school at Second Ave. and High St., including a gas engine laboratory. Steam heating and power equipment will also be required. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Archts.

Mich., Flint—St. Michael's Parish plans to build a 3 story parochial school including a steam heating plant. About $500,000. Archt. not selected.

Mich., Monroe—The Dansard State Bank will receive bids about Jan. 15 for a bank building including a steam heating system. About $250,000. Weary & Alford, 1732 South Michigan Blvd., Chicago Ill., Archts.

Mich., Muskeegan—The National Lumbermans' Bank, 13 West Western Ave., will receive bids until Jan. 15 for a bank and office building including a steam heating system. About $300,000. Weary & Alford, 1732 South Michigan Blvd., Chicago, Ill., Archts.

Ill., Chicago—The Woodlawn Trust & Saving Bank, c/o Weary & Alford, 1732 South Michigan Blvd., will receive bids until Dec. 15 for a bank and office building including a steam heating system. About $400,000.

Ill., Chicago—The Illinois Malleable Co., 1801 Diversey Blvd., plans to install a 12-panel electric switchboard. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Ill., Hanover—The village clerk will receive bids about February 1 for a waterworks system including a pump house, pump, etc. About $25,000. Holland, Ackerman & Holland, Ann Arbor, Mich., Engrs.

Wis., Albany—W. G. Kirchoffer, Engr., 31 Vroman Block, Madison, received no bids for centrifugal pump, motor and controlling apparatus for waterworks plant. Noted Nov. 9.

Wis., Helenville—The Blochowiat Dairy Co., 1364 4th Ave., Milwaukee, has selected a site for a 2 story, 80 x 140 ft. dairy products factory on Main St, here. About $75,000. Archt. not selected.

Wis., Manitowoc—The Manitowoc Hotel Realty Co. plans to build an addition to hotel at 825 8th St. S. About $500,000. H. B. Hamschulte, North 8th St., Archt. W. C. Loeggering, c/o Forest Avenue Hotel, 170 Forest Ave., Fond du Lac, is interested.

Wis., Milwaukee—The Milwaukee Reliance Boiler Co., 1102 32d St., had preliminary plans prepared for a 1 story, 100 x 125 ft. boiler shop addition. A. D. Koch, Wells Bldg., Archt.

Wis., Milwaukee—The Milwaukee Children's Hospital, 219 10th St., had preliminary plans prepared for a hospital and power plant on Grand Ave. About $450,000. Scott & Mayer, Colby-Abbot Bldg., Archts. and Engrs.

Wis., Park Falls—The city plans to extend the water mains about 2 miles and will require pumping equipment. About $50,000.

Wis., Racine—The Grant Furniture Co., 502 6th St., is having plans prepared for a 3 story, 80 x 120 ft. factory on Washington Ave. Electric motors will be installed in same. D. R. Davis, Schultz Bldg., Archt. and Engr.

Wis., Superior—W. J. Little, Secy. of the Bd. of Normal School Regents, will receive bids about Jan. 2 for a 2 story, 150 x 265 ft. gymnasium including a steam heating system. About $300,000. Archt. and Engr. not selected.

Wis., Wausau—The American Nat'l Bank, 502 3d St., plans to build a bank and office building including a steam heating system. About $300,000. C. S. Gilbert, Pres. Archt. not selected.

Wis., West Allis—The city plans improvements to the water supply plant including a reservoir near Woodlawn and Lincoln Aves., and a new pumping station to be equipped with 2 electrically-driven pumps of a 2,500,000 gal. daily capacity.

Ia., Rheinbeck—The Bd. Educ. plans to build a 2 story, 90 x 144 ft. high school and install boilers, pump, etc. About $225,000. Nitcotts & Nitcotts, 516-19 Black Bldg., Waterloo, Archts.

Minn., Mankato—The Immanuel Hospital Assn. plans to build a 2 or 3 story addition to hospital including a central heating plant. About $150,000. Rev. A. F. Winter, Chn. of plan committee. Archt. not announced.

Minn., Minneapolis—The Radison Hotel Co. plans to build an addition to hotel on 7th St. between Nicollet and Hennepin Aves. About $1,800,000. S. Kraus, Pres. Archt. not announced.

S. D., Tyndall—The city has made arrangements for the issue of $50,000 bonds to be used for a municipal light, heat and power plant.

Okla., Nowata—The Gunther City Coke & Coal Mining Co. is interested in an electric light plant. C. B. Circles, Pur. Agt.

Tex., Halletsville—The city plans an election Dec. 12 to vote on $20,000 bonds for the purchase and installation of a new steam engine for the electric light plant.

Col., Denver—The Simm Finance Co. has leased a site at East 17th Ave. and Broadway to an organization for a 6 story, 125 x 150 ft. physicians' building, also a 2 story garage and filling station. About $1,000,000. W. N. Bowman Co., Central Savings Bank Bldg., Archt.

Utah, Fillmore—The Telluride Power Co., 415 Walker Bank Bldg., Salt Lake City, plans to extend its power line for pumping purposes, through the artesian well belt, McCormick, Delta and other nearby towns.

Utah, Provo—F. W. C. Hathenbruck has filed application with the state engineer for permission to divert water from the subsoil flow in Slate canyon to operate a 300-hp. hydro-electric plant for mining purposes.

Que., St. Laurent—The Canada Heaters Co., Ltd., plans to build a 1 story plant. About $250,000.

Ont., Belleville—The Albert College plans to build a 3 story college including a vacuum steam heating system. About $500,000. Chapman, Oxley & Bishop, Harbor Bldg., Toronto, Archts.

Ont., Brantford—The Lake Erie & Northern Power Plant, recently destroyed by fire, will be rebuilt and equipment purchased at a cost of $110,000.

Ont., Brockville—The Lanig Produce & Storage Co., Water St., E., plans to build an addition to the present plant. About $400,000. J. G. Gardner, Pres. Archt. not selected.

Ont., Richmond Hill—The city plans to establish a complete waterworks system including a pump house, reservoir, electrically driven centrifugal pumps, etc. About $95,000. E. A. James Co., 36 Toronto St., Toronto, Engr.

Ont., Shelburne—The town plans to extend the existing waterworks including new pump house, installation of three stage, 1,000 g.p.m. electrically driven centrifugal pumps, etc. About $100,000. E. A. James Co., 36 Toronto St., Toronto, Engrs.

Ont., Toronto—The Toronto Skating Club, c/o Lt. Col. A. E. Kirkpatrick, Excelsior Life Bldg., has purchased site and plans to build a 1 story skating rink including steam heating system in clubhouse portion. Equipment for the manufacture and maintenance of an artificial ice surface will be installed.

Cuba, Havana—M. Diaz is having plans prepared for a bottling plant including a steam heating system. About $1,000,000. Ophuls, Hill & McCreery, 112 West 42d St., New York City, Archts. and Engrs.

CONTRACTS AWARDED

S. C., Summerville—J. F. Prettman & Sons, has awarded the contract for a 32 x 68 ft. power house to H. K. Ferguson Co., Vickers Bldg., Cleveland, Ohio, at $25,000.

O., Cincinnati—E. F. Keith, c/o Rapp & Rapp, 190 North State St., Chicago, Ill. has awarded the contract for a 12 story 123 x 200 ft. theater and office building, here including a high pressure steam heating system, to Ohio Bldg. & Constr. Co., Burnet St., at $1,250,000.

O., Cleveland—St. Hyacinth's Catholic Church, 2965 East 75th St., has awarded the contract for a 2 story, 40 x 80 ft. boiler house and garage to Law & Strauss, Builders' Exchange, at $35,000. Noted Oct. 5.

O., Cleveland—The Cleveland Heater Co., 1540 West 112th St., has awarded the contract for a 40 x 50 ft. boiler house addition to the H. K. Ferguson Co., Vickers Bldg., at $20,000.

O., Lima—The Crystal Ice & Coal Co. has awarded the contract for a 1 story ice plant to be electrically operated, to the Triumph Ice Machine Co., Cincinnati, at $25,000.

Mich., Buchanan—The city has awarded the contract for furnishing 3 centrifugal pumps, motors, etc., to the Manistee Iron Wks., Manistee.

Mich., Detroit—Julius Stroh, 1676 Jefferson Ave., has awarded the contract for an 18 story, 80 x 100 ft. office building including a high pressure steam plant to the Lanquist & Illsley Co., 1100 North Clark St., Chicago, Ill., at $1,200,000.

Mich., Oxford—The city has awarded the contract for improvements to the waterworks system to the Gang Constr. Co., 737 Second Nat'l. Bldg., Akron, Ohio, at $29,000. Noted Nov. 2.

Wis., Granville—The T. J. Moss Tie Co., Security Bldg., St. Louis, Mo., has awarded the contract for a creosoting plant here including three buildings and a 30 x 40 ft. boiler house to J. L. Strange, 144 Oneida St., Milwaukee.

Wis., Marshfield—The city has awarded the contract for a 1 story, 36 x 40 ft. addition to the power house to Krasin Bros., at $20,000. Noted Nov. 16.

Wis., Milwaukee—The Shope Brick Co., 49th and State Sts., has awarded the contract for a 25 x 47 ft. boiler house to the American Contg. Co., 198 Milwaukee St., and for one 150-hp. boiler for heating system to J. S. Jung, 1010 Greenfield Ave.

Minn., Cloquet—The North West Paper Co., East End, has awarded the contract for work on dam to Siems, Helmers & Schaffner, 514 Guardian Life Bldg., St. Paul.

Kan., Liberal—The city has awarded the contract for furnishing a deep well centrifugal pump to the American Well Wks., 319 Reliance Bldg., Kansas City, Mo., at $20,300.

N. D., Ashley—McIntosh County has awarded the contract for furnishing a 20-hp. engine, one fuel tank, one 12½ kw. generator, 125-volt, d.c. to engine, one 112 1/1 amp. hour Edison storage battery and one switchboard, for the court house, to Fairbanks & Co., 111 West Washington St., Chicago, Ill., at $5,225.

Col., Wellington—The DuPont Sugar Co., 627 19th St., Denver, has awarded the contract for a sugar factory, here, to the Schwartz Engineering Co., 310 Mack Bldg., Denver, at $1,000,000.

Man., Winnipeg—The Provincial Government, Parliament Bldgs., has awarded the contract for a 2 and 3 story school for the deaf on Tuxedo Park site to Carter-Halls Co., 515 Union Bank Bldg., at $621,000. Separate bids will be taken for the heating, etc.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft Lengths
Underwriters' 2½-in.		75c per ft.
Common, 2½-in		40%

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0 50	$0 35	$0 25

Steam—Discounts from List

First grade	20%	Second grade	40%	Third grade	50

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	40%	Best grade	25%
Standard	40-10%		

LEATHER BELTING—Present discounts from list in fair quantities (½ doz rolls):

Light Grade	Medium Grade	Heavy Grade
30%	25%	20%

RAWHIDE LACING
- For cut, best grade, 25%, 2nd grade, 30%
- For laces in sides, best, 79c per sq. ft.; 2nd, 75c.
- Semi-tanned: cut, 20%; sides, 83c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1 00
Asbestos for high-pressure steam	2 00
Duck and rubber for piston packing	1 20
Flax, regular	1 [illegible]
Flax, waterproofed	1 70
Compressed asbestos sheet	1 00
Wire insertion asbestos sheet	1 50
Rubber sheet	50
Rubber sheet, wire insertion	70
Rubber sheet, duck insertion	60
Rubber sheet, cloth insertion	[illegible]0
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 50
Asbestos wick, ½- and 1-lb. balls	85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		List +5%
For low-pressure heating and return lines	4-ply	50% off
	3-ply	52% off
	2-ply	54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	8½	6 6	8@ 9	8½	13½
Fiber or sponge	8½	8.6	12@15	8½	20
Transmission	10	8 1	12@15	8½	20
Axle	...	4.8	6@ 6½	5¼	7¼
Gear	6½	6 1	8@ 9	5¼	8½
Car journal	12(gal.)	4 7	23@25	8½	8½

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
White	15 00@17 00	13 00	16 00	11 00 to 14 00
Colored mixed	9 00@14 00	9 00 to 12 00	12 00	9 50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows

	13½ x 13½	13½ x 20½
Cleveland	$55 00	$65.00
Chicago	41 00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl lots)	$0.95	$2.15	$1.25	$2.37
5-gal. cans	1.10	2.30	1.50	2.57

With lower prices obtainable in New York.

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	14 25	15 75	13 00	14.50	14 25	13 00
25- and 50-lb. kegs	14 50	16 00	13 25	14 75	14 50	13 25
12½-lb. keg	14 75	16 25	13 50	15 00	14 75	13 50
1-lb. cans	17 25	18.75	15 00	16 50	17 25	15 00
5-lb. cans	19 25	20 75	16 00	17 50	19 25	16.00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel $\frac{7}{16}$ and smaller	List net	40%	30%
Tinned	List net	40%	30%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$6.11	Chicago	$5.00	Pittsburgh	$4 50

Structual rivets, same sizes:

New York	$7.10	Chicago	$5.10	Pittsburgh	$4 60

REFRACTORIES—Prices in carlots:

Bauxite brick, 56% alumina, f.o.b. Pittsburgh	per 1000	$160
Chrome brick, eastern Shipping points	net ton	100@ $110
Chrome cement, 40@45% Cr_2O_3	net ton	55@ 60
Chrome cement, 40@45% Cr_2O_3, in sacks	net ton	60@ 65
Clay brick, 1st quality, fire clay, 9-in. shapes, Pennsylvania, Ohio and Kentucky	per 1000	55@ 60
Clay brick, 2d quality, fire clay, 9-in. shapes Pennsylvania, Ohio and Kentucky	per 1000	45@ 50
Magnesite brick: 9-in. straight	net ton	110
Magnesite brick: 9-in. arches, wedges and keys	net ton	121
Magnesite brick: Soaps and splits	net ton	134
Silica brick: Chicago district	per 1000	65@ 70
Silica brick: Birmingham, Ala	per 1000	56@ 61
Silica brick: Mt Union, Pa	per 1000	55@ 60

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	70 00	90.00	47 00	70.00	45.00	60 00
Commercial	30 00	50.50	18 00	16.50	11.00	13.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$5 50	$5.80	$5 50
Flats, square and hexagons, per 100 lb. base.	6.00	6. 0	6 00

SHEETS—Quotations are in cents per pound in various cities from warehouse, also the base quotations from mill:

	Large Mill Lots		San	New York	
Blue Annealed	Pittsburgh	Chicago	Francisco	Current	One Yr. Ago
No. 10	$3.55@$4 50	$6.13	$8 65	$6 15@$7 25	$4 82
No 12	3 60@ 4 55	6 18	8 70	6 20@ 7 30	4 87
No. 14	3.65@ 4 60	6.23	8 75	6 25@ 7 35	4 92
No. 16	3.75@ 4 70	6.33	8 85	6.35@ 7 45	5 02
Black					
*Nos. 18 and 20	4.20@ 5 35	6.90	10 60	7 90@ 8 80	5 80
*Nos. 22 and 24	4.25@ 5 40	6.95	10 65	7 95@ 8 85	5 85
*No. 26	4.30@ 5 45	7.00	10 70	8 00@ 8 90	5.90
*No. 28	4.35@ 5 50	7.10	10 80	8 10@ 9 00	6 00
Galvanized					
No 10	4 70@ 6 00	7 25		8 65@ 9 50	6.25
No 12	4 80@ 6 10	7 30	11 35	8 75@ 9 50	6 30
No 14	4 80@ 6 10	7 45	11 35	8 75@ 9 60	6 35
Nos. 18 and 20	5.10@ 6.40	7.75	11 65	9 00@ 9 90	6 65
Nos 22 and 24	5 25@ 6 55	8 15	11 80	9 15@10 05	6 80
*No 26	5 40@ 6 70	8 30	11.95	9 30@10 20	6 95
*No. 28	5.70@ 7.00	8.60	12 25	9 60@10 50	7 25

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card:

BUTT WELD

Steel			Iron		
Inches	Black	Galv	Inches	Black	Galv.
¾ to 3	54 to 57½	41½ to 44	⅜	15½ to 25½	+1½ to 11
			½	19½ to 29½	1½ to 11½
			¾ to 1½	24½ to 34½	8 to 18½

LAP WELD

2	47 to 50½	34½ to 38	2	20½ to 28½	6½ to 14½
2½ to 6	50 to 53½	37½ to 41	2½ to 6	22½ to 30½	9½ to 17½
7 to 12	47 to 50½	33½ to 37	7 to 12	19½ to 27½	6½ to 14½
13 and 14	37½ to 41				
15	35 to 38½				

BUTT WELD, EXTRA STRONG, PLAIN ENDS

¾ to 1½	52 to 55½	39½ to 43	¾ to 1½	24½ to 34½	9½ to 19½
2 to 3	53 to 56½	40½ to 44			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	45 to 48½	33½ to 37	2	21½ to 29½	8½ to 16½
2½ to 4	48 to 51½	36½ to 40	2½ to 4	23½ to 31½	11½ to 19½
4½ to 6	47 to 50½	35½ to 39	4½ to 6	22½ to 30½	10½ to 18
7 to 8	43 to 46½	29½ to 33	7 to 8	14½ to 22½	2½ to 10½
9 to 12	38 to 41½	24½ to 28	9 to 12	9½ to 17½	5½ to+2½

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	20 to 40%	1½ to 1¾ in.	+23
2½ to 3¼ in.	11 to 30%	2¼ in.	+10 to +12
2¼ to 2½ in.	3 to 30%	2½ in.	+1 to +10
1½ to 1¾ in.	+7 to 19%	2¾ and 3¼ in.	−1 to +3
		3½, 4 and 4½ in.	+8

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in.	$327	1¾ in.	$207
1¼ in.	267	2 to 2¼ in.	177
1½ in.	257	2½ to 3¼ in.	167
1¾ in.	207	4 in.	187
		4½ to 5 in.	207

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond. M Ft	Three Cond. M Ft	Two Cond. Lead M Ft	Three Cond. Lead M Ft
No. 14 solid	$85.00 (net)	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded...	400.00	500.00	560.00	

From the above lists discounts are

Less than coil lots	5%	+15%
Coils to 1,000 ft	5%	List Net
1,000 ft. and over	10%	7%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever-Ready:

	Each, Net
Less than 12	$0.48
12 to 50	.41
50 to 125 (bbl.)	.38
125 (bbl.) or over	.35

CONDUIT, Price per 1000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces f. o. b. New York, with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
Size, In.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.
½	85.66	90.39	20.20	21.34	6.38	6.74
¾	113.62	119.99	26.58	27.83	7.44	7.86
1	167.96	177.38	39.35	41.56	10.63	11.23
1¼	227.24	239.98	50.10	52.80	13.82	14.60
1½	271.70	286.93	66.80	70.40	18.93	19.95
2	365.56	386.06	122.47	129.07	23.38	24.64
2½	577.98	610.39	200.41	211.21	31.18	32.85
3	755.82	798.20	534.43	563.23	44.53	46.94
3½	936.38	987.52	1,180.20	1,243.80	66.80	70.40
4	1,131.20	1,191.81	1,363.91	1,437.41	89.07	93.87

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
7/32	250	$0.05½	
¼	250	.06	
⅜	250	.09	
½	200	.12	1000 ft. and over.... 40%
⅝	200	.15	Coils 30%
¾	150	.18	Less coils, 20%
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.43
D. P. M. L.	.21	T. P. to D. P. S. B.	.26
T. P. M. L.	.33	T. P. S. B.	.38
D. P. S. B.	.23	T. P. D. B.	.64

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.50	$1.30	$1.68
T. P. M. L.	.70	1.70	2.40
D. P. S. B.	.63	1.60	....
T. P. S. B.	1.15	2.40	....
D. P. D. B.	1.10	3.00	....
T. P. D. B.	1.90	5.40	...
T. P. to D. P. D. B.	1.30	3.80	...

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$23.50
No. 16 cotton twisted	27.00
No. 18 cotton parallel	29.40
No. 16 cotton parallel	36.25
No. 18 cotton reinforced heavy	39.50
No. 16 cotton reinforced heavy	45.75
No. 18 cotton reinforced light	34.80
No. 16 cotton reinforced light	39.45
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
425-amp. to 600-amp.	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 15%
1-5th to standard package 28%
Standard package 45%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$5.25C
0-30 ampere, less than standard package	6.00C

LAMPS—Below are present quotations in less than standard package quantities:

Straight Side Bulbs Mazda B—				Pear-Shaped Bulbs Mazda C—			
Watts	Plain	Frosted	No. in Package	Watts	Clear	Frosted	No. in Package
10	$0.40	$0.45	100	75	$0.75	$0.80	50
15	40	45	100	100	1.10	1.25	24
25	40	45	100	150	1.55	1.70	24
40	40	45	100	200	2.10	2.30	24
50	40	45	100	300	3.15	3.40	24
60	45	50	100				12
				500	4.60	4.90	12
				750	6.50	6.90	8
				1,000	7.50	7.95	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.28
Composition 2-piece attachment plug	.36
Swivel attachment plug	.20
Current taps	.45

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$9.00	$12.50	$16.28	$25.50
12	13.70	17.48	19.79	31.00
10	17.90	22.01	26.06	42.00
8	22.50	31.05	35.00	57.00
6	..	.....	49.00	..
4	......	......	68.00	.....
2	......	......	95.45	.....
1	......	......	140.00	.....
0	......	......	158.00	.....
00	......	......	185.50	.....
000	......	......	228.00	.....
0000	......	....	283.00	.....

Prices per 1000 ft. for Rubber-Covered Wire in Following Cities:

	Denver			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13.50	$16.80	$30.80	$10.81*	$13.50	$28.90
10	21.10	24.60	51.55	19.02*	24.05	49.43
8	27.60	32.35	67.60	27.84*	33.84	63.49
6	49.00	51.30	......	50.00*	......	.....
4	66.00	68.85	......	89.60†	......	.....
2	93.50	95.50	......	108.00	......	.....
1	128.00	131.05	......	156.00	......	.....
0	175.00	175.00	......	194.00	......	.....
00	......	......	......	225.15	......	.....
000	......	......	......	256.00	......	.....
0000	......	......	......	325.00	......	.....

* Solid; † stranded.

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap			⅜ In. Cap		
Key Each	Keyless Each	Pull Each	Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	+50%
1-5th to standard package	+20%
Standard package	−15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	50c. lb
No. 18 B. & S. regular 1-lb. coils	51c. lb

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 56c. lb., 100 lb. lots	52c. lb
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c. lb
Wire solder, less 100 lb. 47c. lb., 100 lb. lots	42c. lb
Soldering paste, 2 oz. cans	$1.50 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+ 5%
$50 to $200 list value	−10%
$200 list value or over	−15%

POWER

Volume 52 New York, December 14, 1920 Number 24

The Operating Record— A Sleuth or a Traffic Officer?

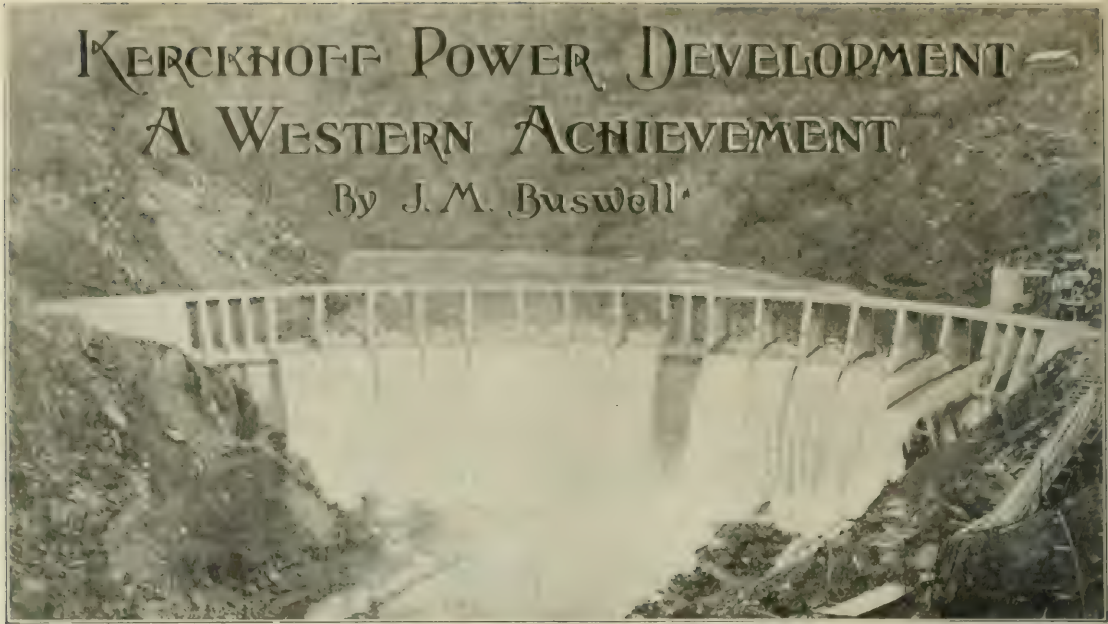
IN SOME organizations the engineer of tests and his staff are looked upon rather as plain clothes men who prowl about the plant and undertake to find operating deficiencies for report to the management. Under other circumstances the operating force recognizes the great value of tests and records of plant performance. It uses the work of the inspection department as a traffic guide, gladly regulating the course of plant operation according to results reported, just as the chauffeur regulates his movements by the "stop" or "go" of the crossing officer's semaphore.

Operating records should under no circumstances be made an end in themselves. A most beautiful and impressive set of records can easily be built up by a careful engineer of tests, but this achievement represents no advantage at all unless real use is made of the findings. Not long ago a well-known mechanical engineer was called in for advice by one of the most elaborately organized municipal water-works departments. He found that this department had a splendid engineer of tests and staff, who could present for his examination graphic records pertaining to every detail of plant operation for years past. Roll after roll of chart was brought out for inspection, showing the ups and downs in every measurable factor. But it quickly developed that the operating force had looked upon this engineer of tests and his records as a spy set to catch them in error, and that so far as possible they had undertaken to discredit his records and had succeeded more or less completely in having them ignored. Under such circumstances it is not surprising that the eminent consultant was sorely needed by the staff.

The operating record of any plant, be it boiler house, engine room or factory, is a most valuable tool both to the management and to the operating force. To dull this tool by misuse or to allow it to lie and rust upon the shelf is most unfortunate. Indeed, either of such practices is likely to be very expensive.

KERCKHOFF POWER DEVELOPMENT—A WESTERN ACHIEVEMENT

By J. M. Buswell*



A 45,000-Hp. Hydro-Electric Development Completed in 15 Months—Pressure Tunnel 18 by 18 Ft., 16,875 Ft. Long—Pieces of Equipment Weighing 58,000 Lb. Transported Over Mountain Roads—Airplane Used in Making Surveys—Project Completed in Record Time Under Most Unfavorable Conditions.

THERE is considerable interest connected with the design, construction and test of the recently completed Kerckhoff hydro-electric development of the San Joaquin Light and Power Corporation, of Fresno, Cal. This development is about forty-five miles northeast of Fresno on the San Joaquin, one of the largest rivers in the state. The project includes a concrete, constant-angle arch dam across the main San Joaquin River bed; an 18 x 18-ft. unlined pressure tunnel 16,875 ft. long; a steel, triple-penstock line; a reinforced-concrete power house, housing three 15,000-hp. vertical-shaft turbines to operate under a head of 315 to 340 ft. and directly connected to 14,200-kva. vertical-shaft generators; an outdoor high-tension step-up transformer and switching station; 206 miles of 110,000-volt transmission line and of four substations, tying in to existing 60,000-volt and 110,000-volt network. When deciding upon the hydraulic development, there was the choice of providing a simple diversion with a rather small dam located at the company's existing No. 1 power house, with an open conduit from there part or all of the way to the head of the penstock for this plant, but decision was made in favor of the dam. This would provide a certain amount of storage to absorb the fluctuation in the river flow, which varies during the twenty-four-hour period on account of the run-off decreasing during the cold night hours and on warm days amounting almost to a freshet. This storage would also enable the plant to be so operated during the low-water season as to carry a high peak by conserving the water during part of the day while the run-off is light; that is, by letting the steam stand-by plants carry the load while the reservoir is allowed to fill up. When the peak comes on beyond the steam-plant and other reserve capacity, the hydraulic plant can be operated at a point beyond the stream flow, which, of course, would draw down the reservoir; but by the time the peak dropped off, the balance of the plants would be able to take care of the load. This may or may not be necessary, but even the small amount of storage makes it possible. In the second place the reservoir displaces several miles of open ditch on rather rough mountainside, which would be expensive to build as well as to maintain and operate; and this is all eliminated by the dam, the maintenance and

FIG. 1 POWER-HOUSE SITE AT LEFT; PHOTO TAKEN AT EXTREME LOW WATER

peration of which will, of course, be negligible; nd in addition the available head at the power lant is increased by the amount of drop that ould have been required in the several miles of ditch give even a flow of 1,750 second-feet, which is the ull-load requirement. On the other hand, it was not onsidered economical to build a tunnel of this size hrough to a diversion dam at the No. 1 power house ecause the additional head (the fall through a longer innel) would undoubtedly have made necessary the oncrete lining of the tunnel throughout its length.

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*General Inspector, San Joaquin Light and Power Corp., Fresno, Calif.

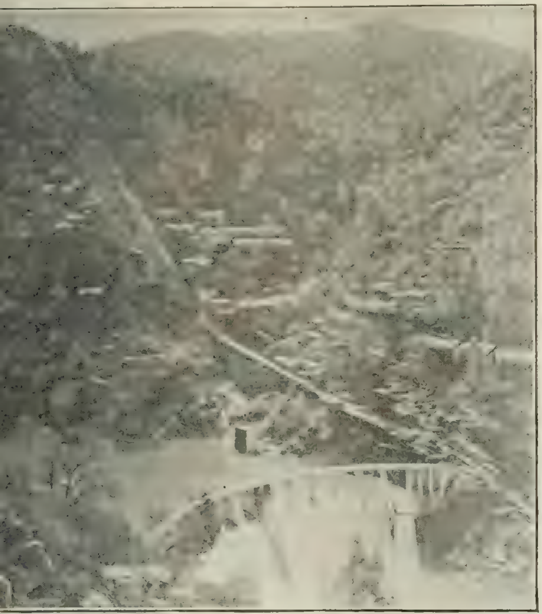


FIG. 2. DAM BEFORE RADIAL FLOOD GATES WERE INSTALLED

Dam and north portal were completed less ian six months after drilling of test holes, ex-epting the radial flood gates which were in-alled the following summer, during lower-ater period, before the tunnel and power ouse were ready, fifteen months after the ork was first started.

The dam (see headpiece and Figs. 2 nd 3) is in a narrow horseshoe of the iver, where it winds through a granite iountain, and contains 23,489 cu.yd. of oncrete, which is about one-half of ie quantity that would be required for gravity dam at this place. This dam 570 ft. along the top, 140.5 ft. in otal height above the original river bed, id the crest is constructed on a para-olic curve, with a lip extending out ver the downstream face in order to scharge the overflow a distance away from the face id free of the toe of the dam, into a pool formed below ie dam by casting excavation material downstream in ich a way as to form an embankment and provide a ool about thirty feet deep, which eliminates the danger the falling water cutting the rock at the toe of the im. Above the crest there are provided fourteen x 20-ft. Taintor (radial) gates. A concrete log iute, shown to the right in the headpiece, was con-ructed, extending out from the downstream face of the dam beyond one of the Taintor gate openings in order to take care of driftwood which sometimes comes down the river with the first heavy floods.

At elevation 994.5 ft. is the top of the dam, Fig. 3, forming a floor over the walls which separate the Taintor gates, and along this floor there is provided a track on which is operated a specially designed motor-driven hoist for operating the Taintor gates by means of chains that extend up through small openings in the floor. Near the bottom of the dam there are three 72-in. rising-stem sluice gates. The Taintor gates, when open, will permit the discharge of 100,000 cu.ft. per sec., this capacity being amply safe for any possible floods.

When the gates are closed, as they normally will be, and the lake raised to their top, its surface elevation will be 985 ft., which is approximately that of the floor of the tailrace of the company's existing No. 1 power house about two miles up river, thus forming a storage impounding 4,000 acre-feet of water, approximately 3,000 of which is above the Kerckhoff pressure tunnel. This available part will operate the new Kerckhoff plant nearly twenty-four hours at full load, which requires 1,500 cu.ft. per second.

As is well known, all the power companies in the West have suffered for the last two years on account of power shortage, and in order to relieve this condition it was decided to get the Kerckhoff development into operation at the earliest possible time. In addition, it was necessary to complete the foundations of the dam during the low-water period before the fall rains raised the waters, interfering with construction.

At the time R. C. Starr was called to take charge of this development, only rough preliminary surveys had been made, and under his direction, on May 20, 1919, work was started on the engineering, and at the same time diamond drilling at the dam site selected was started. By July 20 test holes had been drilled

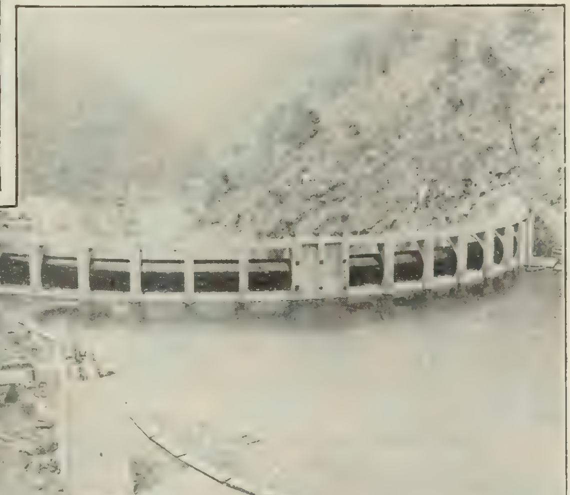


FIG. 3. RADIAL FLOOD GATES INSTALLED IN DAM

Radial flood gates are operated by an electrically driven hoist mounted on a traveller which moves along the dam on a track, the three 72-in. sluice gates also being operated from the top of the dam.

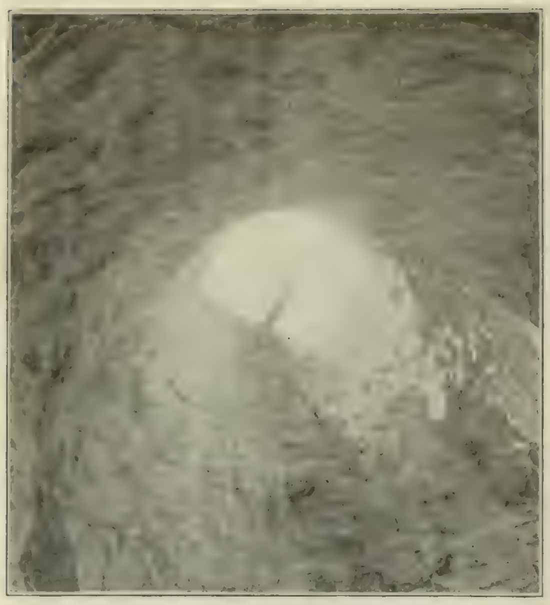


FIG. 4. SURGE TANK CUT IN SOLID ROCK

Looking up through the milk-bottle shaped surge tank which rises 70 ft. from the roof of the tunnel through solid granite to the hill-slope above.

for the foundation of the dam, camps constructed, roads built, etc., and on that date excavation of the dam was begun. An incline was built down a steep grade immediately at the dam site (see Fig. 2), and even before that was completed and during the heat of the summer, in this box-canyon, crews of men worked feverishly, dragging and lowering compressors and other machinery down the steep mountainside amid such dangers as loosened boulders, poison oak, etc., and on Aug. 12 the first concrete was poured. Work went on day and night until the dam was completed on Dec. 15 of that year, marking the accomplishment of a feat that is probably unparalleled. W. A. Whitmire was personally responsible for pushing the construction work on the dam to such rapid completion.

The north portal, or intake of the tunnel line, is closed by a substantial gate and grizzly and is located close to the dam, as shown at the left in Fig. 3. The tunnel extends from this point 16,875 ft. entirely through hard, gray-granite formation, requiring no timbering during driving, nor lining. This tunnel has an average driven cross-section of 320 sq.ft.—approximately 18 ft. square—designed for 2,100 cu.ft. per second.

Near the south end, Fig. 5, where the triple penstock line is concreted into the tunnel, a surge tank was constructed, called the "Milk Bottle" by the construction men, as it is of that shape (see Fig. 4). It is 40 ft. in diameter at the tunnel roof, extending upward approximately 70 ft., and approximately 17 ft. in diameter at the top, where it opens out on the side of the mountain to form a spillway. The chamber itself forms a surge tank to absorb or dampen out surges in either the pipe lines or tunnel. This bottle-shaped shaft is hewn out of the solid granite mountain above the tunnel.

The method used in driving the tunnel is known as the "Heading and Bench Method," under which a bench about fourteen feet long and seven or eight feet from the roof is carried forward, on which the "heading crew" drills from thirty-five to forty holes fifteen to twenty feet deep into the heading, those near the center pointing toward each other and coming together at the bottom. These are called the "cut holes," and when shot throw a wedge-shaped piece of the rock, and are drilled while the former shot is being mucked out in front of the bench.

After the muck is cleaned up, the "bench crew" drills from twelve to sixteen holes horizontally into the bench, requiring about four hours, after which this crew shoots the holes. This loading time generally occupied from midnight to 7 a.m., and by 8 o'clock the tunnel was clear of gas and the crew sent in to clean up the track preparatory to moving the shovel ahead. By 10 o'clock the steam-shovel crew would be called and start operation, and by noon the heading crew was ready to go, and later on the bench crew went in. A complete round was made in each twenty-four-hour period, in this manner making sometimes as high as 19 ft. progress.

The mucking was done with Marion 40-in. steam shovels operated with air at 100 lb. The very skillful and efficient manner in which these shovels were operated represented one of the greatest factors in the remarkable record made in driving this tunnel.

Tunnels of this size, where shovels have been used for mucking, have invariably been constructed by first driving a pioneer heading outside of the required tunnel section, and have cost approximately 50 per cent more per foot where driven in similar gray granite, although the wage scale and cost of powder on this job was 100 per cent higher than was paid before the war.

The triple penstock, consisting of three steel-pipe lines 950 ft. long, 8 ft. in diameter at the portal and 7 ft. at the wheels, was completely erected, riveted, calked

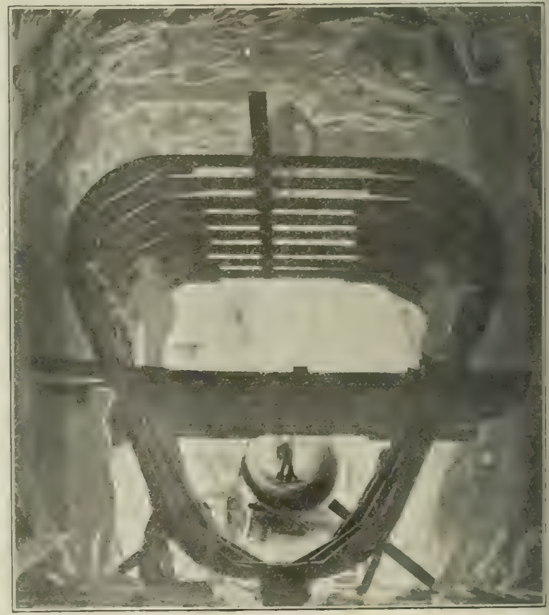


FIG. 5. TRIANGLES IN SOUTH PORTAL FOR SUPPORTING THREE STEEL PENSTOCKS

At the south portal of the tunnel the three eight-foot penstock pipes were cemented into the tunnel in a triangular position, coming to a horizontal plane a short distance beyond.

and anchored in thirty-two days by the power company's construction crew. There are no standpipes on these lines, there being provided a surge tank a little inside at the point where these lines are cemented into the south portal.

Air relief valves are installed on the top of each pipe line at two points to permit air to enter the penstock lines to prevent collapsing. At the lower end of each line where it enters a turbine there is provided an 84-in. butterfly valve, electrically controlled from the switchboard and designed to withstand full penstock pressure if it is desired to empty the turbines for inspection or repairs without emptying the penstock.

At the upper end of the pipe lines there are installed three 8-ft. rising-stem gate valves provided with bypass valves, Fig. 6. They weigh 60,000 lb. each, complete, and were designed and built in record time. They are electrically operated from the power house, being so interconnected as to require the main gates and the bypass valves, which are also electrically equipped, to be operated in the proper sequence. The reinforced-concrete power house is located in a box-canyon, Fig. 1, through which the San Joaquin River flows; the main floor, 100 x 36 ft., is at elevation 675 ft. above sea level, the roof being 45 ft. above and the turbine floor 23 ft. below. The building is constructed on a site entirely excavated out of the solid granite side of a mountain, inaccessible by road, and to which access was obtained by building an incline railway 1,000 ft. long (Figs. 6A and 11). This railway has a maximum grade of 100 per cent just before it enters the power house, and at the door of the power house it straightens out to a level, under the crane. A chamber entirely excavated down into solid granite to the low-water river level forms the turbine room, the generator floor above being constructed as an arch over this cavern the sides of which did not require concreting, Fig. 7.

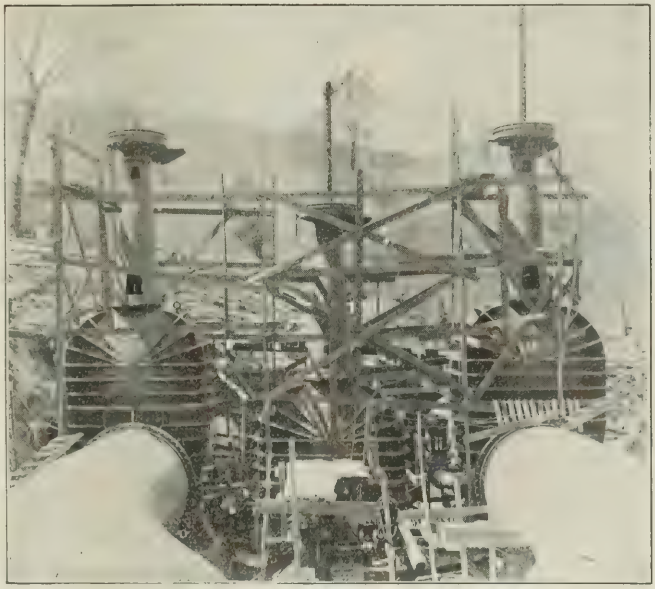


FIG. 6. RISING-STEM GATE VALVES FOR PENSTOCKS

Eight-foot rising-stem gate valves weighing 60,000 lb. each, motor operated and with motor operated bypass valves, were installed close to the tunnel.

The unusually small floor space provided for three units of such large capacity is rather striking and causes considerable comment, but all the equipment is so compactly built and placed that there is ample room in the building for all purposes. In fact, the design is a striking example of compactness, efficiency and economy in every way and is credited to the power company's engineering department on this project, of which B. F. Jakobsen was chief designing engineer.

Three 15,000-hp., vertical turbines, direct-connected to 14,200-kva. generators; two 500-hp. turbines direct-connected to 300-kw. exciters, on top of each of which is mounted a 15-kw. control-current generator; oil-pressure governors and pumping sets make up the main equipment of the plant (see Fig. 9). An excellent record in delivering the equipment within the schedule time was made by the manufacturers in spite of difficulty due to labor and material shortage. The manufacturer's erector completely installed the turbine, generator and exciter equipment, using men furnished by the power company, in less than ninety days; and with the aid of the power company's riggers, installed the first two turbines in twenty days without the use of the crane, which had not then been installed. The winders completed the stators on the job in fourteen days per machine. All of this is considered excellent erection time. As indicated in Fig. 7, the turbines are of the vertical-shaft, single-runner "Francis" type, equipped with pressure-relief valves, which are automatically operated by the governor or by excessive increase in pipe-line pressure due to surge or load changes, etc. The governors are of the latest type manufactured by the Allis-Chalmers Manufacturing Co., with the flyballs mounted on the mainshaft and mechanically connected to the relay and floating valves, which control the oil pressure in the gate-operating cylinders. The latter in turn operate the wickets and relief valve. Elimination of driving arrangement by placing the governor actuating parts on the mainshaft is a distinct improvement.

Bolted immediately to the butterfly valve at the end of the penstock line is the 84-in. spiral casing, so that all acceleration to the required velocity will occur in the casing, the water passing through the butterfly valve at penstock velocity. The casing, which is in two parts, and the speed ring, which is one solid casting, weigh 85,000 lb. The weight of the casing, speed ring, etc., is carried on a foundation ring, which in turn is carried on, and bolted to, the concrete foundations.

Steel-plate draft tubes are used, discharging straight into tunnels driven through the solid rock to the river, these tunnels measuring 10 x 12 ft.; and openings are provided in the steel draft tubes for inspection of the runner and other parts from the discharge side.

Special composition water bronze was used in the construction of the runners, the guide vanes being of cast steel with solid-steel stems. These gates are operated by two regulating cylinders for each unit, mounted on top of the spiral casings to which they are bolted, providing compact, self-contained units, controlled by the governor.

Each main unit is provided with its own motor-driven governor oil pump, pressure and receiving tanks, and a hand-operated oil pump. These pumps are interconnected, however, so that either may be used on any machine.

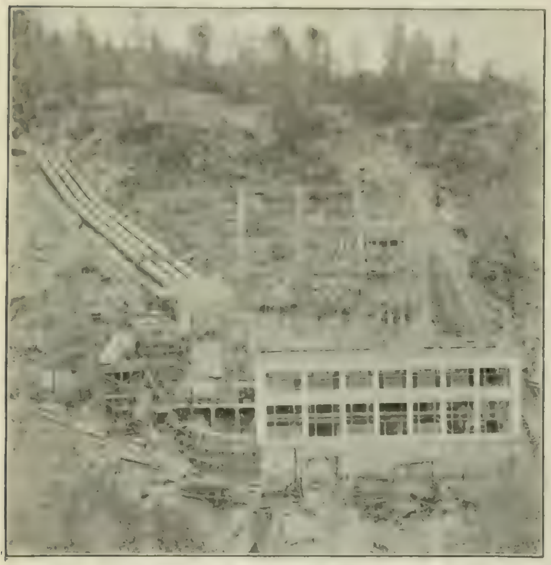


FIG. 6A. EXTERIOR OF POWER HOUSE

The Kerckhoff power house is on a bench excavated out of the granite hillside, and the 110,000-volt switch structure is built on an angle of 45 deg. An incline railway, on the right, was constructed, having a maximum grade of 100 per cent. The penstocks 8 ft. in diameter are shown on the left.

The weight of the rotating elements complete, together with the reaction from the runner due to the water passing through the wheels at maximum load, is carried on 29-in. diameter special Kingsbury bearings, the friction loss of which at normal speed and with 150,000 lb. load, rotating and thrust, is approximately 20 hp. These are the first bearings of this type which are self-contained as to lubrication. They are equipped with cooling coils to keep the oil temperature within proper limits, the power company's engineering department specifying this arrangement in order to eliminate the objections in connection with external oil-circulating and cooling systems, which may permit foreign particles and scale from the pipes getting into the oil. These are of necessity expensive, requiring pumps, coolers, filters, etc., and one of the principal features considered was that with the external-pressure circulating systems the oil is broken down and has much shorter life

This thrust bearing is mounted on the upper bridge over the generator, and immediately below it is located the upper guide bearing so designed as to be removable without disturbing the thrust bearing. The second, or lower, guide bearing is in the lower generator spider, on which are also mounted three friction asbestos-lined brakes, operated by a system of levers controlled by a handwheel on a column alongside the generator. All of the guide bearings are lubricated by a small pump located in the pan below the lower guide bearing of each unit, these pumps being geared to the mainshaft and easily accessible. The pans form large reservoirs from which the pumps raise the oil to the top of the upper bearing down through which it flows. After this it is conducted to the top of the lower bearing through pipes that revolve with the shaft, being placed through the hub of the rotor spider. The wheel bearing is of lignum-vitæ and is split so that it may be removed without disturbing the rotor or shaft.

All three main generators are of the vertical type, three-phase 60-cycle 6,600-volt 1,240-ampere, with a maximum rating of 14,200 kva. at 80 per cent power factor. The stator winding is insulated with mica in the slots and in accordance with Class B specification, A.I.E.E., good for 125 deg. C. continuously, and both ends of each phase winding are brought out to make them easily accessible for any combination of metering and relay equipment, and grounding. Ventilation of the generators is accomplished by taking air from the room at the top and from the turbine cavern below and discharging it out through the sides of the stator's frame into a sheet-steel casing which surrounds the yoke and conducts the air outdoors, openings being provided, however, for warming the power house in the winter.

The entire rotating element is good for 100 per cent overspeed, and they were actually tested in the pit at 690 r.p.m., which is the runway speed. At normal speed, 360 r.p.m., the peripheral speed is 11,000 ft. per minute.

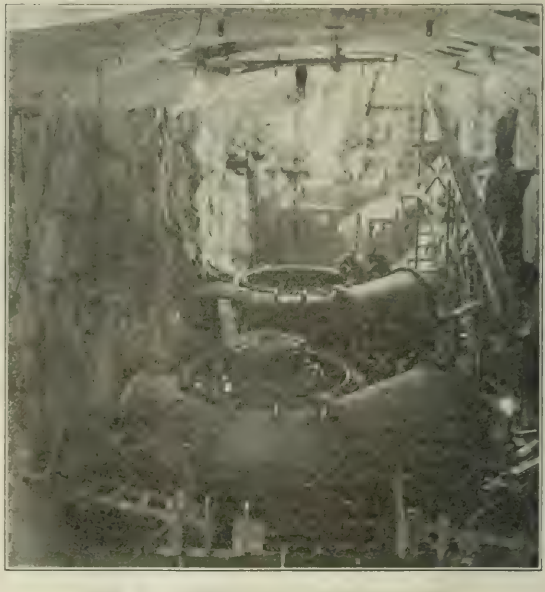


FIG. 7. INTERIOR OF TURBINE ROOM

Two of the three turbines were erected in this cavern in twenty days before the crane was installed. This cavern is cut out of solid granite, down to low-water level.

Excitation is supplied by two vertical waterwheel-driven shunt-wound 300-kw. exciters, which are amply large to provide excitation for all three main units. On top of each of these exciters there is mounted a 15-kw. 125-volt compound-wound generator, either of which will furnish all control current for operating oil switches, governors, etc. These exciters are driven by 500-hp. 900-r.p.m. vertical turbines similar in type to the main units except that they are not equipped with governors, complete electric and hydraulic control being provided at the switchboard, it being possible to depend on the relation between the speed and torque, and the rather wide range of speed through which it is possible to operate the exciters without trouble.

When the exciter set is operating at a point on the drooping side of the efficiency curve, where increased speed results in lower efficiency, it is readily seen that a rejection of load by the Tirrell regulator would result in the exciter set speeding up until the speed comes to a point where, on account of reduced efficiency, the given gate opening would correspond to the reduced horsepower, which would prevent further speeding up. As the load on an exciter varies but little, a governor normally operates in a very short range within which parts wear free, the governor sticking and refusing when called on by trouble to act beyond that range, requiring close supervision by operators in any case. No complete load tests were conducted at the factory, but core loss, windage, friction, etc., were measured by input to a vertical direct-current motor driving a machine, and from these results an efficiency was predicted of 97.1 per cent at maximum load and 80 per cent power factor, on the generators.

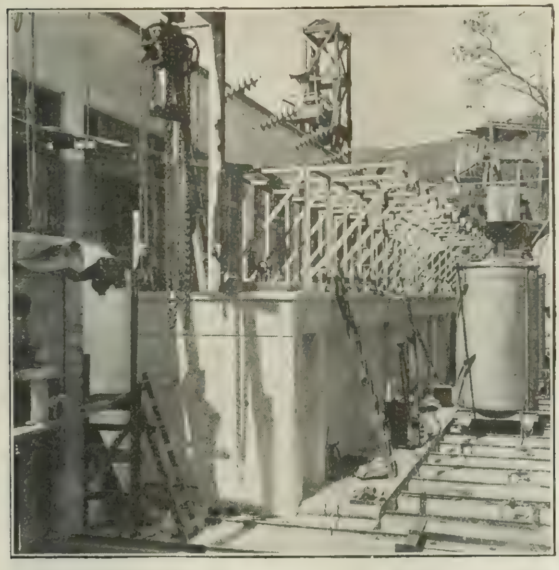


FIG. 8. TRANSFORMERS AND BUSSES LOCATED OUTSIDE POWER HOUSE

At the rear of the building is located the switch room, on top of which are the 6,600-volt transformer busses, serving the nine 5,000-kva. transformers.

On Sept. 29, 1920, the power company conducted a test to determine if the guaranteed efficiency had been met. The chemical, or salinity, method was used, and although the conditions were rather unusual for this method, remarkably uniform results were obtained. These tests were conducted by H. R. Stevens, who had charge of power-house construction.

Because of shortage of power in California, it was decided not to interrupt the operation of the power plant as far as the output to the system was concerned, and the test was conducted on one unit operating on a fixed gate, with the generator tied into the system, which of course held the speed variation down and provided for a very satisfactory uniform block of load at a constant speed for a period sufficiently long to enable the taking of necessary readings and samples, etc. During the test elevations were read at the lake, and also in the surge tank at the head of the penstock, in this case a float being used attached to a steel tape running over a pulley so that readings could be taken against an established benchmark.

A platform was constructed in the stop-log shaft, which extends vertically down to the tailrace tunnel, and from this platform the elevation of the water in the tailrace was accurately read, and also, gages were connected through separate piezometer openings at different points around the circumference, the center line of these three gages being established at a given elevation. For providing the salt solution sufficient to make all the tests, a 10,000 gal. wood-stave tank was erected, close by the top of the pipe line, containing 7,500 gal. of water to which was added six tons of common salt, after which the solution was agitated for sixty hours by air released from submerged pipes, under pressure. The resulting solution contained 86,543 parts of salt to 1,000,000 parts of water, the density being 1.09248. This solution was then allowed to flow into a barrel

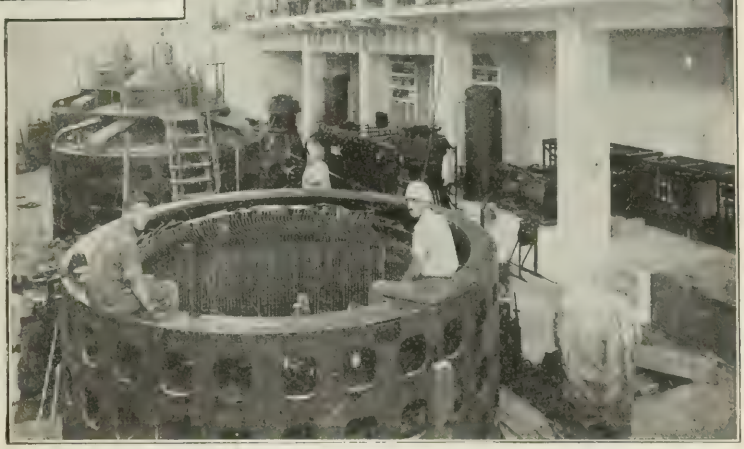


FIG. 9. INTERIOR OF GENERATOR ROOM

Interior of the Kerckhoff power house is a model of compactness and efficiency of design. This view shows the main units, exciters, governor-oil pumping sets, rheostats and auxiliary board, on the main floor, with the bench control-board and low-tension switches on the gallery.

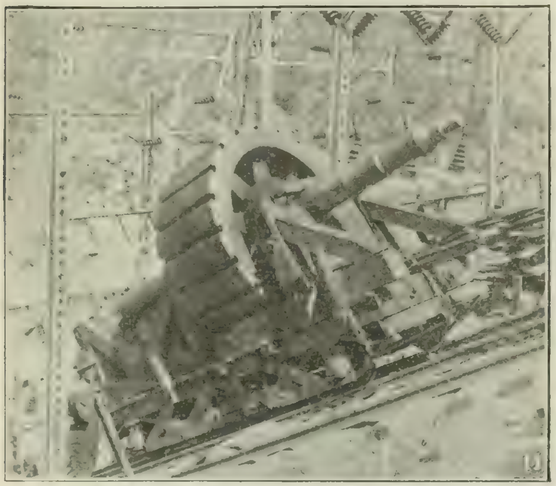
mounted on a frame and provided with an orifice at the bottom and a marker at the top, the barrel kept filled to the marker while the solution flowed freely out through the orifice, falling into a second barrel from which it was discharged by a 3-in. 150-g.p.m. four-stage centrifugal pump, through quick-opening valves and regulating valves, either into the penstock or back to the supply tank or to a third barrel mounted on a calibrated platform scale.

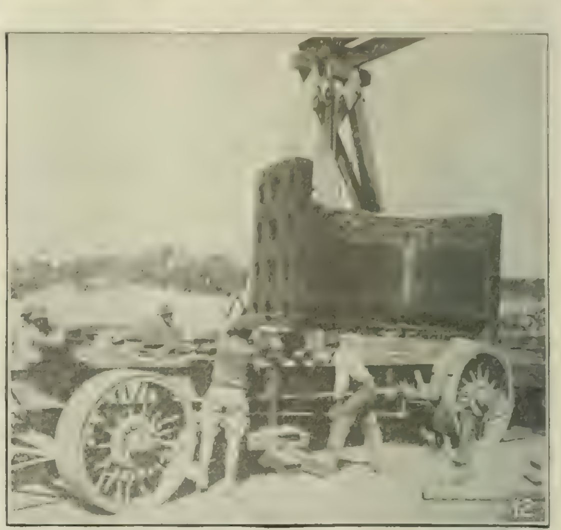
The orifice was checked by weighing the solution that passed through in a given time, then the solution was allowed to pump into the supply tank until a test signal was given, when the quick-opening valves were thrown over and the solution discharged into the penstock through four ½-in. nozzles arranged around the circumference.

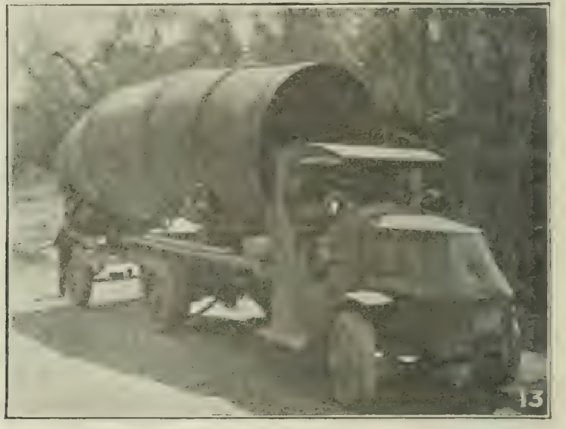
This arrangement was located near the top of the penstock. The rate was 14.905 lb., or 0.2185 cu.ft. per second.

By keeping record of the load of the other units during the test, it was possible to include a determination of the tunnel friction loss, which was 5.38 ft., and velocity, which was 2.37 ft. per second, at 760 cu.ft. per second.

The resulting efficiency was found to be in excess of the guarantees by a considerable margin. The guaranteed maximum turbine efficiency was 87.5 per cent at 0.8 gate, 332-ft. net head, corresponding to approximately 13,000 hp. Actual turbine efficiency at 0.8 gate opening and 329.387 ft. net head was 90.1 per cent, when the output was 16,260 hp. At a generator efficiency of 97.62 this represented 11,860 kw. The discharge was 483.5 cu.ft. per second, and the penstock loss 4.7 ft. At full gate opening the turbine developed 18,680 hp. at 327.374 ft. net head, discharging 575 cu.ft. per sec., the efficiency of the turbine being 87.45 per cent, the generator output 13,610 kw., the penstock loss 6 ft. and the velocity 12.8 ft. per sec. The maximum generator output to date is 14,500 kw. on one machine.







FIGS. 10 TO 13. SHOW METHODS OF TRANSPORTING EQUIPMENT

Fig. 10—Six ten-ton trailers were operated in a train, shown here loaded with transformer cases, drawn by a 75-hp. caterpillar. Fig. 11—An incline railway 1,000 ft. long, having a maximum grade of 100 per cent (45 deg.), was constructed to serve the power house, which was inaccessible by road. The 29.5-ton rotors were in this way sent down. Fig. 12—Loading a half of a generator stator on a 35-ton special trailer, by means of which the 29.5-ton rotors were also transported over a mountain road, having a maximum grade of 12 per cent. Fig. 13—5-ton truck, with 5-ton dolly, loaded with 22-ft. section of the eight-foot penstock pipe, weighing about eight tons.

All of these results show that the machines are above rating, that for a given gate position a greater output is generated but without a corresponding full increase in use of water; and it is contemplated to add another, perhaps smaller, unit at some future time in this power house; the tunnel, having an average section of 320 sq.ft., will accommodate 2,100 second-feet at only 6.6 ft. velocity.

The main control board is of the bench type, flanked with a pedestal-type Tirrell voltage regulator. Watthour meters and various combinations of relays are located on the rear of the bench. This entire switchboard was wired in completely in the field in fourteen days by the employees of the power company's construction department, under H. L. Wood. A mimic bus is located on the benchboard, and on the front of this board are the testing receptacles connected with the temperature exploring coils, which are inserted in the generator windings. The 6,600-volt layout includes a main bus and, for each generator, a transfer bus which permits connecting the generator direct to its corresponding transformer bank and operating these as a unit on one outgoing 110,000-volt line independent of the main-station bus; and there are disconnecting switches provided, so that, when so operating, a unit may be closed in to the main bus and changed to normal parallel operation without interrupting its load. This scheme is nearly as flexible as a double-bus system, but much less expensive; and while it may be conceded that a double-bus layout is preferable in connection with a switching or distributing center, it is not considered so important in a generating station containing its equipment in comparatively few units. Generators and step-up transformers are protected by differential relays in such manner as to isolate faulty apparatus. The generator and exciter field rheostats, field switches, governor control, hydraulic gate opening and closing mechanism, both on the main and exciter units, are remote-controlled from the switchboard.

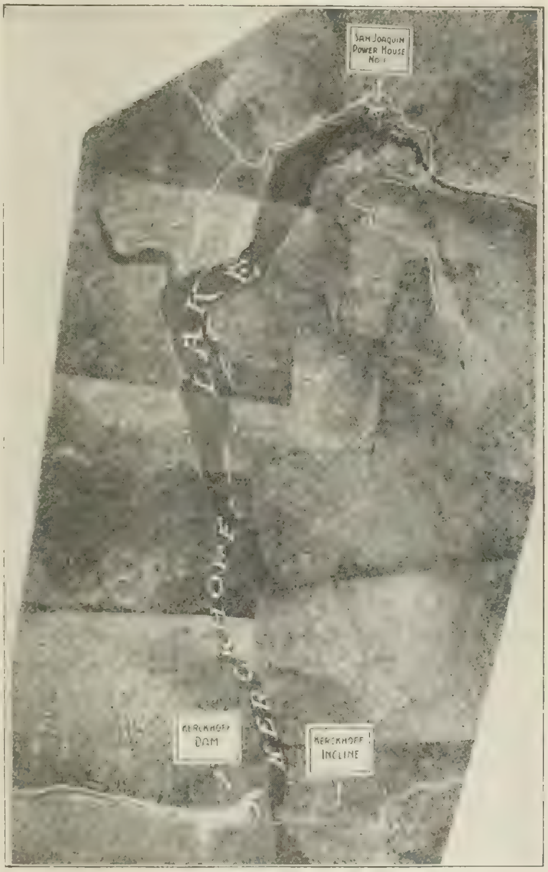


FIG. 14. AERIAL PHOTOGRAPHIC ASSEMBLAGE KERCKHOFF DEVELOPMENT

This is a reduced reproduction of a "mosaic" map made up of photographs taken from the air at 7,000 ft. elevation, showing the Kerckhoff lake, dam, etc. Similar "mosaics" are now being completed over the San Joaquin Light & Power Corporation's Kings River project.

The high-tension layout is outdoors on the hillside, Fig. 6A, which was so steep that the steel structure, which consists of three bays, had to be designed with the supporting trusses and braces built at an angle of 45 deg., so as to give proper clearance without requiring expensive excavation in the granite mountainside.

There are nine step-up transformers, arranged in three banks, and having a capacity of 5,000 kva. each, wound for 6,600-volt delta to 127,000-volt "Y." They are located outdoors on a bench cut in the steep mountainside close to the rear wall of the power house, Fig. 8. Catch basins are arranged in such a manner that the oil from an exploded tank will run away from the transformers and be discharged into the river. As two banks of these transformers will carry the load of all three generators without serious overheating, it was not considered necessary to provide a spare unit. There are two outgoing 110,000-volt transmission lines, one extending south approximately 140 miles to McKittrick in the lower end of the San Joaquin Valley, near Bakersfield, near where the company is now completing a 30,000-kw. gas-burning steam power plant, and at which point connection is made to the lower end of the existing 60,000-volt network. [For a description of the Bakersfield gas-fired steam plant see *Power*, Dec. 7 issue.] The other line extends from the Kerckhoff plant west, approximately 52 miles, thence north 14 miles, to Merced, near the north end of the company's existing network, and where interconnection is made with the great system of the Pacific Gas and Electric Co. on the north. During the progress of this work labor shortage was a serious condition, and railway transportation was even more serious. Chief engineer Starr gave the latter considerable of his personal supervision, giving shipments only to the railroad that would not only promise but actually deliver the cars in the least time; and he actually secured deliveries from Chicago in the record time of eleven days and an average time of fifteen days. He accomplished this through connections at Eastern points, by following up personally at this end, and by placing a man on each car coming out. These men reported their location daily, and received instructions as to any necessary immediate arrangements for coming forward.

The railroad delivery point was at Auberry, on the San Joaquin & Eastern Railroad. From here 17 miles of road was constructed, serving the camps and main construction points. All road used by the construction department was built since this job was started. These roads were entirely in rough mountainous country, with grades as high as 12 per cent and many sharp turns, and soon they became almost impassable on account of the deep dust and ruts. Because of this condition, together with the fact that on account of the dry season the water gave out in the wells at Auberry, a pipe line was laid a distance of approximately five miles from the river along the road between Auberry and the dam site. Pumps were installed to supply water for the camps, and for filling tanks that were placed at night on the trucks, which were used for hauling cement during the day, but served as sprinklers at night, with different forms of drags attached. Inside of a week of thus caring for the roads, they were transformed into boulevards, and were maintained so in spite of the extremely hard usage which followed.

The hauling was accomplished over these roads principally by Mack 5-ton and White 2-ton trucks and a 75-hp. Holt caterpillar with 10-ton and 35-ton trailers of the cross-connected-reach type, under which both axles turn, causing the trailers to "track" around turns (see Figs. 10, 12 and 13). The caterpillar hauled six 10-ton trailers, loaded, in single trains; and as high as 1,000 tons of equipment was transported in seven days' time. The heaviest piece of equipment, which weighed 58,000 lb., was hauled to the power-house incline without difficulty on the special 35-ton Holt trailer with 60-in. diameter wheels, 14-in. tread, the distance of five and one-half miles being made in four hours, including loading and unloading. The penstock pipe, in 22-ft. lengths, averaging eight tons per section, was hauled over this road with Mack 5-ton trucks, trailing 2-wheel, 5-ton dollies.

PRINCIPAL EQUIPMENT KERCKHOFF POWER DEVELOPMENT

Equipment	Manufacturers
Turbine, generators and exciters....	Allis-Chalmers Mfg. Co.
Butterfly valves....................	Allis-Chalmers Mfg. Co.
Steel penstocks	Western Pipe and Steel Co.
Penstock rising-stem valves........	Joshua Hendy Iron Works
Power transformers	Allis-Chalmers Mfg. Co.
Switchboard and Tirrel regulators...	General Electric Co.
110,000-volt switches	Kelman Elec. and Mfg. Co.
110,000-volt switching bushings.....	Ohio Brass Co.
Taintor gates	California Culvert Co.
Rising-stem sluice gates in dam.....	Coffin Valve Co.

An interesting feature in connection with the study of the topography of the country in which this development was made is the fact that it has been photographed from airplane and a "mosaic" map, Fig. 14, made and checked with the topographic maps made by the company, the results proving so favorable that this method was adopted for accomplishing reconnaissance survey in the Kings River country, in which a development aggregating 500,000 hp. has been started by the San Joaquin Light and Power Corporation.

Mr. Starr, since the Kerckhoff development was about completed, has been engaged in connection with the Kings River development, and also additional work in Crane Valley and Kern River territories. He has purchased a Varney Lincoln-Standard plane with a 150-hp. Hispano-Suiza motor, and by permission of the Air Service and with the personal co-operation of Major H. H. Arnold, in charge of the Air Service, Ninth Corps Area, and other officers of the Air Service at San Francisco, installed a "G. E. M." Eastman Kodak Co. special aërial camera belonging to the War Department. The machine was piloted by Lieut. F. T. Honsinger of the Ninth Corps Area, Air Service, while R. L. Bryant, of the company's engineering organization, operated the camera.

After viewing the country, a map is prepared on which is laid out the areas to be surveyed, and fixed points are established, after which a certain amount of field work is done, establishing triangulation points to be picked up from the air when the pictures are made, and to serve as the basis for laying out the air pictures into a "mosaic," on which contours can be sketched in quite accurately; and then study of the possible schemes of development may be made, and of the value of areas for early or late run-off, the location of reservoirs, some of which may be developed from existing glacial lakes, many of which exist in this part of the Sierra Nevada Range at elevations from 10,000 to 12,000 ft.

These air pictures indicate better than anything else the value of each possibility and the capacity to which each may be economically developed.

A note of appreciation necessarily occurs throughout an article of this kind in connection with a project which was started under such extremely unfavorable conditions and a design worked out that has proven to be most conservative, economical, and successful, planned and carried forward to completion in such record time without mishap of any kind and without any regrets, the entire organization working through to the finish in perfect harmony, with the foremen, superintendents, designing engineers, etc., all working in hearty co-operation and with the relation between those at the top and those at the bottom being marked by a firm but just treatment of the men by those in charge, who received in return loyalty and willingness. Contributing considerably to the results there was the earnest co-operation of all the manufacturers in furnishing their equipment in time so as to avoid holding up the work. Early completion of this plant was of vital importance to a vast agricultural territory of the West, which was suffering for lack of water and for lack of power with which to pump it. If this plant merely replaced steam generation and saved fuel, as it does, the completion of it would have been of utmost importance.

Diesel Engine Pointers

If a piston ring fails to bear against the cylinder walls, hammering the inner surface of the ring will increase the diameter of the ring.

In replacing piston rings, a clearance of 0.01 in. between the ring and side of the groove is amply large.

Each piston ring should be fitted to the cylinder, allowing 0.01 in. clearance at the gap.

In many Diesels the top rings gum up very quickly. This may be caused by the kind of lubricating oil used and an excessve amount of it. Often it is the result of low compression pressures, much of the heavier portions of the fuel failing to burn.

If a piston distorts and scores the cylinder, the rough place can be removed by a emery stone or by placing grinding compound on a wooden block shaped to fit the curvature of the cylinder.

In checking the clearance of a piston-pin bearing, place the piston or rod in an upright position, having the rod end free from the floor and the piston suspended from a chain block. If the rod can be swung like a pendulum without tilting the piston, there is ample play. If the rod swings freely, the bearing is too loose.

Steam Making with Fuel Oil

It is generally recognized that it is impossible, in every-day operation of coal-fired boiler plants, to secure results that approach test results where all conditions are as favorable as possible. The same truth applies to oil-fired boiler plants. It is of small practical worth to run a test and then base estimates of operating costs on the test results. If a test is desirable, it should be conducted as nearly as possible under actual operating conditions.

The accompanying table covers the results of a series of tests conducted under such conditions in a mill having two boiler plants. One of the plants contained four Babcock & Wilcox water-tube boilers, each having 9,200 sq.ft. of heating surface. The second plant had seven horizontal-tubular boilers 72 in. x 20 ft. with 70 tubes, 4 in. x 20 ft. each. These boilers had 1,650 sq.ft. of heating surface each.

The men ordinarily in charge of the boilers were left in charge during the tests, and the observing engineers were not permitted to change conditions in any way. The results, then, are as nearly as possible representative of every-day practice.

On the tests the fuel oil was weighed, while the feed water was measured in large calibrated tanks provided with overflows. All pipes not in use were blanked off. The test data were kept in duplicate by the engineers representing the parties interested in the several tests.

The fuel oil was stored in two large tanks supplied with pumps which were driven by steam from the horizontal-tubular boilers. For this reason some of the steam used to heat and pump the oil to the B. & W boilers was supplied by the tubular boilers. For this reason it is necessary to treat the tests by pairs to arrive at the steam used by the oil-burning system. This has been done in the concluding portion of the table.

Consolidating all the tests, the evaporation of water from and at 212 deg. F. per pound of oil was 13.962 lb. The percentage of the steam generated which was used to operate the fuel-oil system was 4.04.

No higher efficiencies are ordinarily obtained with fuel oil than prevail in coal-fired plants. The use of oil increases the boiler and setting repairs and therefore interferes with the mill operation to a greater extent than would coal.

TESTS OF BOILERS USING MEXICAN FUEL-OIL

Date of test	1/9-10/20	1/23-4/20	3/19/20	3/22/20	10/1-2/20	10/8-9/20
Duration, hours	24	24	12	12	24	24
Kind of boilers	B. & W.	Hor. Tub	B. & W.	Hor. Tub	B. & W.	Hor. Tub
No. of boilers	4	7	4	7	4	6
Total heating surface of boilers	9,200	11,550	9,200	11,550	9,200	9,900
Type of burner	Best	Best	Best	Best	1 Hammel 3 Best	Hammel
Pressures:						
Steam gage pressure, lb	120.1	94.5	124.4	101.7	124.0	108.9
Absolute steam pressure, lb	134.9	109.4	139.07	116.6	138.77	123.7
Furnace draft, in	0.32	0.21	0.14	0.18	0.17	0.13
Draft under damper, in		..	0.54	0.32	0.41	....
Oil pressure to burners, lb	30	45	19.6	36	40	40
Temperatures:						
Atmospheric, deg. F	37	37	42	58	56	64
Fire room, deg. F	84	80	74	67	74	77
Feed water at boilers, deg. F	174.9	193.8	180.7	201.1	182.1	176.5
Waste heat at dampers, deg. F	486	368	486	464	533	492
Oil to burners, deg. F	183	161.5	180.3	172.3	182	162
Moisture in steam, per cent	1.00	0.67	1.00	0.45	0.60	0.80
Factor of evaporation	1.08	1.0575	1.075	1.051	1.0738	1.0774
Fuel-oil:						
Heat per pound, B.t.u	18,500	18,600	18,320	18,370	18,350	18,370
Weight per gallon at 60 deg. F., lb	8.037	7.978	8.00	8.00	7.984	8.002
Weight of oil used, lb	59,070	103,666	28,403	49,883	68,623	78,020
Gal. of oil at 60 deg. F	7,350	12,994	3,550.4	6,235.4	8,595	9,750
Water:						
Total water fed to boilers, lb	737,788	1,424,388	340,144	707,286	843,036	1,053,027
Total water evaporated, lb	730,410	1,414,892	336,743	704,103	837,978	1,044,603
Water as steam used by fuel-oil system, lb	22,320	58,820	9,220	33,919	21,412	59,573
Net water evaporated and available for the mill's use, lb	708,090	1,356,072	327,723	670,218	816,566	985,030
Total water evaporated from and at 212 deg. F., lb	788,843	1,496,248	361,999	740,012	899,821	1,125,455
Water evaporated per hour per sq.ft. heating surface from and at 212 deg F., lb	3.57	5.40	3.28	5.34	4.07	5.97
Net water for mill use evaporated from and at 212 deg. F., lb	746,737	1,434,046	352,087	704,398	876,829	1,061,271
Steam made, boiler hp.:						
Rating of boilers in use, hp	920	1,155	920	1,155	920	990
Economic evaporation:						
Gross water evaporated from and at 212 deg. F. per pound of fuel-oil, lb	13.354	14.43	12.745	14.835	13.113	14.425
Net water for mill use evaporated from and at 212 deg. F. per pound of fuel-oil, lb	12.946	13.83	12.396	14.12	12.777	13.602
Efficiencies in the use of fuel-oil:						
Gross efficiency, per cent	70.05	75.08	67.51	78.36	69.35	76.20
Net efficiency, per cent	67.91	72.15	65.66	74.59	67.56	71.85
Combined and weighted results:						
Gal. of fuel-oil at 60 deg. F	20,344		9,785.8		18,345	
Weight of fuel oil, lb	162,736		78,286		146,643	
Heat in a pound of oil, B.t.u	18,564		18,352		18,361	
Total water evaporated from and at 212 deg. F., lb	2,285,091		1,102,011		2,025,276	
Net water for mill use evaporated from and at 212 deg. F., lb	2,180,783		1,056,485		1,938,100	
Steam used by fuel-oil system, per cent	3.77		4.13		4.29	
Gross evaporation from and at 212 deg. F. per pound of fuel-oil, lb	14.042		14.077		13.811	
Net evaporation from and at 212 deg. F. per pound of fuel-oil, lb	13.401		13.495		13.216	
Gross efficiency, per cent	73.40		74.44		72.997	
Net efficiency, per cent	70.05		71.36		69.85	

* * *

The majority of Diesel engines have a compression pressure ranging from 450 to 500 lb. With the ordinary fuel oil ranging from 26 deg. Baumé upward, 450 lb. is ample to ignite the fuel. With a heavier oil which has been topped—that is, has had the lighter oils distilled off—a higher compression may be necessary to ignite the fuel charge.

Economic Value of Coal—II.[*] Calorific Value and Relative Plant Economy with Coal as Fuel

By B. S. MURPHY
Superintendent of Power, Hudson & Manhattan Railroad

The value of a coal depends not upon its total B.t.u. content, but upon the available heat above a minimum. This minimum is determined by the characteristics of each plant.

THE only reason for using coal under a steam boiler is to convert heat into useful work, so it is of the utmost importance that there is heat available, and, as a general rule, the more heat the better the efficiency in this transformation. Broadly speaking, the heat element in coal is the carbon, and we can expect to get but little more heat from a pound of coal than from a pound of carbon, or, say, 14,500 B.t.u. A pound of fuel contains a varying amount of impurities, depending on the kind of coal, location, method of mining and treatment; and as the major portion of the impurities are incombustible, the greater the quantity in one pound of coal the less the carbon, and consequently the heat in the coal is reduced or the calorific value is lower. Again, as will be taken up later, not only the bulk of these impurities but their characteristics will influence to a great degree the removal of the heat from the carbon or combustible portion, for of necessity, if the carbon for any reason is not consumed, this unconsumed portion is of no more value for heat generation than if it were an incombustible; so any impurity that will prevent the combustion of this carbon will reduce the effective heat value in the boiler furnace.

Laboratory Tests of Coal

It is of primary importance to make laboratory tests for the heat content, but this does not tell us how the fuel will behave under actual furnace conditions. For instance, in an anthracite stoker plant that ordinarily uses No. 3 buckwheat as its regular fuel, the supply became low due to rail congestion, and in order to tide over, a few cars of No. 1 buckwheat were borrowed. The regular No. 3 at that time was running about 10,800 B.t.u. to possibly 10,900 B.t.u. on a wet basis and was not considered very good fuel. The borrowed No. 1 was considered by the owner as an excellent coal for his purpose—being used under marine boilers in river vessels—and had a calorific value of about 12,000 B.t.u. On account of the emergency no special preparation could be made, nor was it really thought of.

The boilers of this station had to be operated at over 200 per cent rating during the peak hour to meet the demand, and of necessity this required very high furnace temperatures. The coal started going to the grates at about the beginning of the peak, first in a few boilers and, as it was being elevated all the while, soon to all of them. The stoker operators lowered their grates somewhat to thin out the fuel bed and shut off a little on their air, but soon the whole surface of the grates was one large fused mass of coke and ashes. More wind was applied, gates shut down still more and hand slicing attempted, but it was of no use. The steam continued to fall, and it was finally necessary to push this clinker off the grates with levelers and build up new fires by hand with soft coal and some No. 3 before conditions were restored to normal. The fireroom crew claimed that the coal had no heat, but on the contrary, it actually contained more than they were used to, with the result that the temperature was so high under the forced conditions that the ash melted and fused. Still this particular coal, as normally used with hand-firing and with normal rating, would have been considered excellent. All this has been discussed to attempt to show that while the determination of the heat content by laboratory means is necessary and that it is safe to insist on high calorific-value coal, this is not the only criterion.

Effective Heat Range

In the discussion of the heating value of coals it is usual to compare the heat contents of the coals directly. This is most fallacious and should be guarded against. It is common to hear in a discussion of the bituminous-coal situation that the coal has fallen off from 14,000 B.t.u. to 13,500 B.t.u., or 3.6 per cent; but when it is attempted to harmonize this 3.6 per cent loss in calorific value with an increase in coal consumption of from 2.5 lb. to 2.8 lb. per kw., something is found to be amiss. Now any such argument as the foregoing is manifestly wrong, for, taking the extreme conditions, coal of 5,000 B.t.u. could not be used to make steam in a power station, as there would not be grate area enough to burn a sufficient quantity to give the heat desired, though this would only be a loss of 64 per cent from 14,000 B.t.u. coal. On the face of it we might consider that if, in place of operating our boilers at 200 per cent, we could tide over with such a coal by possibly getting 90 to 100 per cent rating from them, though from an operating standpoint we know that this is physically impossible. Therefore we must compare coals by their calorific values, not directly, but by the variation through the effective range.

It follows that in any discussion on the relative calorific value of a coal for a particular installation we must first determine the effective range, or the high and low limits of heat content. This will be for the high limit the best coal that we can expect to purchase irrespective of the price, and for the low limit the poorest coal that can be used to get the desired rating from the boiler plant, again irrespective of the price. The high limit must not be influenced by the price per ton, for it may or may not be economical to use the more costly coal. The low limit is more complex; here the location of the plant and existing equipment in the case of an old plant, or the location and the extra first cost of the new one, will be the guides.

In most small industrial plants of, say, 1,000 b.hp. enough boiler capacity is usually installed so that it is far from customary to work the units to their limit. In such a case it may be possible to have a rather wide effective range by not forcing the boilers to a high rating. But in modern central stations the boilers are usually expected to be, and the number installed is such that they must be, operated at about their ultimate capacity, with very few spare units, under normal conditions. A very low limit would, then, be out of the question on account of lack of grate surface to burn the additional quantity of coal required.

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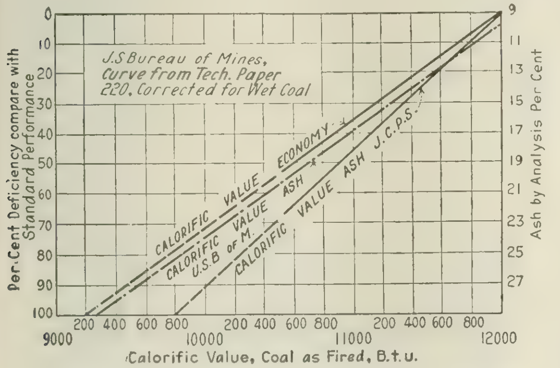
[*] For first article see *Power*, Dec. 7, 1920.

Again, for new installations, the location would play a very important part in this determination. If the station is to be located where eventually all stations will be, that is, close to the fuel supply, it would be good practice to install enough additional boilers to use the poorer but much cheaper coal. But if the station is in the city, where floor space is extremely valuable and where at least one-half of the first cost of the fuel is freight, then from both a standpoint of capital invested and of operating fuel costs, the effective range will not be as great. It, therefore, simmers down to the fact that every plant must have its own effective range. For existing bituminous electric plants in the East this high limit will be about 14,000 B.t.u. as received and the low limit 11,000 B.t.u., while for stoker-operated anthracite stations the effective range may be considered as extending from 9,000 to 12,000 B.t.u., giving about 3,000 B.t.u. range for each. With smaller, hand-operated plants using hard coal, this low limit is much too low, for as a rule sufficient draft equipment is not available and it is extremely difficult to procure firemen who can or will use this poorer fuel.



CALORIFIC VALUE VS. RELATIVE PLANT ECONOMY

Calorific Value of Coal

From a large anthracite station the results of some six years were taken and plotted by months for the pounds of coal per kilowatt-hour against the calorific value of the coal as fired, and though this station had, fortunately, never to use the low limit of 9,000, a prolongation of the curve showed that this tentative figure was essentially correct. Also, plotting the ash or impurities in this same manner against the calorific value showed again that the low limit was about 9,000 B.t.u. In the figure this curve has been given. The "Calorific Value—Economy" curve is an average of the actual results as found, and this extends to 10,600 B.t.u., or the lowest monthly average that was found, though individual coals run considerably lower. The balance, or the dash line, is the prolongation at the same inclination, and this reaches zero at 9,200 B.t.u.

By the relative plant economy is meant the working efficiency of the fuel under discussion when compared with a coal giving standard performance. The curves are drawn showing the relation of the calorific value of a coal and its relative plant economy in terms of the deficiency in the plant economy when compared with standard performance. This deficiency, in other words, represents the additional fuel that must be fired to secure evaporation equal to standard-performance coal.

For example, if the station is such that with 12,000 B.t.u. coal, or 100 per cent standard performance, a kilowatt-hour of output can be produced for 3 lb. of coal, then with another coal containing 10,600 B.t.u. we will find 50 per cent deficiency, or one and one-half times more coal will have to be burned to produce the kilowatt-hour of output; or, as assumed, 3 times 1.5 equals 4.5 lb. per kilowatt-hour. Now if the total-heat-content method was used to compare these two coals, there would only be an apparent loss of 12 per cent, or this coal would have 88 per cent efficiency in heat value, which will be equivalent to a permissible increase of from 3 lb. to 3.36 lb. per kilowatt-hour; but experience will soon show the fallacy of such a calculation.

This curve is extremely valuable with varying grades of coal, as it acts as a check not only on the whole boiler room, but also on the whole power station, for it is essentially correct in its upper end at least. Below 10,000 B.t.u. it really should be modified to meet conditions in each plant, for lack of heat and high ash would be too much for most boiler plants to overcome; but above this it may be used in safety for any ordinary installation. For each station, however, another curve should be made so as to plot the actual consumption per kilowatt-hour against the calorific value based on the station's record of performance.

Calorific Value and Ash Content

The other two lines on the graph give the relation between the calorific value and the ash content as determined by analysis. The line marked "J.C.P.S." has been determined by records extending over six years at the Jersey City power station of the Hudson & Manhattan Railroad Co. This has been plotted for the range of coal encountered there, or from 12,000 B.t.u. to 10,600 B.t.u. by months. This shows how rapidly the calorific value falls off with the greater ash content; the dash-line projection of this curve goes to 9,800 B.t.u. for 29 per cent of ash. They recently had an individual analysis that gave 9,396 B.t.u. as received, and this coal contained 30.7 per cent of ash by analysis, showing that the assumption, arrived at first independently and then by prolongation of a curve plotted from known values, was not far out.

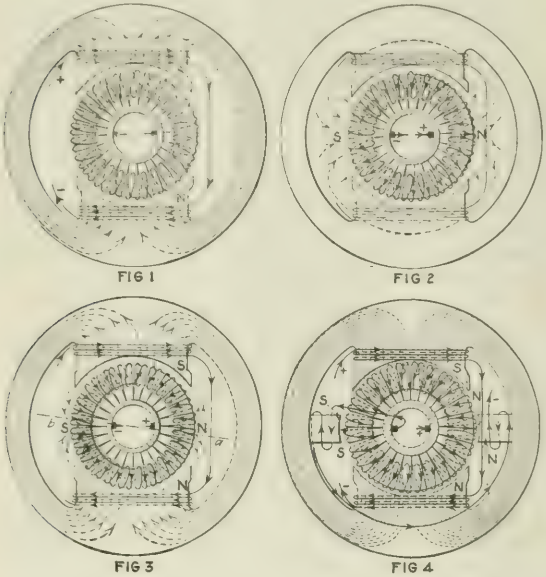
The line marked "U.S.B. of M." has been plotted from data given in the United States Bureau of Mines' technical paper No. 220 in 1919. In this paper the graph was plotted on a dry basis, but to make it comparable with the other data we have converted it to coal as received by taking an average moisture content of 7.25 per cent, which is about a mean value for moisture in No. 3 buckwheat coal. The curve from the Jersey City power station was plotted somewhat before the Bureau of Mines' data was published, and apparently these results show a somewhat more rapid loss in calorific value than the former, but lie very close to one another. It is also very nearly parallel and close to the "Calorific Value—Economy" curve, hence the ash content bears a marked relation to the unit of output.

Direct-Current Motors—Interpole Machines

By B. A. Briggs

Distorting of the field from the main poles is caused by the cross-magnetizing effect of the armature poles, and as a result the neutral points are shifted and sparking at the brushes results. This effect can be prevented by the use of interpoles, and connection diagrams are given for series-, shunt- and compound-interpole machines.

In all direct-current machines the armature is an electromagnet with its north and south poles just as the field poles are. Theoretically, the armature poles should be located midway between the polepieces, but owing to the reaction between the two sets of poles the armature's neutral is caused to shift against the direction of rotation in a motor and with the direction of rotation in a generator. This shifting of the armature's neutral is one of the causes of sparking at the brushes in the simple types of direct-current machines and will be made clear in the following discussion:



FIGS. 1 TO 4. FLUX DISTRIBUTION IN DIRECT-CURRENT MACHINES

In Fig. 1 is shown a schematic diagram of a direct-current machine having a ring-wound armature. If current is sent through the field coils, a magnetic field will be set up which will be uniformly distributed as in the figure. Leaving the field poles dead and passing current through the armature only with the brushes set midway between the polepieces, will cause magnetic poles to be produced in the armature midway between the main poles, as indicated in Fig. 2. The lines of force will be distributed similarly to that shown in the figure. The armature poles are really the resultant of two north and the two south poles. In following the direction of the current through the two halves of the armature winding an *N* and a *S* pole are produced in the upper half of the armature, likewise in the lower half. The *N* poles are produced on the right-hand side and the *S* poles on the left. This brings two like poles together at each brush; these poles repel each other, with the result that the lines of force tend to distribute as in the figure.

Comparing Fig. 1 with Fig. 2, it will be seen that the magnetic field set up by the armature is at right angles to that of the field poles. When current flows through the armature and field coils at the same time, as in Fig. 3, the *N* pole of the armature will repel that of the field poles and attract the *S* pole. Likewise the *S* pole of the armature will repel the main *S* pole and attract the *N* pole, with the result that, instead of the lines of force being uniformly distributed as in Fig. 1, the field will be distorted as in Fig. 3; that is, the lines of force are pushed away from one pole tip over onto the other. This action will vary with the load on the machine. If the load is small, the current in the armature is at a low value, the field poles of the armature will be weak and have very little effect upon the main poles, consequently the line of force from the latter will be nearly uniformly distributed, as in Fig. 1. However, as the load comes on, the magnetic field of the armature will increase and its effect to distort the lines of force from the main poles will be increased. Therefore, with a varying load on the motor the distribution of the field from the main poles will be changing. With the flux uniformly distributed, as in Fig. 1, the correct position of the brushes would be as indicated

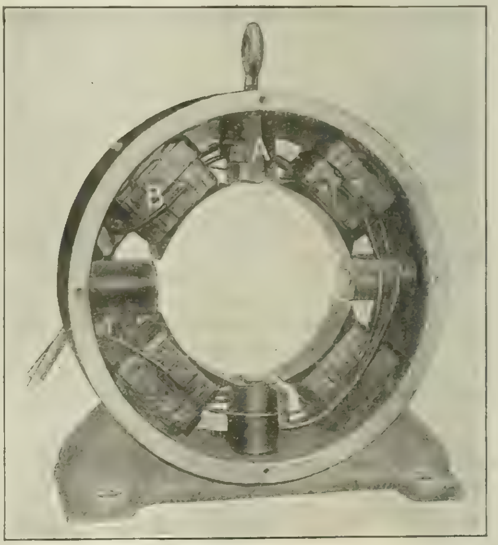


FIG. 5. FIELD FRAME WITH INTERPOLE FOR EACH MAIN POLE

in the figure, or what is known as the neutral point. When the motor is loaded as in Fig. 3, the neutral point has shifted to some position such as indicated by *ab* due to the distorting effect of the armature poles. Consequently, the correct position of the brushes is not as shown in the figure, but on the line *ab*. From this it is seen that on the simple type of direct-current motor the neutral point shifts with the load, and this is one of the reasons for sparking at the brushes with changing loads on the machine.

To prevent this shifting of the neutral point or to at least hold a magnetic field at this position where the brushes are located, to assist in commutating an additional set of poles is frequently used in modern direct-current machines. These consist of a small pole called an interpole or commutating pole, located in between the main poles with a low-resistance winding connected in series with the armature as in Fig. 4. These poles are magnetized the same polarity as the armature poles, as indicated, and if of the same strength they will neutralize the effect of the armature poles and the neutral will remain in a fixed position. Since they are connected in series with the armature, the strength of their magnetic fields will vary as those of the armature. At light loads the current in the armature and interpole windings will be small, consequently the field poles of each will be weak. As the load increases, the current through the armature and interpole windings increases, likewise the strength of the field poles of both; consequently, if the interpoles are properly designed, they will neutralize the effect of the armature pole at all loads from no load to full load, making it possible to obtain sparkless commutation throughout the whole load range of the motor with the brushes in a fixed position.

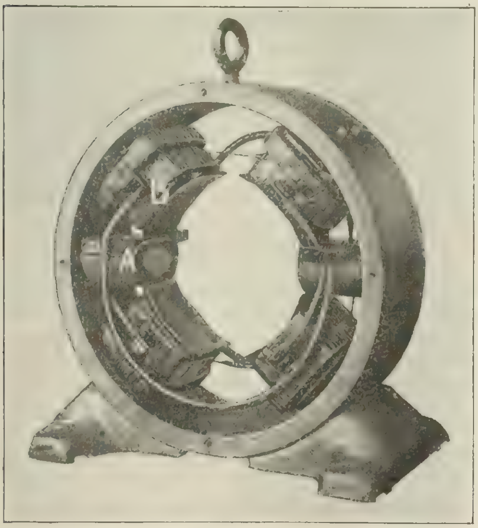


FIG. 6. FIELD FRAME WITH INTERPOLE FOR EACH PAIR OF MAIN POLES

An interpole for each main pole in the motor may be used, as in Fig. 5, *B* being the main poles and *A* the interpoles. However, to reduce the cost of construction, sometimes only one interpole is used for each pair of main poles, Fig. 6. In this case it is essential that the interpoles be so located that they are all the same polarity; that is, in Fig. 6 they would either be two north poles or two south poles. But the best practice is to use an interpole for each main pole, and this is adhered to in a large percentage of cases, especially on medium-sized and large motors.

Interpoles are used on all three types of direct-current machines—series, shunt and compound—although as far as the external connections are concerned, the addition of the interpoles to the machine does not in any way complicate the connections over those for the simple types without interpoles. In Fig. 7 are shown the connections for a four-pole series motor with interpoles, to be started from a manual-type starting box. These are the same as for the simple type of machine. On the shunt-interpole type only four leads are brought outside the motor and the connections to a manual-type starter are made as in Fig. 8. If it was desired to reverse the motor, the connection at the armature terminals would be interchanged, which would reverse the direction of the current through the armature and the interpole windings. This is exactly as it should be,

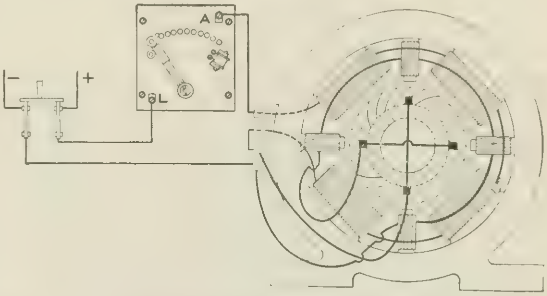


FIG. 7. CONNECTIONS FOR SERIES-INTERPOLE MOTOR TO STARTING BOX

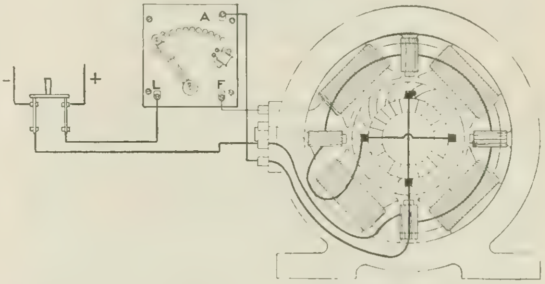
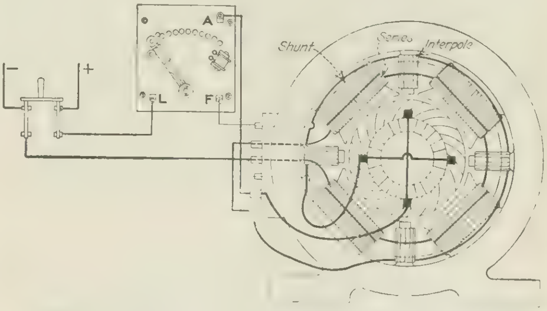


FIG. 8. CONNECTIONS FOR SHUNT-INTERPOLE MOTOR TO STARTING BOX



IG. 9. CONNECTIONS FOR COMPOUND-INTERPOLE MOTOR TO STARTING BOX

since if the direction of the current through the armature is reversed, the polarity is reversed, and if the interpoles are to remain the same polarity as the armature, the current through this winding must also be reversed.

In the compound-wound interpole machine the interpole winding is connected in the circuit between the armature and series winding. The connections to a manual-type starter are given in Fig. 9. It will be seen that, externally, these are the same as for a compound machine without interpoles. To reverse the direction of rotation of the motor, all that is necessary is to interchange the conections on the interpole and armature terminals outside the machine. This will reverse the direction of the current through the armature and interpole windings as in the shunt machine. From the foregoing it is evident that the connections of interpole machines to their starting device are the same as for those without interpoles.

(*The next article will discuss the compensated type of direct-current machines.*)

The Pressure Injection and the Air Injection Oil Engines

By Hermann Shultz

It is indeed surprising, in view of the wonderful strides that have been taken in Europe in the development of the Diesel motor, to discover the amount of experimenting being given to the principle of pressure injection in England and America. In using the term pressure injections, the writer intends it to cover all designs of the internal-combustion oil motor where the oil is introduced into the working cylinder without the employment of injection air and with the aid of a pump. As has been stated, it is surprising, in fact rather bewildering, to see the attempts made to secure Diesel-motor efficiency with pressure injection. In truth one is compelled to speculate more or less if the designers of these latter types of motors really understood the process of combustion occurring in the cylinder of the gas motor, or rather, oil engine. Surely if the processes of vaporization or gasification, ignition and combustion were fully appreciated, hope that the pressure injection or, as the Americans term it, solid injection would show an economy anyways near the Diesel motor would vanish.

It is no great achievement to design a pump that will force the oil fuels into the engine cylinder; nor, even if introduced most inefficiently, will the oil drops refuse to burn—although uneconomically. But to expect that this combustion is other than inefficient is too much.

Fuel Introduction

In considering any method of introducing the fuel oils into the engine, due study must be made of the processes going on during the spraying, and after the introduction has been accomplished. The fuel, whether it is paraffin, tar oil or one of the many oils that lie between these two in complexity of compound, must be introduced into the cylinder, next it must be gasified, then ignited, and finally complete combustion must take place.

With the usual injection of the Diesel motor the oil is broken up into drops averaging $\frac{1}{100}$ mm. (0.00039 in.) in diameter. These minute particles must be gasified and mixed with the correct amount of air to secure combustion. If these particles could remain in the cylinder indefinitely, complete gasification and union with the oxygen would take place, regardless of size of particles. The time interval of combustion is small. The length of time required for gasification and combustion depends, then, on the degree of separation that takes place during injection. If the drops are large, the gasification is but partly accomplished by the time self ignition in some parts of the gas vapors begins. The result is that the gasification is not complete when the normal period of combustion ends; the natural result is that the combustion continues along the entire power stroke—in fact, usually continues in the exhaust lines.

Fuel Atomization

In the design of the Diesel motor spray-valve modifications in the shape of the atomizing discs, etc., affect to a considerable extent the degree of fineness into which the oil is broken in entering the cylinder. It should be understood that the breaking up does not occur in the fuel valve. Here the air and oil are mixed, but the oil cannot be said to be separated into small particles until it enters the cylinder. The force of the blast air as it expands from 70 to 30 atmospheres effectually breaks up the oil into very minute particles. The inrush of the injection air gives rise to a turbulence of the air compressed in the combustion chamber; this whortling mixes the oil particles with the air, affording a very complete union. The air blast performs a greater service in the combustion chamber than in the spray valve. The amount of fuel injected into the cylinder has no effect on the process of combustion since the air blast effectually breaks up and mixes the low load charge as well as it does the full load charge.

Turning now to the pressure injection such as the Vickers, this engine uses an exceedingly heavy pump pressure to inject the oil into the cylinder. To maintain a rate of oil introduction equal to the Diesel motors, the opening in the flame plate must be made small—at about a ratio of 25 to 1, since no injection air is present to increase the volume. The smallness of this opening necessitates a high pump pressure of about 12,000 to 16,000 lb. per sq.in. It is difficult to keep up equipment with such pressures.

Cylinder Pressures

The plan is to use the high velocity of the oil to break it up. If this was possibly to do effectually, it would follow that the larger the cylinder the better would be the mixing. To the contrary, it has been the practice of these builders to keep the cylinder dimensions fairly small. A more important feature of the action of this type of injection is the high maximum pressures occurring at the moment of fuel admission. Frequently, the indicator cards show pressures several atmospheres higher than is usual in Diesel motors. Again, with heavy introductions of fuel, such as at full load, the pressure-injection engine smokes badly. During the war this was the chief criticism against the design. This feature is to be expected from a consideration of the events occurring in the cylinder. The spray of oil as it leaves the fuel valve cannot come into contact with the entire air charge in the cylinder. The direction of the spray must be toward a rather localized area. There is no expansive force to cause diffusion other than what might be termed the non-cohesiveness of the liquid. On low loads, then, most of the oil is fairly well broken up and gasified. On heavy loads only the outer portions are broken up, while the interior is fairly solid. This portion gasifies, but in so doing also goes through a chemical process, so-called "cracking," depositing some of the heavy hydrocarbons, since the gasification is slow and is not completed when ignition of the outer oil vapor starts. At the high temperature of combustion "cracking" always takes place. The engine then smokes on full load. That this inefficiency with heavy fuel charges is due to insufficient mixing of oil and air is proved by the clearness of the exhaust on light loads and the fairly sustained fuel consumption per brake horsepower on low loads notwithstanding the mechanical loss is constant.

The Vickers engine has a needle valve as is common with the true Diesel. The only elimination is the absence of the air compressor. The complication of the fuel-pumping mechanism more than offsets the advantage of the elimination of the compressor. In fact, it can hardly be denied that the engine is made more complex.

A number of engine builders have taken up the pressure injection without the use of a controlled fuel valve. This is, of course, but an improvement of the hot-ball engines such as the Bolinders and Petter, which have had pump fuel-injection systems from the first. That the pump method is fairly good for small engines cannot be denied if low efficiency is not objectionable. Some builders, notably Crossley & Co., realize the danger of defective mixing, so attempt to elongate the combustion chamber to give a greater spread to the oil jet. To obtain part of the turbulence achieved by the Diesel air blast, this concern makes the piston end cone shape, expecting the air rushing up along the cone to give a turbulence effect.

AMERICAN DESIGNS

Certain of the American engine builders have adopted the pump system, using two jets of oil. The design contemplates air turbulence being secured by the interference of the two sprays. On full load the body of the fuel gasifies slowly and "after-burning" occurs. On low loads the fuel mixture is better; so much so that if the air suction is not throttled to reduce the air charge and to retain some of the burnt gases from the previous explosions, violent preignition takes place. The early timing of the fuel admission, about 40 deg. early, often causes excessive pressures. It is by no means uncommon to observe pressures above 50 atmospheres. The excellent efficiencies shown by some of these engines on test are undoubtedly secured with a maximum explosive pressure well above 800 lb. In fact, it has been stated by at least one engine builder that the greatest difficulty was experienced in keeping the pressure within limits.

The action of a pump is by no means as rapid as a needle valve. The cessation of the oil spray into the cylinder is necessarily slow, and the lines may continue to leak.

The high pressures that occur preclude any lightening of the weight of the engine. Indeed the engine should be heavier. The air compressor is, of course, eliminated, but the pressures on the fuel pumps are so high that serious trouble will surely occur.

To an impartial person the conclusion is obvious. For small powers, probably 75 hp. per cylinder, the pressure injection, or the solid injection, as Americans call it, offers certain advantages where fuel consumption is not of primary importance. In large units the results obtained do not warrant claims of superiority over or even equality with the Diesel. Too many foreign firms, especially American and English, attempt to effect sales by building engines with radical features or unusual mechanism. No stress is made on the superiority of workmanship, to which feature the success of German Diesel builders is largely due.

Refrigeration Troubles

By Roland L. Tullis

A sudden drop of the suction or condenser pressure of an ammonia compression system is indicative of some sort of trouble, and the cause should be searched for immediately. If the plant is equipped with double-pipe brine coolers, the trouble may be caused by the brine-circulating pump losing its suction; or if the brine is circulated by a motor-driven pump, it may have blown a fuse and stopped. Stoppage of brine circulation in the coils naturally lowers the rate of ammonia vaporization, and the suction and condenser pressure will drop immediately. If the brine circulation is stopped for any length of time, the coils are liable to freeze up, the suction- and discharge-gas temperature will drop and the suction line will be likely to frost back more than usual.

An experienced operating engineer, by watching his gages and suction and discharge temperature, can tell pretty nearly whether the plant is operating properly or not. Good brine circulation through the coils is essential to economical operation.

The writer was once employed in a refrigeration plant which contained a number of double-pipe brine-cooling coils. One day one of the shift engineers rushed up to the chief and explained that the system was short of ammonia. The receiver was empty, temperatures were going up and the suction and condenser pressures gradually diminishing. The chief glanced at the gages, examined the receiver (which sure enough was empty) and shook his head. There had been plenty of ammonia a few hours previously, but somehow it had mysteriously disappeared. Then he happened to remember that early that morning they had cut one large brine cooler out of service. He remembered having ordered one of the helpers to close the stop valve and expansion valve on the coil.

Upon examination it was found that the stop valve was closed tight, but the expansion valve was only partly closed. In consequence practically the entire ammonia charge had leaked into the coil, where it was trapped. In such a case care must be exercised in opening the stop valve, as a slug of liquid may be thrown back into the compressor suction.

I know of a case where the operating engineer was attempting to pump the liquid out of an ice-cream hardening room. He had forgotten about the expansion valves being open, and the room temperature had dropped to between 15 and 20 deg. below zero. Then, when he shut off the expansion valves and attempted to pump the liquid out, the suction pressure naturally decreased and the temperature continued to drop. The more he pumped the lower the pressure dropped, and the temperature went down correspondingly; the liquid refused to vaporize on account of the low temperature. The engineer was having a time to get the liquid out of the coils and back into the receiver, where it belonged. Finally, he hit upon a bright idea, but it proved disastrous;

he opened the gate valve on an auxiliary line which connected with the suction of two large compressors. This threw a 22 lb back pressure from the big machines down into the hardening rooms. This brought the liquid out in a hurry, resulting in loosening the heads on two compressors and nearly knocking them off the foundation.

After all this is said and done, handling ammonia liquid or gas is somewhat of a tricky proposition. It requires experience, study and good judgment to handle it successfully.

The Protection of Motor Windings

BY GORDON FOX

In his article "Treatment of Direct Current Motors for Mining Conditions," which appeared in the Oct. 12 issue of *Power*, Mr. Arnold mentions the importance of keeping armatures and field coils well varnished. This cannot be too well emphasized. The cotton and other insulations commonly used in the make-up of coils serve largely as mechanical separators and as a medium for absorbing the varnish. The varnish acts as an insulator, a heat conductor, a binder and a protecting medium.

There are many qualities of varnish. So called "air-drying" varnish is most easily applied, but is less elastic and tends to crack and chip in time. Elasticity is important in maintaining a continuous covering without cracks and crevices in which dirt and moisture may lodge. Baking varnishes have greater elasticity and are more effective. Clear baking varnish is the best, but is slow-drying and hardest to apply. The slower-drying the varnish the better the ultimate job.

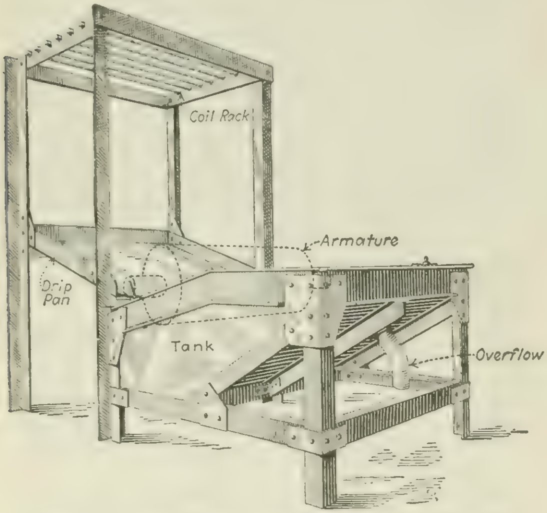


FIG. 1. INSULATING COMPOUND DIPPING TANK

The dipping tank shown by Mr. Arnold has many commendable features. Another type of tank used for dipping armatures and all kinds of coils is shown in Fig. 1. By adjusting the stop pins in the sloping upper edge, any size armature may be allowed to be submerged at the coils, yet the commutator and shaft are kept clean. A paper is wrapped about the commutator to keep off any drip. The armature is rotated slowly to submerge all the coils in the varnish. It is then rolled up the incline and allowed to drain while resting on the upper horizontal portion. A movable cross-member having a similar incline may be inserted for use with armatures having short shafts. A separate coil-drying rack can be moved in front of the tank so as to drain into it. Covers are provided to prevent excessive evaporation of the varnish in the tank. This equipment has proved very satisfactory in service.

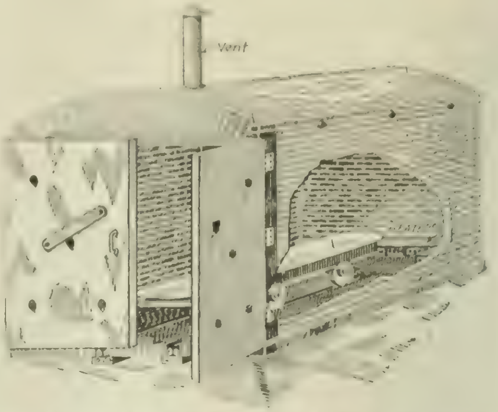


FIG. 2. OVEN FOR BAKING COILS AND ARMATURES

A small, brick drying oven is shown in Fig. 2. This is arranged to house a small car, which is rolled in after loading outside. The car is arranged to carry two large armatures, and a removable rack for coils may be attached to it. The oven is heated by grid resistors, several connections being afforded to govern the temperature. Openings are left at the bottom of the oven behind the grids for entry of air. The heated air passes out a small stack. A pipe inserted in the arch carries a thermometer for indicating the oven temperature. The doors are made up of angle frame covered with sheet steel on both sides, the space being filled with loose asbestos. The whole arrangement has worked out very well.

Dirt and moisture cause a very considerable proportion of motor failures. While varnish affords a measure of protection, dirt and moisture should be excluded from motors so far as possible. Totally inclosed motors such as mill-type and mine-type machines are more expensive in first cost, but their better service will usually justify the investment where unfavorable conditions must be met. Open-type motors should be provided with solid inclosing covers on the upper openings when located in dirty places. A little more heating is usually much less harmful than dirt. It must be realized that when coils are covered with dirt and ventilating slots are plugged, radiation of heat is not very effective.

It seldom pays to experiment with different engine oils. After a suitable lubricating oil is secured, continue to use it. All reputable refineries make Diesel lubricating oils that can be safely used. Some refineries have had much experience in the oil-engine field and can supply oil suitable for each particular make of engine.

Refrigeration Study Course—XIX
Applications of Refrigeration

By H. J. MACINTIRE
Professor of Refrigeration, University of Illinois, Urbana, Ill.

SOME thirty years ago mechanical refrigeration was used mainly in the brewery industry, but of late years the great advance, first of ice making, and then of cold storage (including the packing-house industry) had relegated the brewing total tonnage—even before the advent of adverse legislation—to secondary importance. However, there is now hardly any branch of engineering that is developing with the speed of refrigeration in variety of application and in the amount of sales. The chemical industries are paying more and more heed to the latent possibilities of mechanical cooling in their processes, as are also the engineers in almost every branch of work. The steel mill uses refrigeration in tempering and hardening, the oil refinery in separating out the paraffin, the oil and natural gas men utilize refrigeration to some extent in separating out the gasoline. The chemical industry, the baker, the candy maker and the miner use refrigeration to secure standard conditions—a cold water, cold air or a cold strata of earth. As an example of the extremity to which the industry is carried, it may be mentioned that the Haber process for fixation of atmospheric nitrogen is to form ammonia in a mixture of hydrogen and nitrogen by means of a special catalyst, and then to freeze the mixture to —20 deg. F. or lower until the ammonia is liquefied and separation may be secured by means of gravity and a modified trap. In making an analysis of the different kinds of applications of refrigeration, one will be surprised at their similarity. As just noted, it is nearly always the matter of the cooling of a fluid, liquid or a gas, which in turn does the work desired of it. However, there are a few other special applications which, because of their general use, are worthy of special mention. A few of these will be taken up in turn.

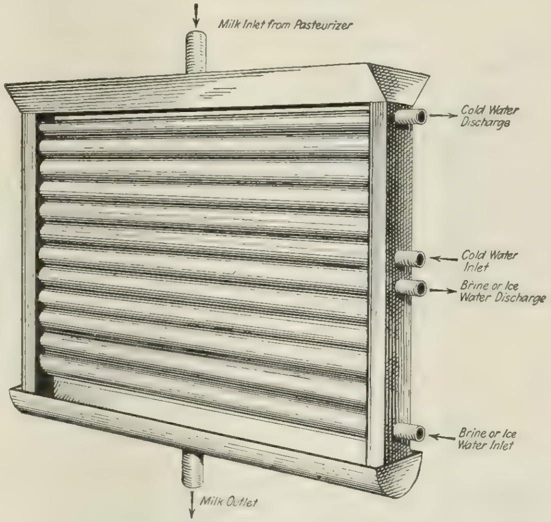


FIG. 1. THE BAUDALOT COOLER

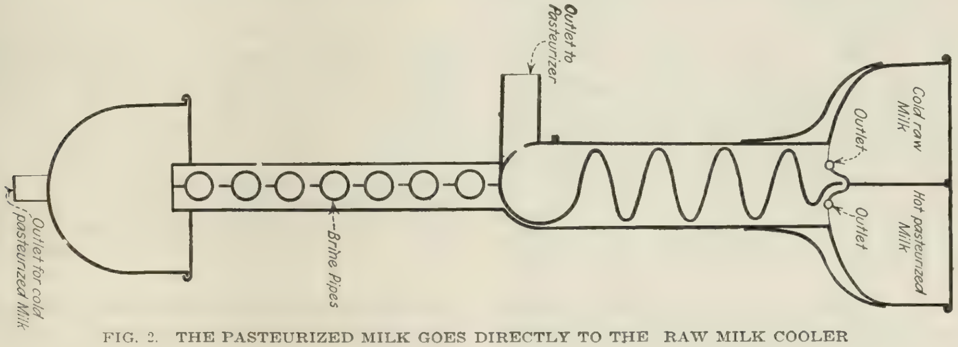


FIG. 2. THE PASTEURIZED MILK GOES DIRECTLY TO THE RAW MILK COOLER

The milk industry is an important one. It is a daily necessity, a food that cannot be dispensed with. In consequence of the distance from the source of supply the city milk trade is subject to a delay so that by the time it is ready to be served the milk may be 36 to 48 hours old. The result is that raw milk is frequently badly contaminated with bacilli of intestinal or lung variety, especially if the temperature of the milk is allowed to remain even for a short time at a temperature 60 or more deg. F. So to reduce the danger from disease the pasteurizing process has been perfected. This consists of either bringing up the milk temperature to 140 to 150 deg. F. and holding at that temperature for thirty minutes (the preferred method) or of raising the temperature to 160 to 165 deg. F. and maintaining this temperature for only one-half to one minute. After the pasteurizing process the temperature should be reduced to 35 to 45 deg. F. as quickly as it is practical. This cooling may be accomplished in either of two ways—first, by means of a regenerative apparatus, and second, by means of the old-style Baudalot cooler.

Assuming that the milk leaves the pasteurizer at about 140 deg. F., it would be sent to the regenerator as shown in one design by Fig. 1. The regenerator is a sort of counterflow exchanger. The raw milk is relatively cold and must be heated to 140 deg. F., and the pasteurized milk is at 140 deg. F. and must be cooled. By using a counter-current device, both of these may be accomplished easily and cheaply. The last portion of the work of cooling is by means of brine, reduced in temperature by means that are usual in mechanical refrigeration.

The second method is to pipe the pasteurized milk directly into the cooler. This cooler is usually made of block tin (for cleanliness) and is arranged so that the milk flows on the outside, being cooled first with water and then by brine. The refrigerating problem is a simple one, requiring brine of about 20 to 25 deg. F. The most important point is that the milk cooling after pasteurizing makes a heavy load, usually for a short part of the day only. It usually works out best to have a brine-storage tank of sufficient size to carry a large part of the load. In so doing the compressor may operate over a longer period of the day, and the machine may be a small one. The amount of refrigeration stored in the brine depends on the temperature rise of the brine. Assuming this to be 20 deg. F., the brine storage necessary to cool 1,000 gal. of milk from 80 to 40 deg. F. would be

$$\underset{\text{number gallons}}{1000} \times \underset{\text{lb per gallon}}{8.58} \times \underset{\text{temp range}}{40} \times \underset{\text{specific heat}}{0.9} = \text{vol.} \times \underset{\text{weight of cubic foot}}{62.5} \times$$

$$1.2 \times \underset{\text{specific heat}}{0.7} + \underset{\text{temp range}}{20} = 294 \text{ cu.ft.}$$

ICE CREAM MAKING

In ice making there is required frequently from 1.4 to 1.7 tons of refrigeration for 24 hours to produce a ton of ice. In other words, much more refrigeration has to be put into the manufacture of ice than it is possible to secure in cooling effect by the melting of the ice after it is made. The reason is that in ice making the water has to be cooled first to 32 deg. F., then frozen, and finally the ice cooled down to somewhere near the brine temperature. All this require (assuming 70 deg. water)

$$(70 - 32) + 144 + \frac{32 - 14}{2} = 191 \textit{ B.t.u. per lb. of ice.}$$

To this should be added the losses by radiation, conduction, etc., and the meltage and other losses in removing the ice from the cans and storing the cake in the storage rooms. The total input in heat units per pound net of ice is therefore from 210 to 230 B.t.u., from which only about 144 B.t.u. is usually available for refrigerating purposes. In ice making, therefore, it is necessary to cool the water, freeze the ice and finally cool the ice.

Ice-cream making is about the same kind of refrigerating work. About the only difference between ice making and ice-cream making is in the details of the operation. Ice cream, of course, is not frozen in a mold like can ice, but as a rather soft mush, after which it is placed in a container and allowed to cool to a solid condition in the hardening room. The refrigeration problem in ice-cream making is in the cooling of the cream, freezing into a plastic condition, and finally the hardening process, which is much like the cooling of can ice down to the temperature of the brine in the ice tank.

Calculations for the duty required are not as positive as in ice making, because the latent heat of fusion of the mixture of cream and the specific heat before and after freezing are not constant for all kinds of ice cream or ices. In general the mixture is usually placed in the freezer at about 50 deg. F. and the whipping of the cream is at about 26 deg. During the process of freezing the cream "swells" an amount from 50 to 100 per cent, although the amount is usually about 80 per cent. Using the latent heat of ice cream as 84 B.t.u. and the specific heat before and after freezing as 0.68 and 0.38 respectively, the refrigeration necessary to make 100 gal. of cream from a mixture at 50 deg. F. and cream at 0 deg. F. would be:

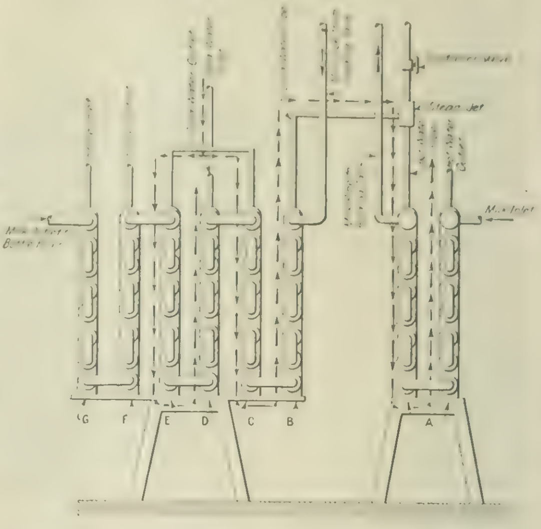


FIG. 3. DOUBLE-PIPE PASTEURIZER AND COOLER
Follow course of water and brine through the coils A, B, C, D, E, F and G.

$$\frac{100}{1.8} \times 8' \times 1.2 = 556 \textit{ lb. (weight of cream to be frozen}^{1}\textit{)}$$

$$\underset{\text{(Weight}}{(556} \times \underset{\text{specific heat}}{0.68} \times \underset{\text{temp range)}}{50 - 26)} + \underset{\text{(weight}}{(556} \times \underset{\text{latent heat of fusion}}{84)} +$$

$$\underset{\text{(weight}}{(556} \times \underset{\text{specific heat}}{0.38} \times \underset{\text{temp range)}}{26 - 0)} = 61{,}271 \text{ B.t.u.}$$

If, for example, this work was to be done in one hour, there would be required 61,260 ÷ 12,000 = 5.1 tons capacity. Of course there are the usual leakage losses to be taken into account as well as the ice for icing the deliveries and other incidentals still to be considered.

Mechanical efficiency is a term intended to express the ratio of indicated horsepower to that available for doing work. Brake horsepower divided by indicated horsepower gives the mechanical efficiency. For four-stroke-cycle Diesel engines the mechanical efficiency may be as high as 80 per cent or as low as 70 per cent of the indicated power. For two-stroke-cycle engines the mechanical efficiency is sometimes as high as 80 per cent of the indicated power.

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[1] Weight of cream depends on the swell and the specific gravity of the mixture.

How to Cut Belts Square

Although many articles relating to belt lacing, etc., have been published in *Power*, the instructions prepared by F. D. Rich for the Crescent Belt Fastener Co. contain some interesting information, which is published in part herewith.

Cutting the ends of a belt to put it into service seems such a simple thing that often the belt man does not give it the consideration necessary to insure the best results, and much of the difficulty with otherwise good belts is due to their not being cut and joined accurately. When one knows how, it is as easy to make a belt joint that will run the same as an endless one as it is to do it by careless rule-of-thumb methods. When a belt runs "wabbly" or races back and forth across the pulleys, it is not giving its best service nor can it have its longest life. If its ends are cut square and it is joined with care, it can be made to run as straight as an arrow if the pulleys are lined up true.

Don't guess at cutting your belt ends. Use a square always, and use it with care. If you do not use a square, one or both ends will be cut unevenly or irregularly, which prevents smooth running. Even the use of a straightedge does not assure the perfect results obtained by using a square, for the slip of a fraction of an inch will bring the belt ends together at an angle, as shown in Fig. 1.

This results in the belt "shimmying" on the pulleys, which is bad for the belt and impairs its service, for as it moves from side to side the line of direct pull *AB* moves from one side of the belt to the other, imposing shifting and irregular strains, which no belt can stand indefinitely.

There is only one way to assure correct results. That is to use a belt square and to keep it in place until you have cut all the way through the belt. Don't just scratch the surface and then hack through. Cutting to the square assures an even cut all the way through the belt and all the way across. It means that the ends can be brought together in a tight, butt, evenly running, flush joint.

For belts up to 15 or 18 in. wide an ordinary square may be used. Press it firmly against the edge of the belt and, when cutting, hold the knife vertically, as shown by Fig. 2.

Be sure your knife is sharp. Wet its point occasionally, as it cuts more easily when the blade is wet.

When a number of belts have to be cut, a good stunt is to drive two nails in a large block of wood, and against these set the edge of the belt and the edge of the square, as shown in Fig. 3. This prevents either the belt or the square from slipping. Some men tack a slip of leather or a piece of old belt on the end of the block to protect the point of the knife as it comes through the belt.

Wide belts are harder to square correctly, and the difficulty is often increased by slight variations in the width, which throws the square out. To avoid this and assure perfect results, the following method has proved the best.

At any point near where you are going to cut the belt, measure across and find the center, as at *AA*, Fig. 4. At any distance back of this, say two or three feet, find the center again, as at *BB*. Between these two center points draw a clean, sharp line. This marks the center axis of the belt. Then, as shown by Fig. 5, using the square against the center line, trim off the end of the belt, holding the square firmly in position while you cut all the way through. Two small nails driven in on the center line will keep the square from slipping.

For cutting the other end of the belt find the center line as just described. Then, at any point on this line other than where your belt clamps will come, take a point *C*, as in Fig. 5, and using the square as illustrated, draw a line *DCE* at right angles to the axis and all the way across from edge to edge. It is sometimes easier to draw this line by marking the points *D* and *E* and then placing a straightedge through the points *D*, *C* and *E* (see Fig. 6). Be sure that the straightedge *is straight*, not warped. This line *DCE* will constitute a "base line" to measure from after the belt is in the clamps. Do not cut on this line.

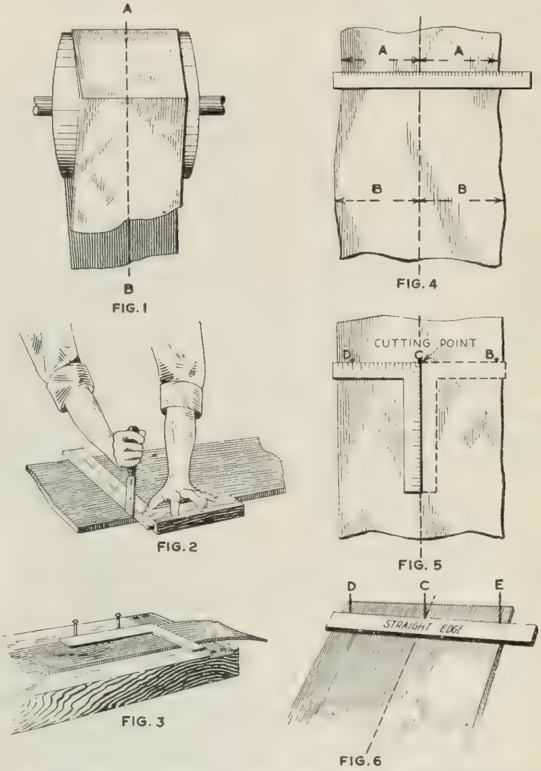


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIGS. 1 TO 6. DETAILS FOR CUTTING BELTS SQUARE

Fig. 1—A belt joined this way cannot run true. Fig. 2—Hold square tightly against the edge and cut all the way through the belt. Fig. 3—Simple "stunt" makes square cutting easy and positive. Fig. 4—Finding the center by measuring in from the edges of the belt. Fig. 5—Using square from the center line. Fig. 6—On wide belts use a straightedge when a large square is not at hand.

You can determine exactly where you want to cut after the clamps have been put on and the belt brought into position. Then measure forward from the line *DE* an equal distance on each side of the belt to the cutting point. You can use calipers and measure over the belt clamp or run your ruler through the edges of the clamp. As a matter of convenience always cut one end of the belt square and get it ready for making the joint before putting the belt into the clamp. Regardless of whatever method of joint is used, the belt should always be cut square, so that it may exert a straight-line pull.

Willis Lawrence

The Man Who Is Responsible for Generation of the Power That Drives Most of New York's Transit Facilities

RUSHING along at forty miles an hour on the subway trains of the Interborough Rapid Transit Co., one's thoughts quite easily turn to the source of all this power—to the great machines that produce it and the men that guide and control it. That is Willis Lawrence's job—the operation and maintenance of all the power houses in the Interborough system of subway and elevated lines and the four New York Railway power stations, which drive the surface cars. Like most men who have developed the ability to "get things done," his beginning in life was comparatively humble, though he is a descendant of Revolutionary and Puritan forbears. He was born in 1868 at the old Lawrence home in Cold Springs, N. Y. He went through the public schools with the intention of later attending Cornell, but a desire for practical experience, coupled with limited finances, caused him, instead, to go to work on neighboring farms. After the young man had been at this work for five years his opportunity came, and he was not slow in grasping it. Learning that a large stone-crushing plant was to be built at Storm King, two miles from his native village, he went to the contractors and began his engineering career by taking a job with them as a laborer. His natural mechanical ability was recognized here, and he was made oiler, machinist, engineer and finally foreman of repairs. Later, he refused the position of chief engineer and went to Weehawken, N. J., in 1890, to assist in the construction of another large crusher plant, of which he became chief engineer when it was completed. In 1894, the ice making field seeming to offer big possibilities, Mr. Lawrence went with the New York Ice Co., which was at that time remodeling one of its ice stations at East One Hundred Sixteenth Street. Here he was appointed assistant engineer, and when the plant went into operation in the early summer, he was made chief engineer. Late in 1898 he was transferred to the East Eighteenth Street plant to remodel it and take charge as soon as it was in operation. He remained in this position until January, 1902, when he began his career in the railway power houses. At this time, it will be remembered, important developments were being made in the design of power houses. Edwin Reynolds had some time before been hurriedly called upon by the Interborough Rapid Transit Co. to design for it the engines which will forever remain famous, not only as the Manhattan type, but as those which, like the giant redwoods of California, were the last of their kind. Here, in this new field, in a plant where all the great advances in the power-house art were being for the first time applied, Mr. Lawrence was employed as a machinist and assistant operating engineer. One gets an idea of how he must have fitted into the scheme of things from the fact that, after but a year on this job, he was made first assistant mechanical engineer. In May, 1904, he was made mechanical engineer; three years later he was given the position of mechanical engineer of both the Manhattan power houses and the subway power house, and in March, 1912, he became mechanical engineer of the Manhattan and Subway Division and the New York R.R. power stations. The latter consisted of the Ninety-Sixth Street and the Houston Street and Lexington Avenue power houses. It is a tribute to the man's ability that back in 1914 when these great 12,000-hp. Manhattan-type reciprocating engines, after 18 years of hard operation, were to be discarded and replaced by turbines, they were found to be in really better mechanical condition than a year after they were installed.

WILLIS LAWRENCE

While economical performance is largely a matter of design, it must be remembered that attention to operation and to maintenance plays its part. This work was up to Lawrence, and his success in handling it is perhaps best attested by the fact that for economical performance the combined reciprocating-engine low-pressure units at the Fifty-Ninth Street power house long stood unequaled.

EDITORIALS

A Western Achievement

AT THIS time, when so much attention is being centered upon the development of our water powers, the leading article in this issue, "Kerckhoff Power Development—a Western Achievement," is of particular interest. Although in size this undertaking does not rank with many others made in various part of the country, when measured in the period required to complete the work and the difficulties encountered, it is easily entitled to a place alongside our foremost hydro-electric engineering achievements. It is one thing to build a plant in a region accessible by railway and good highways and an entirely different undertaking in a rugged mountainous country seventeen miles from the nearest railroad and requiring the construction and maintenance of highways for the transportation of all materials and equipment. In the East we have become accustomed to thinking of hydro-electric plants being built where there is an actual waterfall. On the Pacific, although falls do exist, many of the sites for such plants are only rapids in the river. A dam is built near the head of the rapids and an open ditch or tunnel run from above the dam to a point down the river where the most economical head is obtained. The Kerckhoff power plant is one of these developments, and required the construction of not only a dam, but also a tunnel eighteen feet square and over three miles long, cut in solid granite.

Although the generators and turbines to a large degree conform to what may be considered standard practice, the waterwheel-driven exciters without a governor and mounting a compound-wound generator on the exciter shaft to supply current for operating oil switches, et cetera, are a departure from the standard. It is well known that the load on an exciter is practically constant, and as a result the wear on the governor parts is only within a very small part of the load range, and if the governor is called upon to meet an emergency, it is very likely to fail. An attempt in the Kerckhoff plant has been made to overcome this by putting the exciter's waterwheels directly under the control of the operator and by designing the exciters so that they will have a tendency to load up the waterwheel at excessive speeds. Making the source of control current independent of the exciter, although driven by the same turbine, allows the selection of the most efficient voltage for excitation and also for the control circuits. It also insures current being available to operate switches, et cetera, in an emergency where the exciter may fail.

One feature that stands out very prominently in making the efficiency tests on this plant is the vast amount of preparation necessary. When it is considered that at the present time machines of three times the capacity of the Kerckhoff machines are under construction, to operate under a somewhat lower head, it is evident there is a pressing need for some simpler means of making tests on hydraulic turbines. Fortunately, a device is already far enough along in its development to indicate that in the near future the testing of hydraulic turbines will be a comparatively simple operation.

An interesting feature in connection with the study of the topography of the country in which this power site is located was the use of an airplane. This was the first time an airplane had been used for such work, and it was so successful that it is now being employed in reconnaissance survey work in other power projects. Apparently, in the not distant future, such surveys will be considered an important part of hydraulic developments, especially in mountainous districts that are difficult of access.

What is the Present Equivalent of $2,500 in 1848?

THE salaries of the examiners in the United States Patent Office were fixed in 1848 at $2,500 per year. At that time this was a good salary. It was as much as a member of Congress or a United States District Judge got, and one-half as much as was paid to the Chief Justice of the Supreme Court. Today the justice receives $15,000, the Congressman $7,500, but the pittance of the examiner has been increased in all these years only some ten per cent, while in relative value and purchasing power it has been more than cut in two.

This is the amount paid to the primary examiners. It has to be worked up to, and is the highest attainable unless one gets to be Commissioner or one of the half dozen higher officers. The lower lights among the examiners get less, and yet to be eligible they must be graduates of technical schools or have an equivalent education. Their duties lead to a knowledge of patent law and a comprehensive acquaintance with the details of the arts or classes of inventions upon which they specialize, which makes them valuable to industry, and twenty-five per cent of them resign every year to accept more remunerative positions outside. The present force is inadequate, and the salary offered does not attract and hold the kind of men that should be trusted with the important issues which a patent examiner decides, for in most cases he is the deciding authority. The result is delay and inefficiency, which cost the industries of the nation much more than the appropriation for adequate and efficient service would amount to.

In his perplexity the Commissioner of Patents has appealed to the engineer, and the National Research Council, Engineering Council and numerous other engineering, scientific and industrial organizations have urged their members, as we urge our readers, to write their Congressmen and Senators, especially Senator George W. Norris, chairman of the Joint Patent Committee, soliciting their favorable consideration of the increase in salaries and staff proposed in the Nolan Patent Office Bill H. R. No. 11,984 without reduction or riders. The present income derived by the Patent office from applications for patents meets all the expenses of the office, and the increase in salaries will not come from the taxpayers, but is provided for by an increase in the fees for patents. This gives an added reason why the Government should be anxious to give inventors the best service possible.

What Is Wrought Pipe?

ONE would naturally suppose that when he specified "wrought-iron pipe" he would get, or at least be entitled to, pipe made of wrought iron. Steel pipe is commonly known and billed, however, as "wrought pipe," and jobbers and contractors are prone to install steel pipe instead of the more expensive wrought-iron material when the latter is specified, and are able to get away with it in court on the plea that "wrought-iron pipe" is a trade term meaning either wrought-iron or steel pipe as distinguished from cast-iron pipe.

In order that there may be on record an authoritative utterance upon this subject, the Executive Committee and Advisory Board of the National Pipe and Supplies Association has forcibly called attention to the distinction made by the American Society for Testing Materials in the following resolution:

> Whereas, The distributors of pipe for many years used terms to designate the various types and makes of pipe that have not been duly descriptive of same; and
>
> Whereas, It is the desire of this association to co-operate in every way with the manufacturers in the development of trade practices and customs of accepted merit, and which will be fair and intelligible to the manufacturer, distributor and public alike;
>
> It Is Hereby Resolved, By the officers and members of the Executive Committee and Advisory Board of the National Pipe and Supplies Association in their fall meeting, held in New York City on Thursday, Nov. 11, that it is their judgment that the terms employed by the American Society for Testing Materials in differentiating between Iron and Steel Pipe—namely: (a) Welded Wrought-Iron Pipe; (b) Welded Steel Pipe—should be accepted and adhered to by the distributors of both iron and steel pipe, this being in the interest of the manufacturers of the pipe, those who distribute it and those who use it, each being entitled to know clearly and without doubt the make and quality of the pipe involved in the transaction.

This means, if it means anything, that welded pipe is pipe that is welded no matter what it is made of; that welded steel pipe is pipe that is made by welding steel; that welded wrought-iron pipe is pipe that is made of wrought iron by the welding process and that "wrought-iron pipe" is pipe that is made of wrought iron whatever the process of manufacture.

Safety-Valve Outlets

A FURTHER thought—brought out of one of our readers, too modest to advance it himself, by our recent editorial on "Safety Valve Outlets."

He says that in the good old days in New England, previous to the war, all real boiler makers placed on each end of the boiler a good-sized steam outlet, fitted with a forged steel nozzle. Each nozzle was large enough to discharge all the steam the boiler could make. One of them was connected to the steam main, and the safety valve was mounted upon the other. When two valves were required, a Y-base connection was used. The steam could be taken off front or back according to conditions or the user's fancy.

If such construction were required it would obviate difficulties like those which arose in Ohio and which called out the editorial in question. In that case a boiler maker fitted a seventy-two-inch boiler with a reinforcement pad for a two and one-half-inch safety valve and a tapped hole for another one and one-half inches in diameter and got away with it because there are specially high-lift safety valves made in those diameters that will discharge five pounds of steam per hour for each square foot of heating surface that the boiler contained. The Ohio Board of Boiler Rules has since adopted the following:

> Safety valves of high relieving capacities which meet the requirements of the 1918 edition of the American Society of Mechanical Engineers' Boiler Code may be used on fire tube boilers, provided the bases of such valves, either screwed or flanged, are cast as an integral part of the valve body and the bases are made to correspond to the sizes required for the intermediate lifts and corresponding relieving capacities given in Table 15, appendix, 1918 edition of the A. S. M. E. Boiler Code.

The A. S. M. E. Code will have to be revised to preclude a boiler maker from providing a safety valve opening large enough only for a maximum-lift valve. Such an opening is a standing invitation for the mounting of an inadequate safety valve, for the ordinary man would put on an ordinary valve of the size that the opening called for. Only the specialist or the inspector would know that a high-lift valve was the only one that would do, and that the owner was committed to the use of that type when he bought the boiler.

Neither the A. S. M. E. committee nor the Ohio Board of Boiler Rules would be warranted in prescribing that all boilers should be provided with the two similar nozzles fore and aft suggested by our commentator, but purchasers can specify them and it is a good thing to do. If the boiler maker objects because more than one safety valve is required, tell him that you will use a yoke or Y connection.

High Capacities in the Average Plant

IN THE power plant high capacity has been considered desirable, as supposedly it goes hand in hand with economy and brings a greater return on the investment. In the ordinary plant capacities of from twenty-five to forty per cent over rating have shown encouraging results. Central stations are in the habit of running up to two hundred per cent of rating and above, and this has led engineers in industrial establishments to follow the same practice, which in numerous cases has resulted to their disadvantage.

High capacity necessarily means high-class operation, and this is not always possible in the average plant. When operating at much over rating, it is necessary to be assured of the cleanest of feed water, such as is obtained in surface condensing installations, the use of raw water under these conditions often being disastrous from the standpoint of boiler maintenance. Draft and other conditions affecting the furnace must necessarily be the most favorable. As a matter of fact, the ordinary industrial plant is not yet ready for the capacities obtained in central-station practice. It is better to operate such a plant at a conservative rating, decreasing the amount of attendance required, repairs and depreciation. High-speed duty is something that must be accompanied by high-speed operating conditions, and these are not generally found in manufacturing plants.

In such plants better over-all results will obtain if the following four points are kept in mind: First, keep the wheels turning under all conditions; second, keep the economy at a reasonable figure; third, keep the maintenance low; fourth, keep the men contented to stay on the job.

It is queer how the admitted ex-profiteering on the part of a very few quite exceptionally naughty coal men makes the price of coal so universally high.

CORRESPONDENCE

Why Does a Leaky Compressor Valve Get Hot?

Replying to Donald McFee's question in the Nov. 16 issue, page 795, "Why Does a Leaky Compressor Get Hot?" heating of the valve is caused by the friction produced by air blowing or wiredrawing past the valve. Dr. Steinmetz states that the same thing happens when high-pressure steam is throttled by using an ordinary hand valve. This will also occur in the water end of a pump working on high pressure.

At one plant we operated a vertical triplex pump that was fitted with brass check valve and bushings. When the check valve began to leak, the pump barrel would become quite hot. G. M. MATTHEWS.

Dover, N. J.

Is Hydrogen Gas Sometimes the Primary Cause of Boiler Explosions?

In discussing a recent water-tube boiler explosion with a well-known boiler inspector, the conversation developed the information that, to all appearances, the boiler was in perfect condition and was working at probably less than 50 per cent of rating, also that the recording gage showed but 140 lb. pressure at the time of the explosion, while the working pressure allowed by insurance and state inspectors was 175 lb. The water was at about two gages, and all gages and water column were in good order.

One of the drums ruptured through the longitudinal seam between the rivet holes, tearing the sheet for about six feet. Several rivets were sheared in the flange of the front head. Chemical and physical analysis of the steel in the ruptured sheet showed it to be standard. The boiler had been in service about eight years. After an investigation, the insurance and state boiler board found no reasonable cause for the accident.

During thirty-six years' experience I have read of many so-called mysterious boiler failures. About twenty-four years ago I had charge of three water-tube boilers, equipped with shaking and dumping grates and a damper regulator. As we were burning a mixture of buckwheat and run-of-mine coal, the main damper could be almost closed without smoke leaking through the setting. In cleaning fires, it was customary to wing over and dump the ash and clinker into the ashpits and clean them immediately after cleaning fires.

On one occasion, just after cleaning fires, I was wetting down the ashpit, which contained a considerable quantity of red-hot clinkers, and just as the water struck a large red-hot clinker near the back of the pit, a violent explosion occurred in the furnace, blowing both firedoors open, throwing fire out onto the floor and blowing me about twenty feet back against a large brick pillar, behind which I scrambled as quickly as possible, thinking that a tube had burst. I was somewhat burned, but not seriously. Beyond the fire and ashes that had been blown out on the floor in front of the boiler, everything was normal.

After studying the matter, we concluded that the explosion was caused by hydrogen gas, as follows: There was probably a small hole in the fire near the back end, and directly under this hole was a red-hot clinker. When the water struck this clinker, the resulting steam was drawn through the hole into the furnace and, combining with the gas from the fresh charge of coal, formed an explosive mixture. If the damper had not been nearly closed, the draft would have taken enough excess air through the hole in the fire to have made the gas and air mixture non-explosive.

I can readily imagine a similar set of conditions where the explosion might be violent enough to cause an initial rupture of some part of the boiler which, through the sudden release of water under steaming temperature and pressure, might result in a serious explosion. For instance, a tube might develop a slight leak that would spray just enough water into the furnace to be instantly superheated and, if combined with the proper volume of gas, to make an explosive mixture which would instantly be ignited with results that no one could foretell.

The fact that no defects could be found in any part of the metal or accessories of the boiler under discussion leads me to believe that possibly a hydrogen-gas explosion caused the initial rupture. I have read a number of accounts of boiler explosions in which statements were made that two reports were heard in quick succession, which would seem to indicate that some such action had taken place.

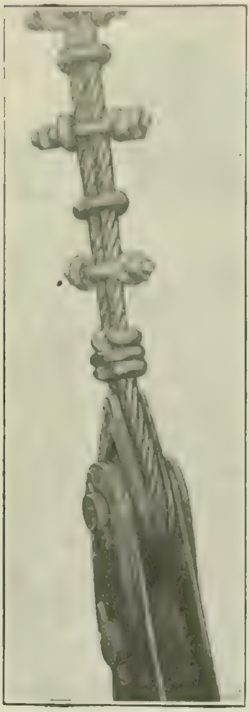
I am offering this as a possible solution of such cases where there seems to be no good reason for an apparently strong, well-designed boiler to explode.

Cleveland, Ohio. C. A. GREEN.

[Water or steam could be projected onto a furnace fire, resulting in the formation of enough water gas to dislodge a boiler from its setting and thereby produce a rupture with the same result as the explosive effect of a rupture from internal pressure. The "explosion" while wetting down clinkers and blowing the fire out of the firedoor may have been due to the formation of water gas or only to the formation of steam. The writer's notion that hydrogen was formed is probably wrong. Hydrogen cannot be disengaged from water or steam at ordinary furnace temperatures.—Editor.]

Socketing Hoisting Ropes

In reply to the article, "Socketing Hoisting Ropes," on page 474 of *Power*, Sept. 21, 1920; over fifteen years ago we used open-end wire rope sockets, which were discarded in favor of what we consider a better method of attaching ropes to cages and skips. I am inclosing a photograph showing the method we have adopted instead. This is 1¼-in. rope attached to a large double-deck cage, the average load amounting to about 17,000 lb. We double our 1¼-in. wire ropes back five feet around a thimble and force eight 1-in. cold shuts around this piece with a heavy sledge. One-inch ropes are bent back 4 ft. and five ⅞-in. cold shuts are used. This outlasts the rope itself, whereas the open-end socket requires continual watching and renewing, and water worked in around the rope and rusting took place. When the cage or skip reached the bottom, should there be any slack in the cable, there was a sharp bend at the top of the socket, and as a consequence the wires were broken in the babbitt. Sometimes a number of wires were broken without being noticed and the rope reached a dangerous condition before being resocketed.



METHOD OF ATTACHING CABLES TO CAGE

Norway, Mich. THOMAS PASCOE.

Why Exempt Oil-Country Boilers?

In the issue of Nov. 2 I read an editorial on "Why Exempt Oil-Country Boilers?" The boilers used in the oil fields should be subject to inspection, and the valves, fittings, construction and installation should be made to conform to the A. S. M. E. Code the same as any boilers that are used for factory or other purposes.

Many of these oil-field boilers are operated by men who do not have the slightest idea of the destructive power stored in them. Such boilers are just as dangerous as any others, and while we are practicing and preaching "Safety First" to protect the employee and the employer, let us also take into consideration these boilers. Following are a few instances that have come to my notice:

I have found that staybolts had been removed and gas-pipe plugs screwed in their place. Safety valves of the lever type have been so loaded with weights that I doubt if they would blow off at 250 lb. instead of 100 as the safe pressure. I have found pipe plugs screwed into the safety-valve outlet, also into the blow-off pipe, so that the boilers could not be blown off regularly. There were also boilers with no water glass and with gage cocks not in the best of working order. Holes had developed in the sheets below the grates, and wooden plugs have been found driven in them to make them tight.

In one instance the front flue sheet below the tubes was found to be almost as thin as tissue paper and the handhole plate did not have over an ⅛-in. bearing surface. Tubes were pulling out of the front tube sheet, and the fusible plug had melted owing to low water, and a solid plug had been inserted in its stead.

Under such conditions is it any wonder that boilers explode? Why then should the oil-country boiler be exempt if human lives are to be protected?

Olean, N. Y. CHARLES W. CARTER, JR.

Oil-Engine Crankshaft Repair

A repair job that may be of general interest was completed recently at the municipal power plant in Clayton, N. M. The crankshaft of a 180-hp. single-cylinder oil engine developed the two cracks indicated in Fig. 1.

The expense of a new shaft weighing over four tons, and slow delivery, influenced the decision to weld the old shaft. With an acetylene torch a cut was made where the cracks were visible until it was certain that the bottom of the cracks had been reached, the cut varying from 1½ to 4 in. deep. These cracks were then filled in with an electric arc weld, using steel electrodes of as near the same kind of metal as the shaft as could be obtained.

Then two pieces of round shafting 5⅞ in. in diameter were cut about 30 in. long and one placed on either side of the throw of the crank, as shown in Fig. 2, well overlapping the old cracks. These were built up with an electric arc weld until they appeared as integral parts of the shaft. After the job was completed, the engine was placed in operation about Aug. 1 and has been running from 18 to 24 hours a day for three months with no sign of any defects. The work was done without the labor of removing the shaft from the bearings, which is a great saving in this kind of repair work.

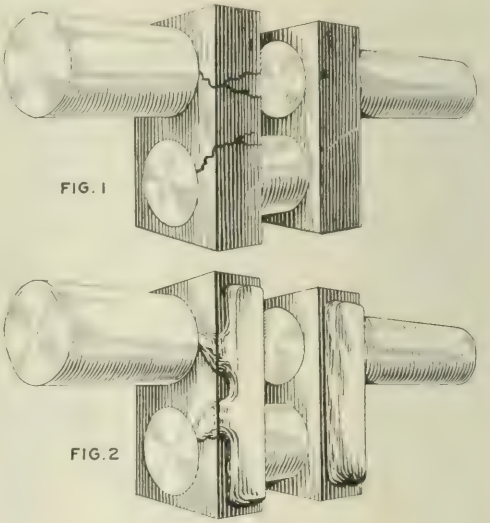


FIG. 1

FIG. 2

CRANKSHAFT REPAIR

J. H. BENDER.

Clayton, N. M.

Steel Foundations for 30,000-Kw. Horizontal Turbo-Generators

My attention has been called to an article by J. R. James in the Oct. 26 issue, page 646, in the synopsis of which the statement is made that the use of steel foundations for large units has been initiated at Detroit.

This is not the case. This company has been using steel foundations exclusively for turbines for the last ten years and has had in operation for two years a 30,000-kw. unit on a steel foundation in the Riverside Station of the Minneapolis General Electric Co. A second turbine of the same size is on order for this plant, which will also be put on a similar steel foundation.

Some three or four years ago the Twin City Rapid Transit Co. put a 20,000 or 25,000-kw. unit on a steel foundation after seeing a 15,000-kw. turbine operating in the Riverside Station on a steel foundation.

Chicago, Ill. H. BOYD BOYDON,
Mechanical Engineer,
Byllesby Engineering & Management Corporation.

[The word "initiated" was inadvertently used by the editor, who wrote the synopsis of Mr. James' article. *Power* had previously published several articles in which steel foundations for turbo-generators were featured.—EDITOR.]

Removing Broken Wedge Bolts

On page 632 of the Oct. 19 issue Mr. Baker illustrates his method of removing broken wedge bolts. I believe that his way is the approved method of making wedge bolts. The slotted ends certainly save time in removing them when broken. With the hatchet-head connection, where but one bolt and hole are used (Fig. 1), I have a special chisel and cut a slot in the broken bolt, then unscrew as Mr. Baker suggests.

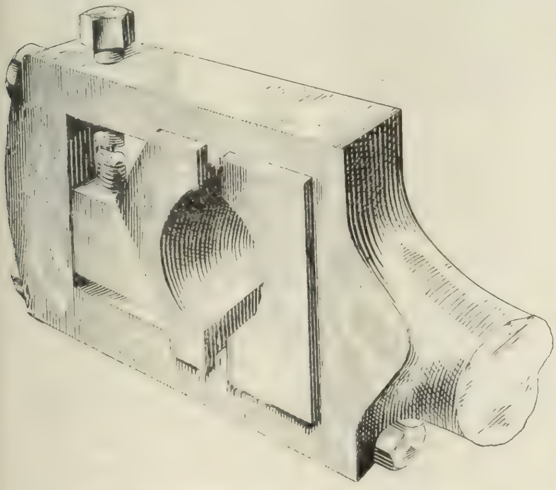


FIG. 1. HATCHET-HEAD WEDGE AND BOLT

Where bucket air pumps are used, it is a source of annoyance to be forced to drill out the broken studs used in coupling the bucket rod to the bucket, as shown in Fig. 2. With a small space to work in and time a big factor, it saves patience and perhaps much cussing to drill a ¼-in. hole in the stud (as a help in locating center at a later time) when the stud is being entered the first time.

This ¼-in. hole will act as a lead, and as the studs invariably break off flush with the bucket and cannot always be backed out, the job of drilling is simplified and the time required is actually cut in two.

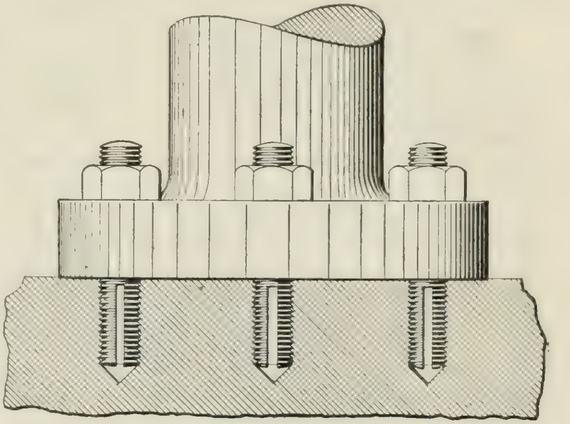


FIG. 2. HOLES DRILLED IN THE STUDS HELP IN REMOVING THEM

New York City. C. W. PETERS.

Preventing Steam in Compressor Water Jacket

John T. Sharp, on page 796 of the Nov. 16 issue, calls attention to a trouble he had with an air compressor. Although he corrected it in a common-sense way, it might be proper to offer a supplementary explanatory remark.

It will be remembered that at the highest point of the water jacket of his compressor there was a ¼-in. pet cock that was intended to be opened occasionally to release steam, and as the opening was neglected, the pet cock was removed and an open connection made to the main overflow.

It does not seem to be best to let the story end there, because as it stands it suggests that the water in the water jacket gets hot, whereas it never gets hot at all. On any modern compressor with normal jacket-water circulation the water at the overflow should not be even blood-warm.

On the compressor under discussion the water was piped into the head-jacket at one end of the cylinder near the bottom, circulated through the cylinder jacket, and was then discharged from the other head-jacket near the top, flowing into the overflow funnel from the open end of the pipe.

It happened that there was, at the top of the cylinder, a small portion of the water jacket above the overflow outlet, and here the water would remain more or less stagnant and would at times get quite hot, occasionally reaching the boiler point, and as a means of relief the pet cock was used. The compressors of this type are now sent out by the makers with a little overflow pipe similar to that provided by Mr. Sharp.

New York City. FRANK RICHARDS.

Air for Combustion

C. C. Phelps' article, page 704 of the Nov. 2 issue, leads me to suggest that the usual assumption of 11.5 lb. of air per pound of combustible is true only if carbon is the sole combustible. The theoretical air requirement for any solid fuel from anthracite to lignite is

$$34.56 \left| \frac{C}{3} + \left(H - \frac{O}{8} \right) + \frac{S}{8} \right|$$

when C, H, O and 3 are given in decimal parts for one pound of fuel. Mr. Phelps' method would be right if no hydrogen, oxygen or sulphur were present. These elements have a very decided effect on the result.

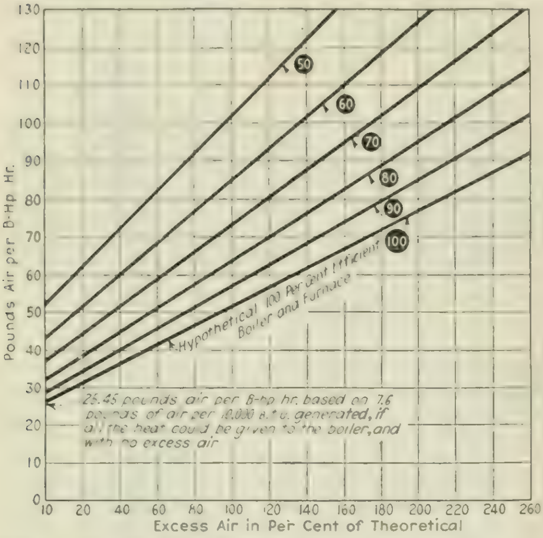


FIG. 1. CHART FOR POUNDS OF AIR REQUIRED PER BOILER HORSEPOWER, BOILER AND FURNACE EFFICIENCY AND PER CENT EXCESS AIR BEING GIVEN

I have had to calculate the air requirements for a wide range of solid fuels—Arkansas anthracite, Pennsylvania bituminous, Indiana and Illinois coals, Western lignites and hogged wood. For this reason, about a year ago, I determined the quantity of air theoretically required for thirty-five different coals, etc. This was done because comparatively little information was available in handy form and it was necessary at times to have the information in such shape that it could be quickly used. This was not original work, but simply the gathering together of scattered information and the calculation for data to connect one thing with another.

AIR REQUIRED FOR DIFFERENT FUELS

	Air Theoretically Required	
	per Lb of Coal	per 10,000 B t u Generated
Illinois bituminous, poor quality	7 0	7 6
Illinois bituminous, good quality	9 4	7 55
Anthracite, average	10 2	7.65
Semi-bituminous, Pocahontas	11.2	7.5
Liquid fuel	14 24	7 04

The kind or grade of the fuel has much more effect on the quantity of air (theoretical) required than on the quantity required per boiler horsepower per hour. The figures in the table are taken from a small book, "Finding and Stopping Waste in Modern Boiler Rooms," published by the Harrison Safety Boiler Works.

On the same page is a curve plotted with available hydrogen per pound of combustible as abscissas and pounds of air per 10,000 B.t.u. generated. I found in my checking, by calculating for thirty-five widely varying fuels, that the deviation from an average of 7.6 lb. of air per 10,000 B.t.u. generated was less than 2½ per cent in all cases but one.

As the air requirement per 10,000 B.t.u. was not as convenient as the air per boiler horsepower per hour, the corresponding value, theoretical, of 25.45 was determined. This figure is for a 100 per cent efficient boiler and furnace, getting perfect combustion with the theoretical air supply. The accompanying chart, Fig. 1, was then made, by means of which, assuming a given excess air supply and a probable efficiency, the air necessary could be read at a glance.

For example, assuming 100 per cent excess air and 60 per cent efficiency, it is seen nearly 85 lb. of air per boiler horsepower per hour will need to be furnished. If this is for a 300-hp. boiler, the values are 25,500 lb. per hour, or 425 lb. per minute.

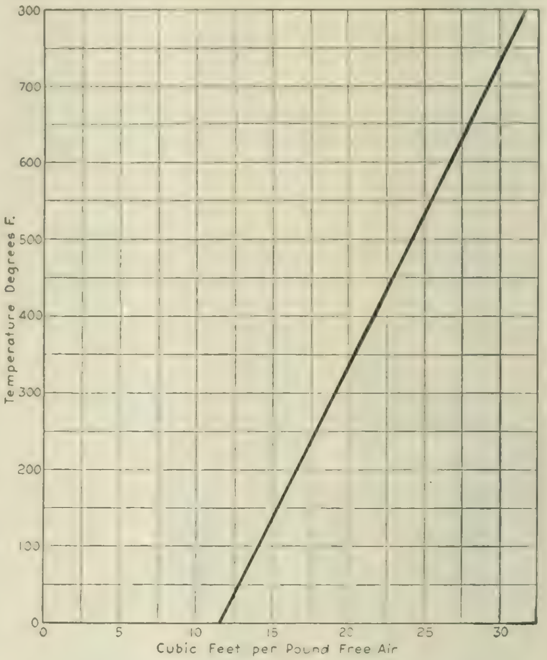
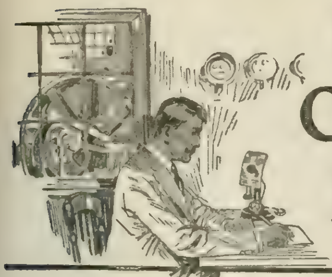


FIG. 2. CHART SHOWING CUBIC FEET OF AIR PER POUND AT VARIOUS TEMPERATURES

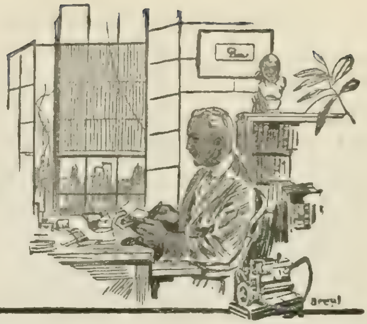
The other chart, Fig. 2, is for quick conversion, at standard barometer, of pounds to cubic feet. The conversion for the example given at, say, 75 deg. F. in one pound equals 13.5 cu.ft. Then the amount of air per boiler horsepower per hour times 13.5 equals 344,250 cu.ft. per hour, or 5,737.5 cu.ft. per minute, but considering the rough assumptions, 350,000 and 5,800 cu.ft. would be used.

The difference between the volume of air supplied at stack temperature and the volume of the actual flue gases passing up the stack is so small that the second chart can be used to arrive at flue-gas volume.

Chicago, Ill. O. R. McBride.



INQUIRIES OF GENERAL INTEREST



Very High Vacuum Uneconomical for Condensing Engine—Why is it not economical to maintain higher than 26 to 27 in. vacuum for a reciprocating condensing engine? J. N.

A higher vacuum entails greater loss from cylinder cooling, and usually, the additional engine power obtained does not compensate the cost of overcoming greater air leakage in connections between the engine and condenser and the cost of handling the necessary additional cooling water.

Determining Constancy of Lead—How can it be known whether a governor of an engine varies the lead? C. D. F.

The constancy of lead would be shown by comparison of indicator diagrams taken with different loads on the engine. Or, block the governor to different positions and ascertain for each position of the governor whether steam is admitted at the same point of travel of the crosshead, just before completion of an exhaust stroke.

Cast-Iron Chimney Caps—Why are brick chimneys provided with cast-iron caps? C. T.

Cast-iron chimney caps are used as copings to bind the top courses of the brickwork together and protect it from the weather. For many situations a more economical and more durable construction can be obtained by embedding an iron ring in the masonry near the top for holding the brickwork together and capping the chimney with terra cotta or other refractory material, made up in interlocking sections, with suitable tile joints and overhang for drainage and drip of rain water.

Choice of Two Speeds for Given Engine and Load—Does a 12 x 12-in. engine require more steam to develop 50 hp. when running 300 than when running 250 r.p.m.? W. H. P.

Under ordinary conditions the most economical point of cutoff for non-condensing engines is between one-fourth and one-third of the stroke. The most economical speed for a given load mainly depends on the point of cutoff required with the given initial pressure to obtain the necessary mean effective pressure, which for development of 50 hp. and 300 r.p.m. of a 12 x 12-in. engine would be 24.3 lb. m.e.p. and for 250 r.p.m. would be 29.1 lb. m.e.p. Hence whether 300 or 250 r.p.m. would be more economical for development of 50 hp. would depend on the initial pressure. The lower speed would be more economical for initial pressures in excess of about 50 lb. gage.

Use of Receiver on Compound Engines—Why is not a receiver employed for tandem-compound engines as well as for cross-compound engines? R. N. G.

On a tandem-compound engine, as the high- and low-pressure pistons are on the same piston rod, an exhaust stroke in the high-pressure cylinder is simultaneous with a power stroke in the low-pressure cylinder and the clearance space of the passages from one cylinder to the other usually affords sufficient temporary storage space to act as a receiver for steam that may not be admitted after cutoff in the low-pressure cylinder. In a cross-compound engine, for greater uniformity of rotation, the separate cranks of the high-pressure and the low-pressure cylinders usually are set 90 deg. apart, and exhaust of the high-pressure cylinder is released approximately during one-half of a power stroke and one-half of an exhaust stroke of the piston in the low-pressure cylinder, making it necessary to provide a receiver for storage of the high-pressure exhaust to prevent undue back pressure on the high-pressure piston and afford better distribution of steam to the low-pressure cylinder.

Lap of Steam Valves of Double Eccentric Corliss—How much lap have the steam valves on a double eccentric, long-range cutoff Corliss engine when the wristplate is in its central position? L. T.

For cutoff to occur later than one-half stroke, in place of the steam valves lapping over the edges of the ports they need to have negative lap; that is, when the wristplate is central, the valves would be partly open, the amount depending on the maximum length of cutoff and desired lead. The cutoff gear must act before the wristplate has been swung over to the farthest point of its travel to one side or the other of its central position, and as such displacement occurs for 90 deg. rotation of the eccentric, or approximately for one-half stroke of the piston, it follows that for a longer period of admission the valves must be set so they begin to open before the wristplate comes up to its central position, and this results in considerable opening, or negative lap, when the wristplate reaches the central position. To correct the lead, the eccentric must be set back of its 90-deg. position with respect to the crank.

Reversing Polarity—Two direct-current compound interpole 400-kw. generators, carrying a motor load, reversed their shunt-field polarity three times within four months. The generators and motors were free from grounds when these reversals took place. In nearly every instance the trouble occurred during a period of unusually low voltage, caused by low steam pressure. At times only one generator was reversed; again both were affected. What is the solution of the trouble? D. F. Z.

Reversal of polarity may be due to either of two causes. If a generator, driving a motor load that has considerable inertia, slows down, the motors will not decrease in speed at the same instant that the generator does, but for a short period may maintain a speed where their counter-electromotive force will be higher than the voltage of the generator, and will supply a current back to the generator in a reverse direction to the original load current. This current will flow through the series-field winding in a reverse direction and reverse the polarity of the generator, and probably this was the cause of the trouble. There is also the possibility that one machine operated at a lower speed, on low steam pressure, than the other, and as a result one machine developed considerably higher voltage than the other. The machine of the higher voltage would motorize the unit operating at the lower emf., and this would result in reverse polarity of the motorized machine.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Interpretations of the A.S.M.E. Boiler Code

THE FOLLOWING answers to requests for interpretations of the Boiler Code have been prepared by the Boiler Code Committee and approved by the Council of the American Society of Mechanical Engineers. The formal inquiry and reply are given together with explanatory references to the code and illustrations where necessary for a better understanding of the interpretations as issued.

Case No. 259 (Reopened)—Inquiry: Is it allowable under the requirements of the A. S. M. E. Boiler Code to fit a high-pressure steam boiler with a blowoff connection larger than 2½ in. in case it is to be used initially for low-pressure steam or hot-water heating, or will it be necessary under the requirements of Par. 308 to apply two or more 2½-in. blowoff connections for the return connections to the boiler?

Par. 308 provides that the minimum size of pipe and fittings for the bottom blowoff shall be 1 in. and the maximum size shall be 2½ in. Par. 308 is in Part I, Section I of the Code, which refers to "New Installations of Power Boilers." The limitation of the maximum size of blowoff connection to 2½ in. is to prevent excessive reactive stresses in the piping due to opening a large line at high pressures. Section II of Part I of the Code, referring to "Heating Boilers," makes no mention of a maximum size for blowoff connections.

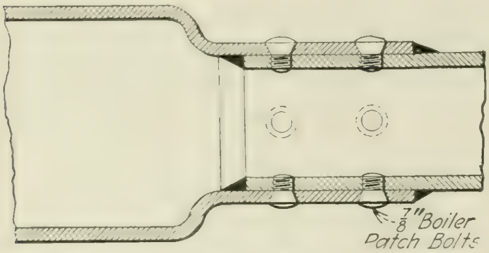
Reply: It is the opinion of the committee that a boiler could be initially fitted with a blowoff connection larger than 2½ in. size when intended for use as a steam or hot-water heating boiler, and when converted to a steam boiler, if to operate at over 15 lb. pressure, but not exceeding 100 lb. pressure, a reducing fitting could be used at the opening to reduce to the pipe size required for the blowoff connections by Par. 308.

Case No. 285 (Reopened)—Inquiry: Is it permissible under the rules of the Boiler Code to use standard extra-heavy cast-iron flanges and fittings on pipe connections between boilers and attached-type superheaters, and on the ends of superheater-inlet headers for pressures up to 250 lb. per sq.in. It is pointed out that neither the inlet-pipe connections nor the superheater-inlet flanges would be subjected to other than saturated steam temperatures.

Reply: It is the opinion of the committee that the flanges and fittings referred to may be made of cast iron, provided the temperature of the steam does not exceed 450 deg. F. as specified in Par. 12.

Par. 12 provides that cast iron shall not be used for nozzles or flanges attached directly to the boiler for any pressure or temperature, nor for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. F.

The destructive effect of high temperature steam on cast iron is assumed to be negligible below 450 deg. F. The temperature of saturated steam at 250 lb. per sq.in. gage is about 406 deg. F.

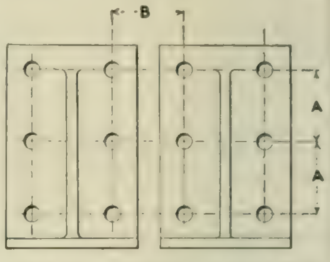


CASE 305. A PROPOSED METHOD OF CONNECTING WROUGHT-STEEL HEADERS

Case No. 305—Inquiry: Is it permissible, under the requirements of the Boiler Code, to connect sections of wrought-steel headers, one of which is shrunk or forced over the end of the other, making a close fit and secured by means of bolts of ample cross-sectional area, the joint being calked or autogenously welded to insure tightness, the design of the joint to be such that it will be of ample strength, neglecting the holding power due to shrinking or forcing one section over the other and the holding power of the autogenous welding?

It is provided in Par. 186 of the Code that autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code, and where the safety of the structure is not dependent upon the strength of the weld. The accompanying illustration shows one type of construction to which this case might apply.

Reply: It is the opinion of the committee that while the construction described is not a desirable one, it is not prohibited by the Code.



CASE 307. METHOD OF LOCATING BOILER SUPPORTING LUGS ON BRACKETS

Case No. 307 (Reopened)—Inquiry: Is it permissible to so locate the supporting lugs on horizontal return-tubular boilers where more than four lugs are required and under Par. 323 of the Code, must be set in pairs, that those in each pair come close together, or must the horizontal distance between the center lines of rivets attaching the adjacent lugs to the shell be at least equal to the vertical spacing of rivets that is required for lug attachments in Par. 323, as shown in the accompanying illustration?

Par. 323 provides for the support of horizontal return-tubular boilers by steel lugs and that not more than two of the rivets attaching the lugs to the shell shall come on the same longitudinal line on each lug. This latter requirement is to avoid excessive weakening of the shell by rivet holes. This paragraph further provides that if more than four lugs are used, they must be set in four pairs. The question then arises as to the effect on the strength of the shell due to the four rivet holes for the two lugs of a pair, if these lugs are set close together.

Reply: There is no requirement in the Code specifying the distance apart of the lugs forming pairs as required by the last sentence of Par. 323. It is the intent of the Boiler Code that the distance between the lugs should be such as to give at least ½ in. between the edges of the lugs and not more than 2 in. The load should be equalized between the two lugs.

A maximum distance between the lugs of a pair is necessary to provide against unequal distribution of the load between the lugs.

Case No. 310—Inquiry: (a) Can a type of boiler other than the horizontal return-tubular type have lap joints where the courses are over 12 ft. long?

(b) With butt and double-strap construction on longitudinal joints for boilers other than of the horizontal return-tubular type, is it required that the tension-test specimens be cut from the shell plate as provided in Par. 190?

Par. 190 provides that in horizontal return-tubular boilers with lap joints no course shall be over 12 ft. long. It further provides that with butt and double-strap construction longitudinal joints of any length may be used, provided the tension-test specimens are so cut from the shell plate that their lengthwise direction is parallel to the circumferential seams of the boiler, and the tests meet the standards prescribed in the specifications for boiler-plate steel.

Reply: (a) The restriction in length of lap joints to 12 ft. in Par. 190 of the Boiler Code applies specifically to boilers of the horizontal return-tubular type, but there is nothing in the rule which prohibits the construction of shells and drums of lengths exceeding 12 ft. for other types of boilers.

(b) Inasmuch as the first sentence of Par. 190 applies specifically to horizontal return-tubular boilers, as pointed out in reply (a), it is the opinion of the committee that this prohibition does not cover other types of boilers.

Case No. 314—Inquiry: Is it the opinion of the Boiler Code Committee that a lap joint reinforced with a cover plate should be considered as an ordinary lap joint and the requirements for factors of safety given in Pars. 379 and 380 applied accordingly?

Pars. 379 and 380 are in Part II of the Code which applies to "Existing Installations." It is provided that the factor of safety shall be at least 4 for boilers in service one year after, and at least 4.5 five years after, these rules become effective. The factor of safety referred to is that in the formula:

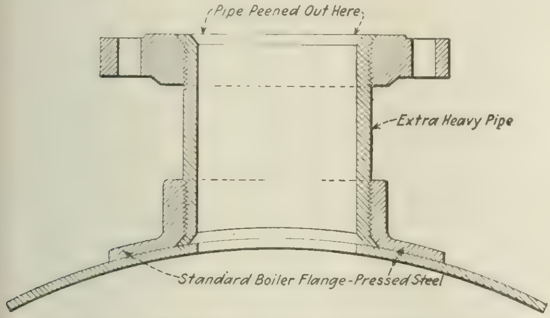
$$\textit{Maximum allowable working pressure} = \frac{TS \times t \times E}{R \times FS}$$

where

TS = Ultimate tensile strength of shell plates, lb. per sq.in.;
t = Thickness of shell plate, in weakest course, in.;
E = Efficiency of the longitudinal joint as determined by Par. 181 of these rules;
R = Inside radius of weakest course, in.;
FS = Factor of safety.

Par. 380 provides that the age limit of a horizontal return-tubular boiler, having a longitudinal lap joint, shall be 20 years, except that no lap-joint boiler shall be discontinued from service solely on account of age until five years after these rules become effective.

Reply: It is the opinion of the committee that a lap joint, even though reinforced by a cover plate, should be treated exactly the same as the simple form of lap joint, so that the factors of safety proposed in Pars. 379 and 380 for lap joints would be applicable.



CASE 317. PROPOSED METHOD OF MAKING PIPE CONNECTIONS TO BOILERS

Case No. 315—Inquiry: Is it to be understood that the requirements of Par. 323 of the Boiler Code, relative to the location of lugs and the distribution of rivets attaching them to the shell, applies to the small sizes of boilers referred to in Par. 324?

Par. 324 provides that horizontal return-tubular boilers between 54 in. and 78 in. in diameter shall be supported by the outside suspension type of setting, or at four points by not less than eight steel or cast-iron brackets set in pairs. A horizontal return-tubular boiler up to and including 54 in. in diameter shall be supported by the outside suspension type of setting, or by not less than two cast-iron or steel brackets on each side.

Reply: The requirements of Par. 323 of the Code are clearly limited to horizontal return-tubular boilers over 78 in. in diameter. It will be found that Par. 325 gives the requirements for attaching the lugs.

Par. 325 provides that the lugs or brackets shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets attaching the lugs shall not exceed 8 per cent of the following strength:

Crushing strength of steel plate, 95,000 lb. per sq.in. of cross-sectional area.

Shearing strength lb. per sq.in. of cross-sectional area of the rivet shank:

Iron rivets in single shear..................	38,000
Steel rivets in single shear..................	44,000

Values for double shear to be twice those for single shear.

Case No. 316—Inquiry: Is it permissible, under the requirements of the Boiler Code, for a boiler manufacturer to stamp a boiler as A. S. M. E. Code Standard, when it is fitted with a safety-valve nozzle or connection that is adequate only for safety valves operating at high lifts?

Reply: The way designated in the Code in which the size of the safety valve or valves that shall be used on any boiler is determined by their relieving capacity, and where the safety-valve opening corresponds to that required from such a valve or valves, the boiler is constructed in accordance with the A. S. M. E. Code in this respect and may be so stamped. The committee suggests, however, that where boilers are sold for a given operating pressure without knowledge of the type of safety valves that will be used, the safety-valve openings be proportioned for the intermediate lifts and corresponding relieving capacities given in Table 15 of the Code.

Table 15 of the Code gives the discharge capacities of spring-loaded safety valves with 45-deg. bevel seats for various sizes, ranging from 1 in. to 4½ in. in diameter at various pressures ranging from 15 to 300 lb. per sq.in. gage. In each case values are given for three lifts called "Minimum," "Intermediate" and "Maximum." The discharge capacities are given in terms of the heat value of the fuel burned per hour and also in terms of the pounds of steam generated per hour.

Case No. 317—Inquiry: If it is permissible, as indicated in Case No. 298, to fit a steam-outlet nozzle with a wrought-steel flange screwed to the outer end of the end neck to which the flange is threaded and peened over into a beveled part cut away from the flange, why should not this construction be acceptable for the attachment of the flange at the other end of the nozzle for attachment to the boiler shell?

The accompanying illustration shows the construction permitted under the interpretation of Case No. 298. This applied, however only to the flange at the top of the nozzle. The present inquiry asks permission to use the same construction at the bottom of the nozzle as indicated in the illustration.

Reply: It is the opinion of the committee that this construction does not conform to the requirement of the last sentence in Par. 268.

The last sentence in Par. 268 provides that when the allowable working pressure exceeds 100 lb. per sq.in., a connection riveted to the boiler to receive a flanged fitting shall be used for all pipe openings over 3-in. pipe size.

Water-Power Permits Applied For

Application for license or preliminary permit for water-power projects were filed with the Federal Power Commission during the week ended Nov. 27 as follows (the name and address of the applicant, the site of the project, and the proposed use are shown): San Joaquin Light and Power Corporation, Fresno, Cal., San Joaquin River, public utility; Utica Mining Co., 1128 Merchants Exchange Bldg., San Francisco, Stanislaus River, mining; Nevada-California Power Co., First National Bank Bldg., San Francisco, Warren Slate and Leevining Creek, Mono County, Cal., public utility; City of Los Angeles, Department of Public Service, Kings River, Fresno County, Cal., public utility; Western States Gas and Electric Co., Stockton, Cal., Trinity and Humbolt Counties, public utility; Flathead Valley Electric Co., Old National Bank Bldg., Spokane, Flathead River, Flathead County, Mont., public utility; Catawba Valley Light and Power Co., Morganton, N. C., Wilson Creek, Caldwell County, N. C., public utility; San Joaquin Light and Power Corporation, Fresno, Cal., Kings River, Fresno County, Cal., public utility; Frank B. Pattee, Samuel Bernhard and J. T. Ross, Call Bldg., San Francisco, Stanislaus River, Calaveras County, Cal., use not stated; Home Colony (an association of citizens) Cody, Wyo., Kitty Creek, Park County, Wyo., community use; Southern California Edison Co., Edison Bldg., Los Angeles, San Joaquin River, Madera, and Fresno Counties, Cal., public utility.

Ten Ways to Kill an Association

1. Don't come to the meetings.
2. But if you do come, come late.
3. If the weather doesn't suit you, don't think of coming.
4. If you don't attend a meeting, find fault with the work of the officers and other members.
5. Never accept an office, as it is easier to criticize than to do things.
6. Nevertheless, get sore if you are not appointed on a committee, but if you are, do not attend the committee meetings.
7. If asked by the chairman to give your opinion regarding some important matter, tell him you have nothing to say. After the meeting tell everyone how things ought to be done.
8. Do nothing more than is absolutely necessary, but when other members roll up their sleeves and willingly, unselfishly use their ability to help matters along, howl that the association is run by a clique.
9. Hold back your dues as long as possible, or don't pay at all.
10. Don't bother about getting new members. "Let George do it!"—*Michigan Architect and Engineer.*

Use and Inspection of Flexible Steel Cables

At the regular monthly meeting, Philadelphia Section, Association of Iron and Steel Electrical Engineers, "Instructions in the Care, Use and Inspection of Flexible Steel Cables" was the subject discussed by Dr. H. C. Boynton and W. Voigtlander. Dr. Boynton, using lantern slides, described the process involved in the manufacture of wire rope at the plant of John A. Roebling's Sons Co. The speaker characterized the present as being pre-eminently the age of metallic alloys. High-grade wire and wire rope are made from carbon steel having a tensile strength of from 220,000 to 300,000 lb. per sq.in. This high tensile strength is obtained by heat treatment, and 90 per cent of the steel used in wire rope is made by the open-hearth process.

W. Voigtlander discussed the subject of proper installation and maintenance of wire rope for hoisting purposes. He said that it had been conclusively demonstrated by repeated tests that the most efficient wire-rope attachment is made by a straight wire brush held in the conical basket of the socket by means of spelter (pure zinc). It was brought out in the discussion that no cable clip or clamp has ever been designed that will give the full strength to the cable. As to the lubrication of steel cables this varies from an application every day where conditions are severe, such as where acid fumes are present, to every two weeks or longer under ordinary conditions. The best method of lubricating a rope is first to heat it; but this can be done only by removing the rope from the sheaves. As a compromise the use of a fairly thick lubricant is recommended, applied hot if possible, using a shallow container and allowing the cable to run in the oil. In the installation of cable care must be exercised so as not to cause a kink in the rope, or this section will greatly reduce its life. The kinked portion will stand only approximately 75 per cent strain that the straight rope is capable of withstanding. Wire rope will safely stand a temperature of 400 deg. F. without affecting its tensile strength. At temperatures above 400 deg. F. its strength may be seriously reduced.

Abrasion is very seldom the chief cause for rejection of wire ropes. In almost all cases the wires of the individual strands break or the rope is damaged from outside causes, to the extent that it requires replacing.

Canada's Use of "White Coal"

Canada's per capita development of water power is now said to be higher than that of any other country except Norway. The figures are 0.54 hp. per capita for Norway and 0.26 hp. for Canada; the United States is far behind, with 0.07 hp. As for the total amount of developed and undeveloped water power, however, without regard to population, the United States comes first with 30,000,000 hp. and Canada second with 19,000,000 hp. These figures and the accompanying chart were prepared by the Canadian Commission of Conservation for the Bankers Trust Company of New York.

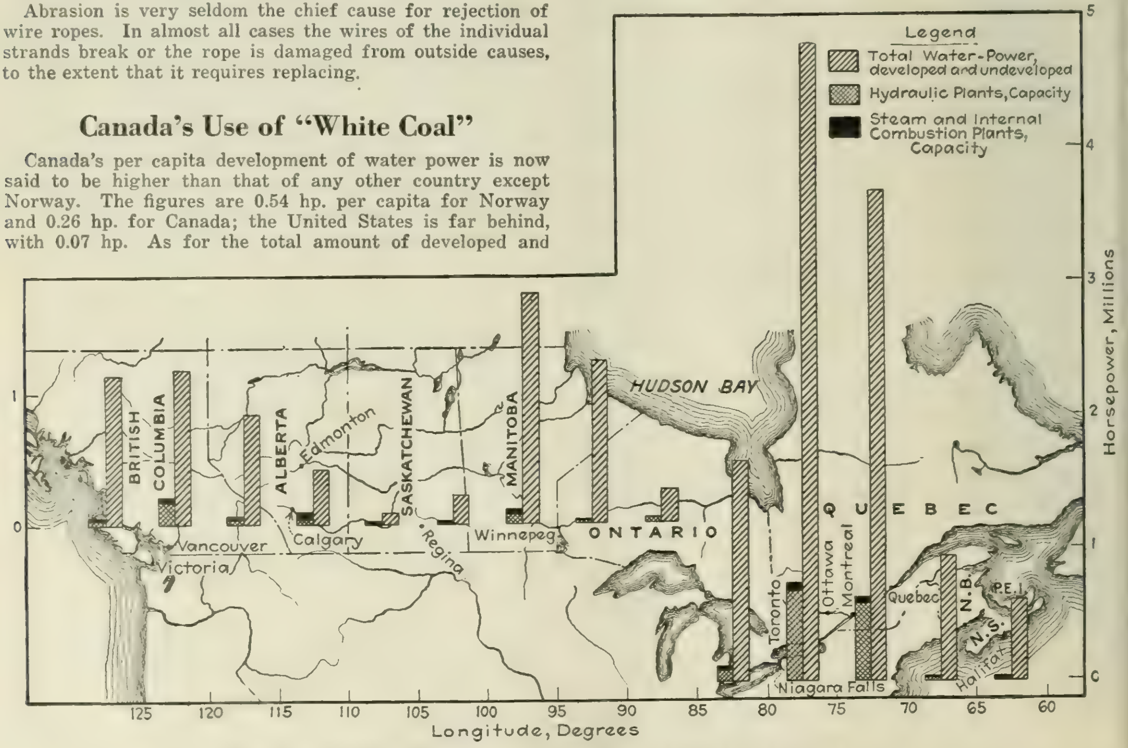
The chart reproduced here repesents graphically the figures given in the table. It shows the total capacity of central-station plants in various areas of Canada, each of which includes five degrees of longitude. For comparison the total of available and developed water power in each area is also shown. It should be noted that the figures of total water power are the estimated amounts of 24-hour low-water power, and that these amounts can be much increased, according to the amount of artificial storage available, the economic head that may be developed and the nature of the industry using the power.

It is interesting to note that although Canada has been most industrious in utilizing her "white coal," the amount in use is only a small portion of the total which may be developed in the future; it is, nevertheless, proportionately far greater than our own development of water power.

HORSEPOWER OF THREE TYPES OF CENTRAL ELECTRIC STATIONS, AND THE TOTAL AVAILABLE WATER POWER, IN EACH DISTRICT

Meridian District	Horsepower of Central Electric Stations			Total of Used and Unused Water Power
	Hydraulic	Steam	Internal Combustion	
60– 65	1,406	23,502	777	620,800
65– 70	13,346	13,131	1,298	942,200
70– 75	596,463	36,325	253	3,690,000
75– 80	686,561	57,934	228	4,820,000
80– 85	112,183	8,135	2,117	1,660,000
85– 90	36,000	0	0	250,000
90– 95	11,800	250	6	1,227,000
95–100	78,550	23,169	0	1,743,500
100–105	0	9,979	3,101	228,500
105 110	0	17,278	1,531	83,000
110–115	31,980	50,835	1,332	406,000
115–120	48,634	5,603	1,525	841,000
120–125	182,620	32,010	755	1,185,000
125–Ala.*	37,075	10,051	0	1,135,000
Totals.....	1,836,618	288,202	12,923	18,832,000

* This district extends from long. 125° to the boundary between Canada and Alaska.



COMPARISON BETWEEN USED AND UNUSED WATER POWER IN CANADA

William T. Price

It is with deep regret that *Power* informs its readers of the death of William T. Price, chief engineer of the oil-engine department, Ingersoll-Rand Co., at his home in Easton, Pa., Nov. 7, 1920.

Mr. Price was born at Montreal, Canada, Sept. 28, 1883. After attending the Toronto Technical School for a few years, he entered the employ of the Constructor's Plant Manufacturing Co., of Buffalo, where he soon became chief engineer. He was then engaged by the Lackawanna Steel Co., where he realized that further technical education was necessary, so entered in 1903 Cornell University, where he completed the course in mechanical engineering, graduating in 1906.

WILLIAM T. PRICE

After a short service with the Wheeling Mould and Foundry Co. he was engaged by the De La Vergne Machine Co., first as sales engineer and subsequently as chief engineer and manager of the oil-engine department.

Leaving this company in 1917, he founded the Price Engine Corporation and brought out the design of a solid-injection oil engine bearing his name. The engine operates at a low compression without the aid of hot surfaces and attains the efficiency of the Diesel. Its manufacture was undertaken by the Rathburn-Jones Co. The Ingersoll-Rand Co. also engaged in the manufacture of the Price engine, and Mr. Price was, at the time of his death, chief engineer of the latter concern.

Mr. Price was a member of the American Society of Mechanical Engineers, and of the Engineers Club of New York City. He was an outstanding figure in engineering circles, being one of the very few American engineers that broke loose from European influences in engine design. Besides his mechanical ability, he possessed unusually keen business foresight. He was the exceptional inventor with sufficient business acumen to reap the benefits of his labor.

It was also Mr. Price's good fortune to be blessed to a high degree with the faculty of making friends. This was partly due to his youth and enthusiasm and partly to his consideration for the feelings of those with whom he came in contact. The humblest shop apprentice or cub salesman was accorded the same courteous treatment as the highest company official. It is little wonder that his acquaintanceship alone limited his circle of friends.

A preliminary statement of the general results of the census of Pennsylvania anthracite operations for 1919 has been issued by Director Sam L. Rogers of the Bureau of the Census, Department of Commerce. The summary shows a decrease in the number of breakers and also in the number of wage earners employed. The number of wage earners decreased from 169,174 in 1909, to 147,069 in 1919, or 13 per cent. Wages paid show an increase from $92,169,906 in 1909 to $210,202,511 in 1919. For operating cost a decided increase is shown. The quantity of coal produced shows an increase over that for 1909 of but 6,302,000 tons, or 8.8 per cent, while the value of the coal produced increased from $145,881,000 to $364,243,000.

Don't blame your coal dealer if your coal refuses to burn. His slate is clean.—*N. Y. Life.*

Pulverized Anthracite and Recovery of River Coal

Use of pulverized anthracite and the recovery and use of river coal were the subjects discussed at a meeting of the Engineers' Club, Philadelphia, Friday evening Dec. 3. Joseph A. Stienmetz, past president of the club, presided and called upon Dr. George Ashler, Pennsylvania State Geologist, to tell of the resources of river coal, which is found in the rivers and their tributaries in the anthracite regions. It is washed into the rivers by the discharge from the washers at the mines and is carried long distances down the river, especially during high-water periods, and deposited on the river bottom. In many cases the tributaries of the river have become practically filled with this class of coal, even to the extent of causing these streams to overflow their banks and spread out over the adjoining lowland. Much of this coal is of grades known as rice and barley, although large quantities are little more than dust. For a number of years this coal has been reclaimed on a small scale, but within the past four or five years its reclamation has reached large proportions, amounting to 2,000,000 tons in 1919. One of the largest sources of this coal is the Susquehanna River around Harrisburg, where about 750,000 tons is recovered annually. Practically all coal used in Harrisburg for industrial power purposes and by the power companies is pumped from the river. During recent years large quantities have been taken from the tributaries of the river, and this is the source of the best coal.

Dr. Ashler was of the opinion that at the present rate of mining there was river coal enough in sight, without any more coming into the rivers, to last four or five and possibly ten years. This will be added to as the dumps at the mines are worked over so that there may be a possible 25,000,000 tons; therefore it is only a mere incident in the power problem.

MR. EDWARDS TAKES EXCEPTION TO DR. ASHLER'S ESTIMATE

J. P. Edwards, who was the second speaker, took exception to Dr. Ashler's estimate for the total available tonnage of river coal. From Mr. Edwards' experience he estimated that river coal of the rice and barley grades was being deposited at the rate of 8,000,000 tons a year. He told of one of his reclamation stations on a river tributary where the coal was deposited ten feet deep. Here a crane was installed on the bank to operate a 1½-cu.yd. clamshell bucket. It has only a 25-ft. digging radius, but in three years has removed 140,000 tons of coal from this space—the coal coming in practically as fast as it is removed. It was Mr. Edwards' opinion that the supply of river coal was practically self-perpetuating and that the possibilities had only been scratched. River coal is of much better grade than many of the sources of supply and can be obtained at less than half the cost of bituminous coal. A test made on river coal shows it to have a heat value as high as 14,000 B.t.u., although in general it will run around 11,000 to 12,250 B.t.u., with an ash content of 13 per cent. If care is not taken in preparing the coal, the ash content may run as high as 15 to 18 per cent.

G. R. Delamater agreed with Mr. Edwards that the supply of river coal was going to last much longer than most people think, although he was of the opinion that the supply of larger sizes was decreasing. He emphasized the necessity of equipping boilers to burn the smaller size of coal or even coal dust. He said he had seen river coal burn with only a 10 per cent ash content and that 14 per cent should be an average. In some cases the ash content was as high as 25 to 30 per cent, but this was only a question of removing the sand from the coal.

R. M. Vail, in discussing the different type of machines for pulverizing coal, expressed the opinion that anthracite, on account of its high abrasive qualities, could be most economically pulverized in some sort of a tube mill using balls for grinding. Success in grinding anthracite would be found in taking advantage of its brittleness and avoiding its abrasiveness, said Mr. Vail.

In discussing the burning of powdered anthracite, J. R Wyllie told of obtaining over 400 per cent rating from boilers and of operating them for days at 300 per cent rating. He told of obtaining 19 per cent CO_2, but this was found very hard on the furnace, and he was of the opinion that 14 per cent CO_2 was about right for economical operation. He said that in burning powdered anthracite it was necessary that 90 per cent of the coal go through a 200 mesh screen, and each powdered-anthracite proposition has to be treated separately.

BRIQUETS FROM CULM COAL

J. H. Kennedy discussed the making and use of briquets from culm coal. He said that a successful briquet must be waterproof; must be hard, not brittle; and must stand up in the fire while burning. Mr. Kennedy told of briquets being manufactured that contained 92 per cent culm and 8 per cent binder. This binder contained 12 parts water, 2 parts asphaltum and 1 part starch. Briquets, said the speaker, have been made for the past fifty years in Europe, but those used in Europe could not be sold in this country. One of the difficulties in burning briquets has been the use of too much draft. On account of the uniformity of the size of this fuel, it is necessary to cut down the draft considerably below that required for burning common grades of coal. The briquets that Mr. Kennedy described could be sold at the present times for $8 per ton f.o.b. factory.

W. W. Pettybone told of the experience of the Bethlehem Steel Co. at Lebanon, Pa., in burning pulverized coal. Four 520-hp. boilers are in operation, burning pulverized bituminous coal. A pulverizer used on bituminous coal for a number of years, was tried on anthracite, and after ten days' operation it was necessary to rebuild it. Nevertheless, Mr. Pettybone was convinced that pulverized anthracite could be burned successfully. It was found that a change could be easily made from burning pulverized bituminous to pulverized anthracite and vice versa. When burning grades of coal ranging from 11,000 to 13,000 B.t.u., over-all boiler efficiencies were obtained ranging from 82 to 87 per cent, with a monthly efficiency averaging a little better than 80 per cent. No trouble has been experienced when operating the boilers at 200 per cent rating; above 200 per cent difficulty is liable to be encountered with the brickwork. Although it is possible to obtain 17 per cent CO_2, it has been found that the highest efficiencies are developed with 10 to 11 per cent.

H. D. Savage expressed the opinion that there is no greater difficulty in burning anthracite at high boiler rating than in burning bituminous, but it cannot be burned so successfully for low and intermittent ratings.

"Turbine" Boiler Furnace

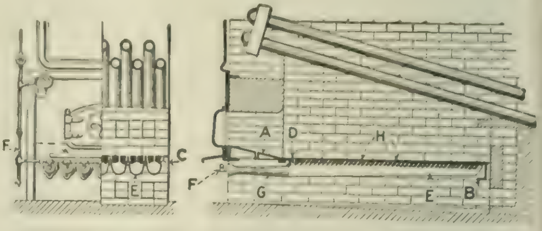
If the air flow into a furnace is uniform and the fuel is spread evenly over the grate, combustion will also be uniform and even throughout the whole area of the fire. In an ordinary boiler furnace these conditions are not necessarily fulfilled, resulting in an excessive air flow through the grate, which is a particularly active source of loss. By the use of the furnace herewith described, it is claimed, says the London *Electrical Review*, that a considerable reduction in the amount of excess air can be made, the air can be thoroughly diffused over the whole area of the grate, and it can be brought everywhere into intimate contact with the fuel.

The furnace under consideration takes its name from the analogy which its form in longitudinal section bears to the jet and blades of an impulse steam turbine, the intention being that the air shall pass up between the fire bars at an equal rate over the whole surface of the grate.

As shown in the illustration several troughs (the number varies with the width of the furnace) rounded at the bottom and measuring about 5 in. across their mouths are disposed longitudinally in the furnace. Each trough is separate from the rest and lies, unbolted, in contact with its neighbors, being hooked at either end over ridges on the dead and bridge plates *A* and *B*, but otherwise unsupported. Angle-sectioned extension pieces *C* are bolted to the two outer troughs so as to fill the gaps between them and the furnace walls.

Within the mouths of the troughs are placed fire-bar members *H* so that each trough has, say, three or four dozen of these separate fire-bar castings, which are supported on the edges of the troughs. Each casting is provided with a slot in front and with a flat web behind which fits into the slot of the succeeding casting. It will be appreciated, then, that the fire-bar castings can be rapidly slid into position, the whole being locked together by the insertion of the last member *H*.

The top surface of the grate thus formed is, however, not continuous; between each pair of castings a $\frac{1}{8}$-in. wide slot is left for the passage of air from the trough below, the width of the slot being preserved even when the castings are tightly pressed together. The rear face of the blade of each casting lies at an angle of 45 deg. to the general top surface of the grate; the forward face of the succeeding casting makes an angle of 60 deg. with the same plane, and the $\frac{1}{8}$-in. slot between the pair is thus continued below in the form of an inclined tapered passage. It is this form of air passage, it is claimed, which enables the finest fuels (even in a powdered form) to be burned, because the inclined surfaces tend to prevent the fuel falling through the slots between the fire-bar members. As shown at *E*, the bottom edges of the sloping blades are formed to a radius so that with the curved bottom of the trough they make an approximately circular passage for the air flowing along the trough. The area of this passage, owing to the inclined trough bottom, the trough being shallower toward the back than at the front, decreases from back to front in such a way that, as air escapes through the successive slots into the fire, the velocity of the remainder in the trough remains constant.



"TURBINE" FURNACE APPLIED TO A WATER-TUBE BOILER

Air is drawn into the troughs by means of a separate steam jet *F*, for each trough, which is placed at the mouth of an injector pipe *G*. For the first portion of their length the injector pipes contract in diameter, for the center portion they are parallel, and for the remaining portion they expand to suit the radius of trough bottom, as shown at B.

All the steam jets are connected to a single source of steam; the nozzles have a large coefficient of expansion, and their form is such that the jet of steam splays out and fills the bore of the injector pipe. Superheated steam is used for the jets. The supply is taken from the top of the boiler and led by a system of piping through a reducing valve and pressure gage for some distance into the side flue before passing to the jets. This form of superheater is very simple and easy to install, it being necessary to remove a single brick only from the boiler setting. The employment of superheated steam, it is claimed, increases the efficiency of the injector jets, because for equal weights the volume delivered is greater if superheated. Further, the use of a number of small jets also leads to economy, for the amount of steam used is proportional to the square of the jet diameter. The air pressure prevailing in the troughs depends on the pressure of the steam delivered to the jets. Therefore, the air pressure below the fire bars can be regulated over a considerable range, so that a wide variety of fuel can be burned in a furnace at different times. The ash and clinker are removed by raking them out over the dead plate *A*. Very little dust falls through the bars into the troughs; what does is removed by a long-handled scoop. "Turbine" furnaces can be readily fitted to any type of boiler.

The Constitution and Properties of Boiler Tubes*

BY ALBERT E. WHITE
Consulting Metallurgical Engineer, Professor of Chemical Engineering, University of Michigan

DURING the winters of 1913-14 and 1914-15 the necessity of frequent boiler-tube replacements in the Park Place heating plant of the Detroit Edison Company resulted in considerable difficulty in maintaining continuity of boiler operation. This trouble, brought to a climax by the failure of a tube in No. 7 boiler in June, 1915, led to investigations to determine the causes of, and suggest remedies for, boiler-tube deterioration. Investigations were started along three lines: (a) Water softening, (b) rearrangement of baffling, and (c) considerations relating to the composition and constitution of boiler tubes.

In practically all tubes removed a thin calcium sulphate scale was found. The feed water contained very little of this salt, but owing to extended periods of overload and to the fact that 98 per cent of the feed was raw water from the city mains water softening was deemed necessary. After considerable research it was decided to treat all the water with soda ash in live-steam purifiers. This treatment has been successful, the flocculent sodium carbonate and soluble sodium sulphate being taken care of by frequent boiler blowoffs.

The fact that the front tubes were particularly prone to develop defects led to the study of baffling conditions. Originally the front baffles were between the first and second rows of tubes (the boilers were of the Stirling type). To distribute the effect of radiant heat the baffles were placed between the second and third tube rows. This resulted in materially lowering tube replacements without decreasing fuel economy or increasing smoke nuisance.

In investigating the constitution of the tubes a number of samples were examined metallographically. The photomicrographs indicated generally that the constituents were evenly dispersed, although there was evidence of phosphorous segregation and in many cases cavities or segregations were evident.

As a result of his studies the author lists the principal causes of tube failure in general (excluding that due to scale formation) as follows: (a) Tube brittleness due to absorption of hydrogen, usually attributable to faulty feed water treatment; (b) blowholes and imperfections in the metal, attributable to steel-mill conditions; (c) recrystallization of the metal.

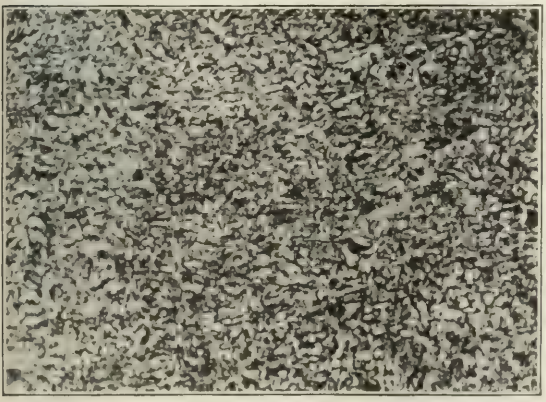


FIG. 1. PHOTOMICROGRAPH OF DEFORMED STEEL BEFORE BEING HEATED

The matter of recrystallization merits much consideration. This will occur if steel with a low carbon content, which has previously been mechanically deformed at a temperature below the critical, is later heated for a sufficient time to any temperature below that at the critical. The common composition for boiler tubes is such that this type of metal is especially susceptible to this phenomenon. In modern mill practice tubes are straightened and often actually brought to final size below the critical temperature. Tubes are often bent during fabrication and erection and are universally rolled into the tube sheet when cold. Methods of cleaning tubes often produce local deformation by repeated hammer blows. Finally, the time and temperature conditions required for recrystallization are present.

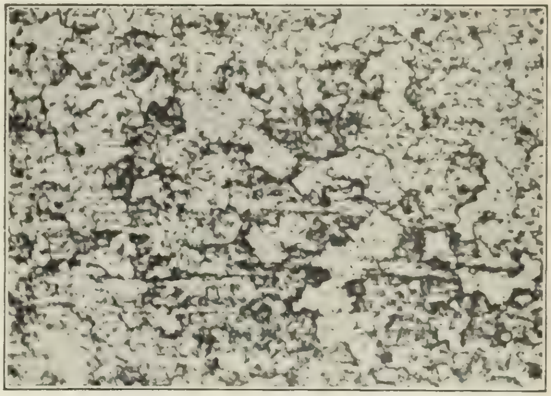


FIG. 2. PHOTOMICROGRAPH OF DEFORMED STEEL AFTER HEATING AT 650 DEG. C. FOR 15 HOURS

The growth of crystals occurs more rapidly the higher the temperature to which the metal is heated. Experiments for a certain set of conditions led to the following formula:

$$T = 8 \times 3^n$$

where T = time in minutes for a certain crystal growth; $n = (675 - t) \div 25$; and t = temperature in degrees centigrade. These experiments covered a range of 550 deg. C (1,022 deg. F.) to 675 deg. C (1,247 deg. F.).

Fig. 1 is a photomicrograph of a tube specimen which has been deformed, and Fig. 2 shows a similar specimen after being heated at 650 deg. C. (1,202 deg. F.) for 15 hours. The increased size of the grains in Fig. 2 shows clearly the crystal growth.

To determine the physical properties due to crystal growth tension and fatigue tests were made on (a) metal "as received," (b) metal annealed for 10 minutes at 950 deg. C. (1,742 deg. F.) and then cooled in the furnace, and (c) on "coarse-grained" metal produced by stressing the specimens beyond the elastic limit and then annealing for three hours at 800 deg. C. (1,472 deg. F.).

The physical properties of the "as received" specimens showed satisfactory metal. The average tensile-strength and elastic-limit values of the "coarse-grain" samples were 27.2 and 58.9 per cent respectively, lower than those of the "as received" samples. In the fatigue tests the "coarse-grain" metal was 16.2 per cent poorer than the "as received" samples and 48.70 per cent poorer than the "annealed metal."

In view of this the question arises as to the possibility of improving the constitution of the metal by using a composition that is as easy to produce, as easy to install, as resistant to the absorption of hydrogen, stronger, as free or freer from blowholes, and above all, less subject to recrystallization. It is suggested that these conditions might be met by steel with a carbon content of 0.30 to 0.35 per cent better than by steel with 0.08 to 0.18 per cent carbon.

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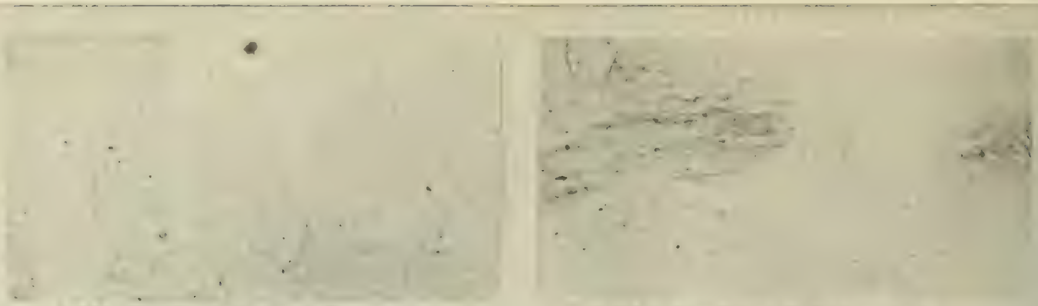
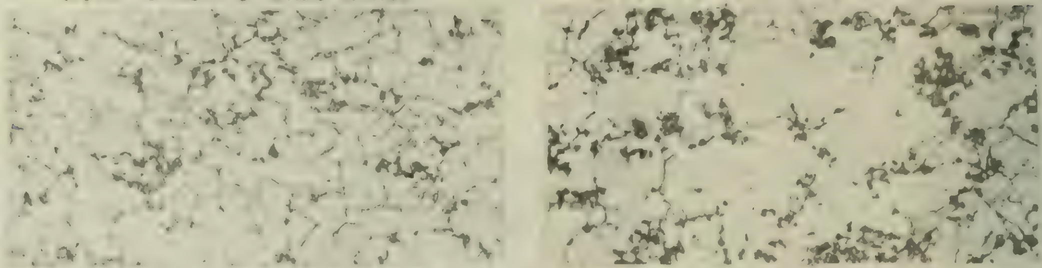
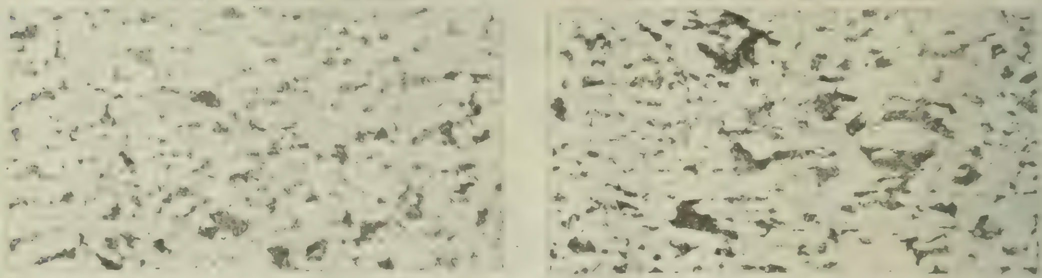
*Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers, in New York City, December, 1920.



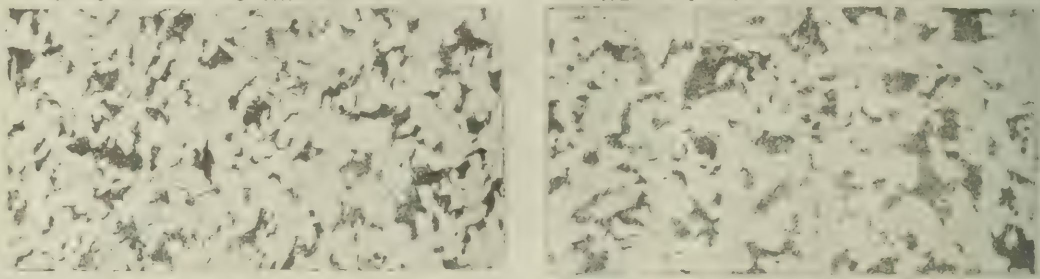
0.006 Per Cent C Undeformed 0.006 Per Cent C Deformed



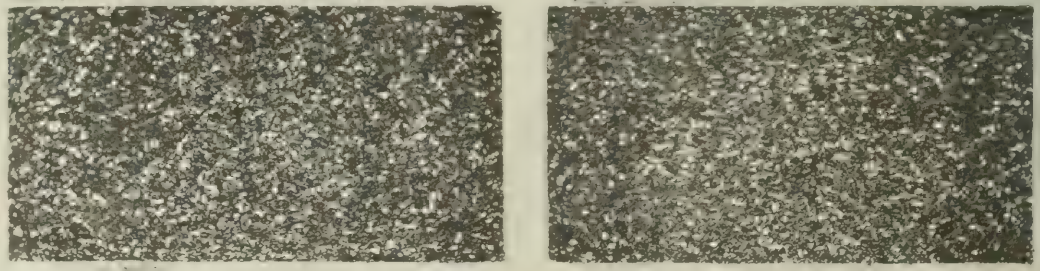
0.103 Per Cent C Undeformed 0.103 Per Cent C Deformed



0.203 Per Cent C Undeformed 0.203 Per Cent C Deformed



0.251 Per Cent C Undeformed 0.251 Per Cent C Deformed



0.315 Per Cent C Undeformed 0.315 Per Cent C Deformed

FIG. 3. PHOTOMICROGRAPHS SHOWING EFFECT OF CARBON CONTENT ON GRAIN GROWTH WHEN DEFORMED STEEL IS HEATED BELOW ITS CRITICAL TEMPERATURE

The higher-carbon tubes will not be appreciably more difficult to make or install, and there is nothing to indicate that they will absorb hydrogen more readily. It should be possible to make them as free from blowholes and they will be at least 40 per cent stronger in respect to tensile strength and elastic limit with no detrimental decrease in elongation or reduction.

To secure evidence of the effect of the carbon content on recrystallization, tests were made on five specimens, ranging from 0.006 to 0.315 per cent carbon. Each sample was annealed and then impressed with a 5 mm. ball under a load of 3,000 deg. The samples were afterward heated for four hours at 675 deg. C. (1,247 deg. F.) and then examined to compare the average grain size in the undeformed portion and in that part of the deformed portion showing the maximum grain size.

TABLE I. EFFECT OF CARBON CONTENT ON GRAIN GROWTH WHEN DEFORMED STEEL IS HEATED BELOW ITS CRITICAL TEMPERATURE

Carbon Content, per Cent	Number of Ferrite Grains per Sq.In.	
	Undeformed	Deformed
0.006	3.9	1.9
0.103	25.4	13.4
0.203	63.4	23.0
0.251	26.3	16.0
0.315	(a)	(a)

(a) Grains too small to count. Photomicrographs from both the undeformed and deformed areas show no appreciable difference in grain size.

TABLE II. SERVICE TEST ON MEDIUM, HIGH- AND LOW-CARBON BOILER TUBES AT PARK PLACE HEATING PLANT, DETROIT, MICM.

Boiler Number	Installation		Replacement	
	Number	Date	Number	Date
High-Carbon Tubes in Front Row				
3	29	June 19, 1916	27	July 27, 1918
			15	Summer, 1920
6	29	May 9, 1916	13	Sept. 11, 1917
			5	July 15, 1919
			1	Summer, 1920
7	29	June 19, 1917		
8	29	June 9, 1917		
Totals....	116		61	
Low-Carbon Tubes in Front Row				
1	29	Sept. 23, 1916	27	July 12, 1918
			5	Summer, 1920
2	29	Sept. 18, 1916	10	Sept. 28, 1917
			27	July 11, 1920
			7	Summer, 1920
4	29	June 14, 1916	18	Jan. 6, 1917
			5	July 27, 1918
			13	June 17, 1919
			5	Summer, 1920
5	10	June 5, 1916		
	19	Aug. 3, 1917	10	Aug. 3, 1917
Totals,	116		127	

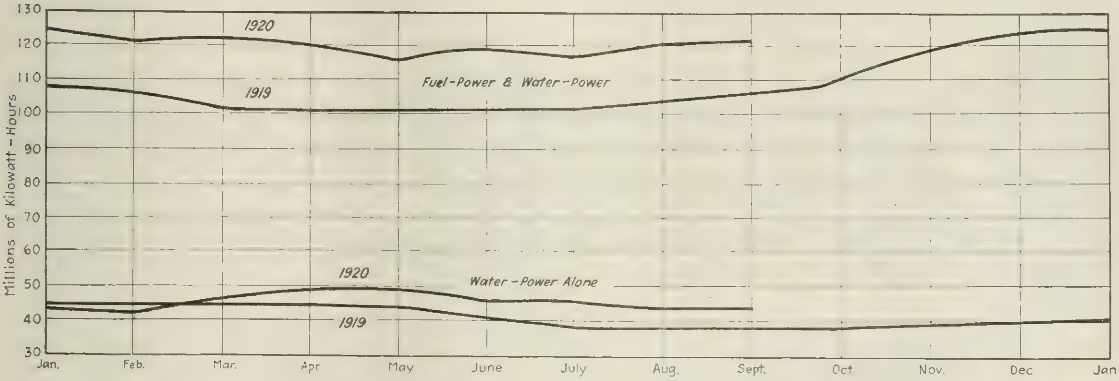
The results in Table I and the micrographs in Fig. 3 indicate a perceptible grain growth for the carbon range from 0.006 to 0.251 per cent, while no visible change appears with 0.315 per cent carbon.

To compare these theoretical results with those under service conditions tubes averaging around 0.30 per cent carbon were installed in the front rows of four of the 750-hp. Stirling boilers at the Park Place heating plant in Detroit, while four other boilers were equipped with front-row tubes ranging between 0.08 and 0.18 per cent carbon. The results of this test are given in Table II and speak for themselves.

The author does not criticize present boiler-tube manufacturing practices, which, all things considered, are on a high quality plane. He does, however, wish to present certain facts and to question whether tubes with a carbon content of 0.30 to 0.35 per cent would not insure longer tube life and safer boiler operation than tubes having 0.08 to 0.18 per cent carbon.

Production of Electric Power in the United States

As shown by the accompanying chart, the average daily production of electricity in kilowatt-hours by public-utility plants in the United States for the first nine months of 1920 was as follows: January, 124,700,000; February, 119,800,000; March, 120,700,000; April, 119,100,000; May, 115,600,000; June, 118,800,000; July, 117,000,000; August, 119,700,000; and September, 120,200,000. The proportion of each monthly total produced by water power was, respectively, 33, 33, 38, 41, 42, 40, 38, 37 and 37 per cent. The total output of electricity in this time was 28,341,000,000 kw.-hr.; this was 15.5 per cent greater than the output for the corresponding period of 1919. The amount of fuels consumed by these public-utility companies in this nine months' period of 1920 was: Coal, 27.7 million short tons; fuel oil, 9.9 million barrels; gas, 18.2 billion cubic feet.



AVERAGE DAILY PRODUCTION OF ELECTRICITY BY PUBLIC UTILITY PLANTS IN THE UNITED STATES OBTAINED BY DIVIDING THE TOTAL FOR THE MONTH BY THE NUMBER OF DAYS IN THE MONTH

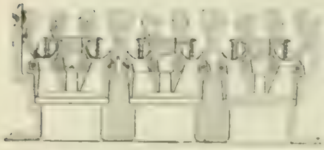
These figures are based on returns received by the Geological Survey from about 3,000 power plants of 100-kw. capacity or more, engaged in public service, including central stations, electric railways and certain other plants which contribute to the public supply. The capacity of plants submitting reports of their operations is about 94 per cent of the capacity of all plants listed; consequently the figures may be regarded as conclusive.

Applications covering 7,726,651 hp. had been submitted to the Federal Power Commission at the close of business Nov. 20. This greatly exceeds the most optimistic estimate made prior to the passage of the Water-Power Act. That estimate will be exceeded by 400,000 hp. if the treaty is modified so as to permit the diversion of 20,000 sec.-ft. additional from the Niagara River. The projects on navigable streams involve 4,790,350 hp. and those on public lands and reservations 2,936,301 hp.

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Valve, Duplex Uniflow Pumping Engine Water
Worthington Pump & Machinery Corp., New York City
"Power," Nov. 9, 1920

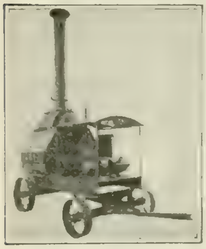


This pump valve consists of a soft-rubber valve seat reinforced by a copper ring. The metal valve is made saucer-shape, with a spring pressure on one side working against the water pressure on the other. The discharged water not only escapes past the outer edge but also finds a passageway through the opening between the outer and center portions of the valve. The valve seat is tapered, and the water is discharged past the valve at an easy angle, which reduces the friction.

Hoist, Telescopic, Ash
Gillis & Geoghegan, 537 West Broadway, New York City
"Power," 1920

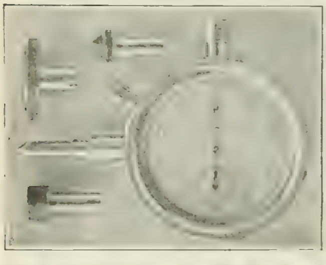
Several types of telescopic hoists are made, "Type D" being designed for handling ashcans from basements and unloading into wagons. This hoist is electrically operated, and the upper part of its telescope is below the grade when not in use. It will raise a load of 300 lb. at a speed of 60 ft. per min. and is designed to raise loads of 6 or 7 ft. above grade, and as much as 3 ft. away from the hoistway, thus permitting of dumping into an ash cart. The steel cable used is non-rotating, which eliminates twisting. The machine is equipped with an automatic stop and gravity lowering device.

Dynamobile, Ludlum
New York Engineering Co., 2 Rector St., New York City
"Power," Oct. 26, 1920



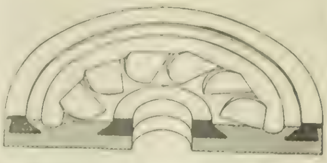
This machine consists of a water-tube marine-type boiler, a steam turbo-generating unit, switchboard, boiler-feed pump, feed-water heater, condenser, and where the highest economy is desired, a superheater. All are set on a steel frame mounted on wheels. The outfit can be furnished for burning any kind of fuel. It is built in 10-kw. capacity up to 220-kw., either alternating or direct current.

Indicator, Hasler Speed
C. H. Boulin, 82 Duane St., New York City.
"Power," 1920



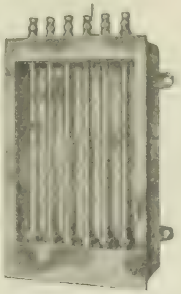
This integrating tachometer counts the speed over a period of three seconds and then "integrates" the results to give the desired information in terms of revolutions per minute or yards per minute. No watch is needed, as the timing is obtained automatically. Once the contact is made with a shaft the spindle of the instrument runs freely until a large button is pressed and released. This makes direct connection with the hands on the dial. After running for three seconds the spindle is automatically freed and the hands remain in the reading position. After the reading has been taken the hands may be brought back to zero by pressing a button. The instrument has a speed ranging from one to 10,000 r.p.m.

Valve, Norbom Rotating Pump
Norbom Engineering Co., Darby, Pa.
"Power," 1920



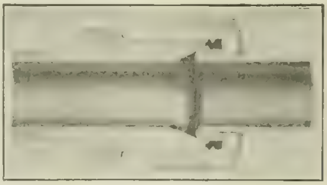
This valve consists of a light and strong alloy body and a special soft-metal face where it comes in contact with the valve seat. This lining will not break and is not affected by oil, cold or hot, acids or alkali water. The under surface of the valve is cast with turbine veins, which cause it to rotate, thus wearing the soft-metal lining evenly. When worn the lining can be renewed.

Multigage, Philo
Schumacher-Santry Co., 141 Mills St., Boston, Mass.
"Power," Nov. 23, 1920



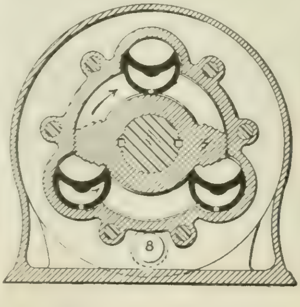
This gage consists of six tubes into which the liquid flows and which connects with a storage tank that is filled to the zero mark on the scale with special gage oil having a specific gravity of 0.89. The six tubes are placed so that a careful comparison of each reading with any other may be obtained. With conditions running normally, the height of the liquid in the various tubes form a certain curve. Any variation in the characteristics of this curve caused by a too heavy fire on parts of the grate or by blowholes will immediately tell the fireman how to adjust conditions.

Union, Reilly Screwed
Griscom Russell Co., 90 West St., New York City
"Power," 1920



The heating surface of the Reilly heater consists of interchangeable coils which are attached to the top and bottom manifolds by screwed union joints. It it is a metal-to-metal joint and eliminates any possibility of leakage and also facilitates the easy removal of the coils. This construction obviates the necessity for brazing, and every coil and union is standard and interchangeable. This type of joint makes a tight connection and is an assurance against breaks.

Engine, "High Speed" Steam Rotary
High Speed Engine Corporation, Union Bldg., Newark, N. J.
"Power," 1920



This engine, of the rotary type, has but four working parts, a shaft with a motor mounted thereon and three rolling abutments. It has no packing stuffing boxes or rubbing surfaces, and all parts are carried on ball bearings. Steam is used expansively, and as the steam receives a cutoff from one rotor piston the one on the opposite side receives a steam impulse before the first one is completed, so there is no idle point in the cycle. The length of the stroke or the amount of steam admitted can be controlled by a ring valve, of which there are three, by a central pinion to a segment.

Clip, paste on 3 x 5-in. cards and file as desired

New Publications

POWDERED COAL AS A FUEL. By C. F. Herington. Published by D. Van Nostrand Co., New York. Second edition; 303 pages; 124 illustrations. Price, $4.50.

The author, who has had a very extensive experience in the burning of pulverized coal, in this volume discusses the several problems encountered and the various pieces of machinery used in powdered-coal plants. The book is well written and covers the field more thoroughly than do other similar volumes. Unfortunately, the field is so broad that insufficient space is given to the several applications, such as power generation, steel furnaces, and other industrial processes. Owing to the increasing adoption of pulverized-coal equipment in boiler plants, the power plant engineer is very much interested in this form of fuel. The engineer will find considerable information here which applies to boiler use. The author points out one prevailing misconception. He states that while a poor coal can be burned successfully when pulverized, there is a limit to the quality that can be used. Furthermore, he states that it is hardly possible to use anthracite culm, concerning which much has been written of recent years. It is unfortunate that more actual operating data are not given; most of the coal figures listed are estimates. In these estimates he rather inclines to underestimate the labor required, which considerably exceeds that required by a stoker fired or an oil burning boiler plant. The power engineer will find the volume well worth his while, since it gives him the best available information on pulverized coal.

Society Affairs

The Akron Section of the A. S. M. E will hold a meeting on Dec. 17, at which E. S. Carman, the president-elect of the society, will speak.

The American Society of Safety Engineers will hold a joint meeting with the New York Chapter of the National Fire Protection Association at 8 p.m., Dec. 17, in the Engineering Societies Building, New York City. The program will include papers, moving pictures and general discussion of the subject of safety from fires.

The Boston Section of the A. S. M. E. will meet on Dec. 17. The speakers will be H. J. Barrows and W. S. Murray, and their subjects will be "Water Power of New England."

The Pittsburgh Section of the Association of Iron and Steel Electrical Engineers will hear an address on "Electric Welding," by Gordon Hughes, of the Truscon Steel Co., Youngstown, Ohio, on Dec. 18.

The Buffalo Section, A. S. M. E., will meet at the University Club on Dec. 21 to hear a talk by C. F. Collins, of the General Electric Co., on "Industrial Applications of Electric Furnaces."

The Engineer's Society of Western Pennsylvania will meet in the William Penn Hotel, Dec. 14. G. G. Bell, of the West Penn Power Co., will read a paper entitled "Steam vs. Electric Driven Power-House Auxiliaries"; the paper will be illustrated by lantern slides.

The Engineering Society of Western Massachusetts will meet at 8 p.m., Dec. 14, in the Holyoke High School, Holyoke, Mass. There will be presented a motion picture on "The Story of Petroleum," which was prepared by the Bureau of Mines. Prof. Charles M. Allen, of the Worcester Polytechnic Institute, will speak on "Uses and Abuses of Gasoline, Kerosene, etc."

Personals

Ray Mayhew recently motor engineer with the American Hoist and Derrick Co., St. Paul, has taken a position with the Clyde Iron Works, Duluth, Minn.

John B. Matthews, consulting engineer and surveyor, San Francisco, is now designing the first large turbo-electric driven passenger and cargo steamer to be built on the Western coast, and will have entire supervision of its construction.

W. R. Webster has resigned his position as assistant chief engineer for the Cambria Steel Co., Johnstown, Pa., to become general engineer of the Semet-Solvay Co., of Syracuse, N. Y.

Albert H. Hopkins has resigned from the presidency of the Engineering Advertisers' Association of Chicago, and from the managership of advertising and sales promotion departments of the C. F. Pease Co., Chicago, to become Chicago manager of the J. Roland Kay Co., Chicago, international advertising agents. Mr. Hopkins has been succeeded as president of the Engineering Advertisers' Association of Chicago by J. J. Arnsfield, advertising manager of the Fairbanks, Morse & Co. of Chicago.

Business Items

The Yarnall-Waring Co., of Philadelphia, Pa., has placed upon the market in this country, the Lea coal meter for use with chain-grate stokers. This instrument was first handled by the Lea Recorder Co., Ltd., Manchester, England, and was described fully in the Sept. 16, 1919, issue of *Power*.

The Metal and Thermit Corporation, New York City, has opened a branch office at 141 Milk St., Boston, under the direction of the New England district manager, Robert L. Browne. Inquiries will be answered from this branch office, but orders should continue to be addressed to the general office at 120 Broadway, New York City.

Trade Catalogs

The Cooper Hewitt Electric Co. has ready for distribution two bulletins: No. 86, "Cooper-Hewitt Quartz Lamp Laboratory Outfit," and No. 102, a technical bulletin on the Cooper-Hewitt Quartz Lamp and Ultra-Violet Light. The latter contains scientific data and a short bibliography which should be useful in a study of this form of lighting.

The Elliott Co., manufacturer of power accessories, Jeanette, Pa., has received from the printers a new catalog "C" of forty-eight 7 x 10-in. pages. This catalog contains descriptions and pictures on the company's line of jet and surface condensers, together with a good deal of useful, practical information on condensers in general.

COAL PRICES

Current mine quotations, with interesting comparisons, are given in the following tabulation:

	Nov. 1919*	Aug. 5 1920	Dec. 2 1920	Dec. 9 1920
Pittsburgh steam	$2.30	$10.00	$5.00	$4.00
Pittsburgh screened gas	2.30	12.00	5.50	4.75
Hocking	2.50	9.00	4.50	4.25
Franklin, Ill	2.35	6.50	5.00	5.00
Indiana 4th vein	2.35	7.50	4.00	4.00
Eastern Ohio, No. 8	2.35	10.50	5.00	4.50
Fairmont	2.50	13.50	4.75	4.25
Kanawha	2.60	14.00	4.75	4.50
S. E. Kentucky	3.00	10.50	5.25	5.25
Western Kentucky	2.35	5.25	4.25	4.25
Clearfield	2.95	12.00	5.00	4.75
Cambria and Somerset	2.95	13.50	6.00	6.00
New River	2.70	14.00	5.25	5.25
Pocahontas	2.35			

*Government prices.

Tidewater dumpings in the week of Nov. 27 were 1,034,000 tons, a decrease from the preceding week of 107,000 tons, according to the Geological Survey. The decline was due largely to the falling off of exports, which amounted to 399,000 net tons, as against 532,000 tons for the week before. Foreign shipments were less than 60 per cent of those during the record week of Oct. 17, when exports were at the rate of over 2,900,000 tons per month.

New Construction

PROPOSED WORK

Mass., Boston—The Chamber of Commerce, 177 Milk St., is receiving sketches for a 12 story, 100 x 184 x 184 ft. office building at Federal, Franklin and Congress Sts. About $6,500,000. Archt. and Engr. not selected.

Mass., Boston—The City Hospital, Dr. J. Dowling, Supt., plans to build a 3 story, 60 x 125 ft. hotel on East Concord St. About $350,000. Maginnis & Walsh, 100 Boylston St., Archts.

Mass., Dorchester (Boston P. O.)—The Schoolhouse Dept., City Hall Annex, Boston, had plans prepared for a 3 story junior high school including a steam heating plant on Roger Wolcott St., here. About $400,000. H. H. Atwood, 61 Alban St., Boston, Archt.

Mass., Pittsfield—The Pittsfield Electric Co., 92 Renne Ave., plans to build an addition to power plant. Between $100,000 and $125,000.

Mass., Woods Hole—The Dept. of Commerce, Bureau of Fisheries, Washington, D. C., will receive bids until Dec. 28 for the construction of a boiler and storage house at the fisheries station here.

R. I., Pawtucket—The Hope Webbing Co., 1005 Main St., plans to build a 5 story, 80 x 198 ft. addition to factory and a 1 story, 20 x 30 ft. boiler house. About $300,000. Perry & Whipple, R. I. Hospital Trust Bldg., Engrs.

Conn., New Britain—The School Comn., F. N. Gaffney, Chn., plans to build a state normal school. About $1,000,000. Guilbert & Betelle, 665 Broad St., Newark, N. J., Archts.

Conn., New Britain—The State School Board, State Capitol, Hartford, wants sketches for a state normal school and dormitory, here. About $900,000.

Conn., Putnam — The Nightingale-Morse Mills plans to build a wheel pit, install water wheels and are also in the market for machinery. Lockwood-Greene & Co., 60 Federal St., Boston, Mass., Archts. and Engrs.

N. Y., Brooklyn—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., plans to install a refrigerating system for Building "F," here.

N. Y., Cadyville—The International Paper Co., 30 Broad St., New York City, is having plans prepared for a hydro-electric plant on the Saranac River, here. About $250,000. A. H. White, c/o company, Engr.

N. Y., New York—The United Electric Light & Power Co., 130 East 15th St., will soon receive bids for a transformer station on West 97th St. About $150,000.

N. Y., Rochester—Tatlock Bros., 183 Tremont St., are in the market for one 50-hp. marine boiler.

N. J., Madison—The Bd. Educ. is having plans prepared for a high school. About $300,000. Guilbert & Betelle, 665 Broad St., Newark, Archts.

N. J., Maurer—The Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa., will receive bids until Dec. 20 for machinery and manufacturing buildings and a power house, here. About $1,000,000. Lockwood-Green & Co., 101 Park Ave., New York City, Archts. and Engrs. Noted Nov. 23.

N. J., Ridgewood—The Continental Paper Box Co., 122 Washington St., Brooklyn, N. Y., will soon award the contract for a 2 story, 100 x 500 ft. factory including a steam heating system at Grand and Hall Sts., here. About $250,000. W. B. Wills, Inc., 1181 Myrtle Ave., Brooklyn, N. Y., Archt. and Engr.

Md., Baltimore — Louis Hurwitz, 248 Equitable Bldg., plans to build an 8 story, 45 x 200 ft. office building at 219 Courtland St. About $500,000. J. Freund, 1307 St. Paul St., Archt.

Md., Baltimore — The City Council had plans prepared and will soon receive bids for a 3 story, 125 x 150 ft. school at 33rd St. and Hillen Rd., including a steam heating plant. About $350,000. C. N. Friz, 2010 Lexington Bldg., Archt., C. L. Reeder, Park Ave. and Saratoga St., Engr.

D. C., Washington—The Treasury Dept., Supervising Architect's Office, will receive bids until Dec. 23 for a boiler house and extending outside light and power feeders at the United States Public Health Service Hospital No. 32, 2650 Wisconsin Ave.

S. C., Charleston—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 29 for boiler plant improvements here. Noted Sept. 7.

Ga., Savannah—The Georgia Ice Co. will soon award the contract for a 2 story, 60 x 150 ft. addition to ice plant. One hundred ton ice making machinery will be installed in same. About $35,000. A. M. Dixon, P. O. Box 1352, Mgr.

Fla., Palatka—The United Sugar Corp., 1512 Walnut St., Philadelphia, Pa., is receiving bids for a sugar refinery including

12 buildings, spur track, etc., here. About $1,000,000. G. F. Anderson, c/o above address, Engr.

Ky., Louisville—The Ewald Iron Co., 324 North Clay St., plans to enlarge its present plant. About $1,000,000.

Ky., Louisville—The National Candy Co., 829 South Floyd St., plans to build an addition to present plant. About $1,000,000.

O., Cincinnati—The Cincinnati Gas & Electric Co., 111 West 6th St., is considering plans for the installation of a fourth generating unit. C. D. Jones, Pres.

O., Cincinnati—E. Heidingsfeld, Agt., 1106 Union Trust Bldg., has obtained option on site at McMillan and Manlove Aves. for a 115 x 300 ft. theater. About $500,000.

O., Cleveland—LaRoth-Keller Co., c/o H. Laronge, 10405 Parkgate Ave., N. E., purchased a site at the southwest corner of West 2nd St. and St. Clair Ave. for a 12 story, 146 x 166 ft. commercial building. About $1,500,000. Archt. not selected.

O., Cleveland—B. F. Keith, c/o Rapp & Rapp, 190 North State St., Chicago, Ill., is having plans prepared for a 21 story, 132 x 300 ft. theater and office building including a high pressure steam plant. About $3,500,000.

O., Columbus—The Northern Ohio Traction & Light Company, Akron, plans to build an electric power plant along the Muskingum River, 70 miles from here, to generate an initial capacity of 100,000 kw. Total est. cost, $15,000,000.

O., Youngstown—Strauss-Hirshberg Co., West Federal St., plans to build a 6 story, 300 x 300 ft. store building. About $2,000,000.

Mich., Battle Creek—The Bd. Educ. will receive bids about Jan. 1 for a 3 story, 75 x 400 ft. vocational school including a steam heating system. About $400,000. J. D. Chubb, 109 North Dearborn St., Chicago, Ill., Archt.

Mich., Detroit—The Fellowcraft Club, c/o F. E. Holmes, Washington Blvd., purchased site on Second Blvd. and will have plans prepared for an 8 story, 150 x 207 ft. club house including a steam heating system. About $2,000,000. Architect's name withheld.

Mich., Detroit—The Detroit Federation of Labor, c/o F. X. Martel, 77 East Adams St., plans to build a 10 story temple and office building including a steam heating plant on East High St. About $300,000. Archt. not selected.

Mich., Detroit—The League of Catholic Women, 47 Watson St., plans to build a 4 story, 120 x 140 ft. memorial clubhouse on Parsons St. About $500,000. Steam heating equipment will be installed in same. Archt. not selected.

Mich., Port Huron—C. Kern & Co. plans to build a 2 story electrically operated ice plant. About $100,000.

Ind., Crown Point—J. N. Coleman, Archt., 6257 St. Lawrence Ave., Chicago, Ill., will receive bids about Jan. 1 for several buildings including a 50 x 50 ft. power plant for The Crown Point Hospital, here. About $350,000.

Ind., Terre Haute—The Union Hospital, 7th and 8th Avenues, is having plans prepared for a 6 story, 44 x 200 ft. hospital including steam heating plant. About $300,000. Johnson, Miller & Miller, 105 South 7th St., Archts.

Ind., Valparaiso—The Pioneer Truck Co. is having plans prepared for a 2 story, 300 x 600 ft. factory including a steam heating system. About $500,000. Ronneberg, Pierce & Hauber, 10 South La Salle St., Chicago, Ill., Archts.

Wis., Kenosha—The Kenosha Ice Cream Co., 493 Elizabeth St., is having plans prepared for a 2 story, 46 x 75 ft. ice cream factory on Grand Ave. Refrigerating equipment will be installed in same. C. Augustine, Archt.

Wis., Kenosha—The Sheridan Hotel Co., c/o W. W. Ahlschager, Archt., 65 East Huron St., Chicago, Ill., will receive bids until about March 1 for a 10 story, 95 x 132 ft. hotel here, including a steam heating system. About $1,500,000.

Wis., Milwaukee—The Wisconsin Bed Spring Co., J. A. Mett, 968 Oakland Ave., plans to build a 1 or 2 story factory. Electric motors will be installed in same. Archt. not selected.

Wis., Watertown—The Badger Concrete Mixer Co., 221 Grand Ave., Milwaukee, plans to build a 1 story, 80 x 300 ft. factory here. Electric power motor will be installed in same. Archt. not selected.

Wis., Wauwatosa—The N. W. Chemical Co., State St., is having plans prepared for an air washing system including air compressor, centrifugal pump, mechanical fan, etc. About $8,000. C. Kinner & Son, University Bldg., Milwaukee, Engrs.

Iowa, Cedar Rapids—Linn County plans an election Dec. 27 to vote on $1,300,000 bonds for a 3 story, 128 x 208 ft. court house and jail including a steam heating system. J. W. Royer, Urbana, Ill., Archt.

Minn., Mankato—The Bd. Educ., c/o E. F. Searing, Secy., is considering a bond issue for a 2 or 3 story junior high school including a steam heating system. About $300,000.

Minn., Minneapolis—The Minneapolis Library Board, D. D. Dayton, Secy., 10th St. and Hennepin Ave., has selected a site and plans to build a 2 or 3 story library including a steam heating system at Hennepin Ave. and Groveland Terrace. About $1,000,000. Archt. not selected.

Minn., Rush City—J. D. Markham and A. Kelsey, Benham, Wis., plan to build a power plant, dam, and a 7-mile transmission line across the St. Croix River here. About $2,000,000. Druar & Milinowski, 512 Globe Bldg., St. Paul, Engrs.

S. D., Oldham—The city has voted $25,000 bonds for improvements to the electric light system.

Mo., Kansas City—The White Co., East 79th St. and St. Clair Ave., Cleveland, Ohio, had plans prepared for a 3 story, 120 x 144 ft. auto service station including a steam heating system at 28th and Warwick Sts., here. About $250,000. Watson Engr. Co., Hippodrome Bldg., Cleveland, Ohio, Engrs.

Mo., St. Louis—The Jefferson Hotel Co., T. Hays, Mgr., 12th and Locust Sts., will receive bids until Jan. 15 for a 12 story, 50 x 200 ft. hotel. About $1,200,000. T. P. Barnett, Arcade Bldg., Archt.

Mo., Springfield—The Shrine Temple Bd. of Trustees, C. G. Mark, Secy., Landus Bldg., will receive bids until March 1 for a temple including steam heating system. About $250,000. Archt. not selected.

Ark., Springdale—The Welch Grape Juice Co. plans to build a factory. About $500,000. Archt. not selected.

Tex., Dallas—The Oliver Chilled Plow Wks., 811-13 Elm St., is having plans prepared and will receive bids soon after Jan. 1 for a 10 story, 142 x 200 ft. office and implement house. About $600,000. Lang & Witchell, Amer. Ex. Nat'l Bank Bldg. Archts.

Tex., Dallas—The Dallas Athletic Club, W. E. Greiner, Pres., is having plans revised and will receive bids after Jan. 1 for a 10 story office building including a heating system. About $1,000,000. Lang & Witchell, Amer. Ex. Nat'l Bank Bldg., Archts.

Tex., Denison—The Chamber of Commerce is receiving bids for a 5 story, 150 x 150 ft. hotel including a steam heating system at Woodord and Burnett Sts. About $400,000. E. E. Hall, 123 West Madison St., Chicago, Ill., Archt.

Col., Denver—The Medicos Bldg. Assn. had preliminary plans prepared for a 6 story, 125 x 150 ft. office building at 17th St. and Bway. About $1,000,000. W. N. Bouman, 914 Central Savings Bank Bldg., Archt. and Engr.

Idaho, Hailey—The Mascot Mining & Milling Co. plans to install a 700-hp. hydro-electric unit next spring. C. Peters, Pres.

Cal., Los Angeles—The city, in co-operation with the county of Los Angeles plans to build a 385 ft. high gravity dam to be known as the Pacoima Dam. Plans include a hydro-electric plant. About $1,500,000. J. W. Reagan, Court House, Engr.

Cal., San Bernardino—The city has retained F. C. Finkle, Consulting Engr., I. W. Heilman Bldg., Los Angeles, to make report and prepare plans for water and power development in Cajon Basin. Plans include the Mathew's Lake project, development of 1,000 hp., storage of 630 in. water, $733,000; and the Vincent Cienega project, development of 770 hp., storage of 590 in. water, $767,000.

Cal., Santa Ana—The city plans to build a reservoir on Santiago Creek, and a dam, 100 ft. high, to impound 7,000,000,000 gal. of water. W. W. Hoy, City Engr.

Ont., Brantford—The Bd. Educ. plans to build a 3 story technical school including a steam heating system. About $300,000. Archt. and Engr. not appointed.

Ont., Toronto—The city engineer, R. C. Harris, has submitted report of estimates for 1921 which includes the expenditure of $100,000 for the installation of boilers and generators at the Riverdale pumping station and $156,000 for generator and alterations at the Highland Station.

B. C., Ruskin—The Western Power Co. of Canada, 198 West Hastings St., Vancouver, has received a report submitted by Creer & Mackenzie, Engrs., 837 West Hastings St., Vancouver, in regard to raising the dam and installing an additional unit of about 13,000 hp. at Stave Falls, here.

Sask., Prince Albert—E. F. Webb, City Clk., will receive bids until Dec. 18 for one horizontal centrifugal pump, 1,400 Imp. g.p.m., 50-ft. head, direct-connected to a.c. electric motors; one pump as above without electric motor (alternative); one horizontal centrifugal pump with capacity and head as above direct-connected to steam turbine; one horizontal centrifugal pump, 1,400 Imp. g.p.m., 190-ft. head, direct-connected to a.c. electric motor; one horizontal centrifugal pump, 700 Imp. g.p.m., 190-ft. head, direct-connected to a.c. motor; one horizontal centrifugal pump, 1,400 Imp. g.p.m., 190-ft. head, direct-connected to steam turbine; two vertical centrifugal pumps, 500 U. S. g.p.m., 40-ft. head, suitable for sewage pumping, direct-connected to a.c. motor.

CONTRACTS AWARDED

N. Y., New York—M. Gold, c/o Gronenberg Leuchtag, Archts., 393 5th Ave., will build a 7 story office building including a steam heating system at 127-131 West 33rd St. About $325,000. Work will be done by day labor.

N. Y., New York—The Wendell Estate, c/o B. H. & C. N. Winston, Archts., 2 Columbus Circle, will build a 4 story, 51 x 116 ft. office building including a steam heating system at 1900-8 B'way. Work will be done by day labor under supervision of architect.

N. Y., Sherman Island (Glens Falls P. O.)—The International Paper Co., 30 Broad St., New York City, has awarded the contract for a hydro-electric plant here, to the Barclay Constr. Co., 84 Pine St., New York City, at $5,000,000.

N. J., New Brunswick—The Artic Ice Co., 56 French St., has awarded the contract for a 3 story, 50 x 100 ft. storage plant to N. A. Bugbee Co., 206 East Hanover St., Trenton, at $75,000. Ice machinery will be installed.

O., Cleveland—The Cleveland Land & Security Co., Union Bldg., will build an office building including a steam heating system. About $300,000. Work will be done by day labor.

Ind., Indianapolis—The National City Bank, 14-16 East Washington St., has awarded the contract for a 14 story bank and office building including a steam heating system to the Hoggson Bros., 485 5th Ave., New York City, at $1,000,000.

Wis., Jefferson—The Jefferson Rubber Co., c/o C. Girton, will build a 1 story, 80 x 320 ft. tire factory including a steam heating system and is in the market for one 150-hp. high pressure boiler. About $100,000. Work will be done by day labor.

Minn., Lester Prairie—The City has awarded the contract for a feed water heater and stack, one 300 g.p.m. electric motor-driven pump and connections, and pipings to J. G. Robertson, 2542 University Ave., St. Paul, at $1,692.

Kan., Baxter Springs—The General American Oil Co., 604 New 1st Nat'l Bank Bldg., Tulsa, Okla., will build by day labor, an oil refinery here, and will require boilers. Contract for steam pipes awarded to the General Iron Wks., 604 New 1st Nat'l Bank Bldg., Tulsa, Okla.

Col., Lafayette—The Great Valleys Sugar Co., 800 Central Savings Bank Bldg., has awarded the contract for a sugar factory to Schwartz Eng. Co., Mack Bldg., at $1,000,000.

N. B., St. John—The Dept. Pub. Wks., Ottawa, Ont., has awarded the contract for the installation of a heating system in the Immigration Building to R. E. Fitzgerald, St. John, at $18,500. Noted Sept. 7.

POWER

Volume 52 New York, December 21, 1920 *Number 25*

"HURRY UP, DADDY, AND FIX THE 'LECTRIC LIGHTS ON THE TREE"

New Armour Plant at Kansas City

Modern Boiler Installation, 500-Ton Horizontal Ammonia Compressor and Generating Units, with Mixed-Pressure Turines of the Extraction Type To Give an Approximate Exhaust Steam Balance

AT KANSAS CITY, Kan., the packing plant of Armour & Co. is second only to headquarters at Chicago. It turns out a similar line of widely diversified products and during the war was the plant that made the emergency rations for the Army. This is the condensed food, compressed under 5,000-lb. hydraulic pressure, that made it possible for the "lost battalion" to exist. With this additional demand the capacity of the packing house was taxed to the limit and particularly the power plant, consisting of 8,000 hp. in boilers, Corliss-engine-driven generating units and vertical ammonia compressors, engine-driven. Much of this equipment was old, and the severe service put it in such condition that it was expensive to operate. Continued trouble had been experienced with surface condensers, due to unfavorable water conditions, and the generating capacity was so much below requirements that considerable current had to be purchased.

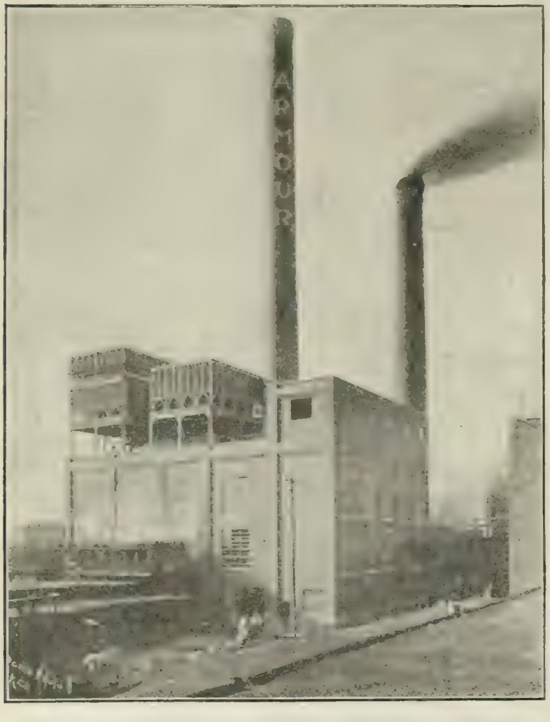


FIG. 1. EXTERIOR VIEW OF THE NEW POWER-HOUSE ADDITION

Shortly before the armistice, plans were drawn up for a new plant, and construction has progressed so that the initial installation will soon be in operation. It is replacing the old original plant known as section No. 1 of the power plant. Two later sections will be allowed to remain and will be operated at moderate capacities in conjunction with the new plant. The latter is to consist eventually of ten 583-hp. water-tube boilers, refrigerating and electric-generating equipment.

As an initial installation four boilers have been placed in service. They operate at 180 lb. pressure and have superheaters with sufficient surface to superheat the steam 50 deg. F. As it is planned to burn Cherokee slack or Illinois screenings from the Springfield district, chain-grate stokers have been selected. Each has an active grate area of 135 sq.ft., giving a ratio to the steam-making surface of approximately 1 to 43. Thus the grate has ample proportions for the inferior coal to be burned, and with the bottom of the front header 15 ft. above the floor, large furnace volume has been provided. Approximately, this volume figures 950 cu.ft., which reduces to 7 cu.ft. per square foot of grate, and when burning 30 lb. of coal per hour per square foot of grate, the furnace volume becomes 0.23 cu.ft. per pound of coal consumed. A suspended arch rising from the gate and then horizontal, in conjunction with a stoker sloping toward the rear, gives expanding volume for the volatile, and a restricted throat between arch and bridge-wall, with expanding volume toward the tubes, helps to mix the air and gases so that proper combustion may be

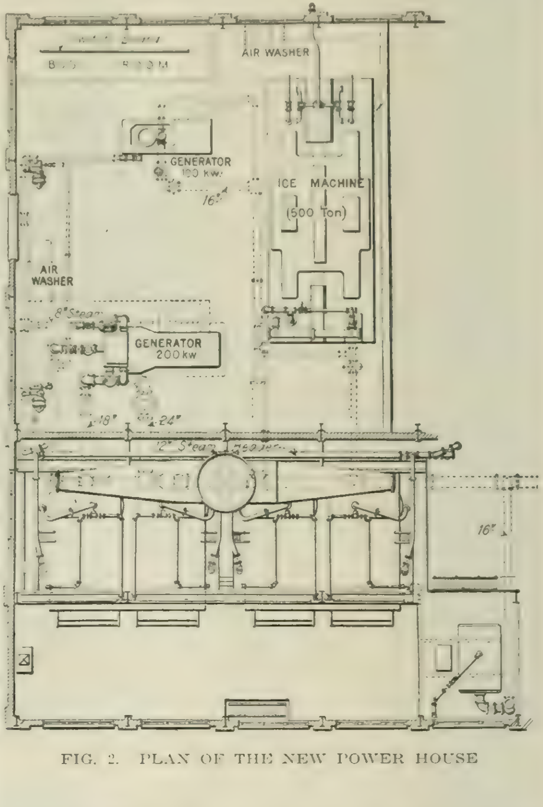


FIG. 2. PLAN OF THE NEW POWER HOUSE

attained before reaching the heating surface. The boiler is baffled for three passes, with the front baffle sloping forward to reduce the gas passage in conformity with the reduction in temperature and the corresponding shrinkage in volume of the gases.

A radial-brick stack resting on a concrete slab at the roof and supported by steelwork serves the four boilers. It rises 235 ft. above the grate and is 10 ft. in diameter at the top. The location is central and symmetrical breechings on either side rise and merge into a common flue discharging into the base of the stack. The breeching is circular and of cross-section tapering from 3 ft. diameter to 7 ft. 9 in. An easy turn at the stack and uptakes sloping with the run give a breeching offering minimum resistance to the flow of gases. The construction is of steel, lined with vitrobestos. Temperatures at the uptake are below 500 deg. F., a test at 175 per cent of rating showing a gas temperature at the outlet of 480 deg.

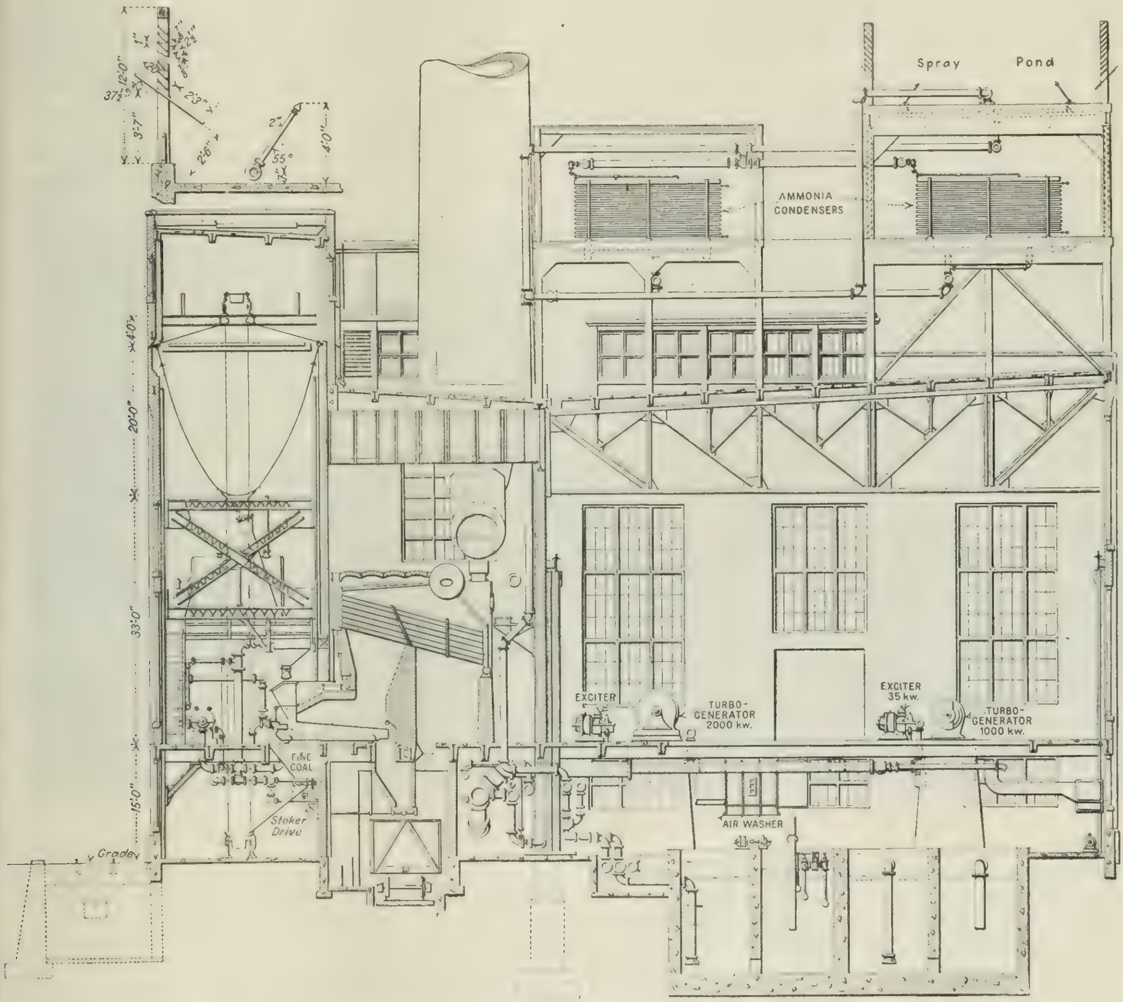


FIG. 3. CROSS-SECTION THROUGH ARMOUR KANSAS CITY POWER HOUSE

From data previously given one square foot of stack area serves, in round numbers, thirty boiler-horsepower and seven square feet of grate area. On the basis of 100 sq.ft. of steam-making surface, 2.3 sq.ft. of grate, 0.404 sq.ft. of breeching and 0.337 sq.ft. of stack have been installed.

Coal for the plant is dumped from railway cars into a track hopper, and by means of an apron conveyor is transferred to a continuous bucket carrier which delivers to the overhead bunker. The latter, which was designed by company engineers, is of parabolic cross-section, with individual sections for each boiler, and has a capacity of 400 tons, a thirty-six hours' supply for the boilers. Provision has been made for a coal crusher, but as yet it has not been installed, as the intention is to burn screenings and fine coal that does not need crushing. The capacity of the conveying equipment is rated at 50 tons per hour. From the bunker the coal gravitates through chutes into a traveling weigh larry and is then passed on to the stoker hoppers. Underneath the chain grate a fine-coal hopper has been provided, which delivers directly to the continuous bucket conveyor, and at the rear ash hoppers discharging directly into railway cars. This was possible as the basement floor line is practically at grade level.

Any one of three separate and distinct lines may be used to feed the boilers. Two of these lines are served by turbine-driven centrifugal pumps and the third by injectors. The original source of supply is the city mains. The water is first passed over ammonia condensers on the turbine-room roof, where during the colder months its temperature is raised to approximately 90 deg. It then gravitates to the jet condensers serving the turbo-generator units, and is delivered at a temperature of approximately 110 deg. F. to a large hotwell by the removal pump of the jet condenser.

By means of turbo-driven service pumps a part of this water is transferred to an open metering heater rated at 1,400 hp. and having sufficient capacity to serve the entire plant when completed as originally planned. The water is taken from the heater by turbine-driven boiler-feed pumps and discharged to the boilers under the control of feed-water regulators.

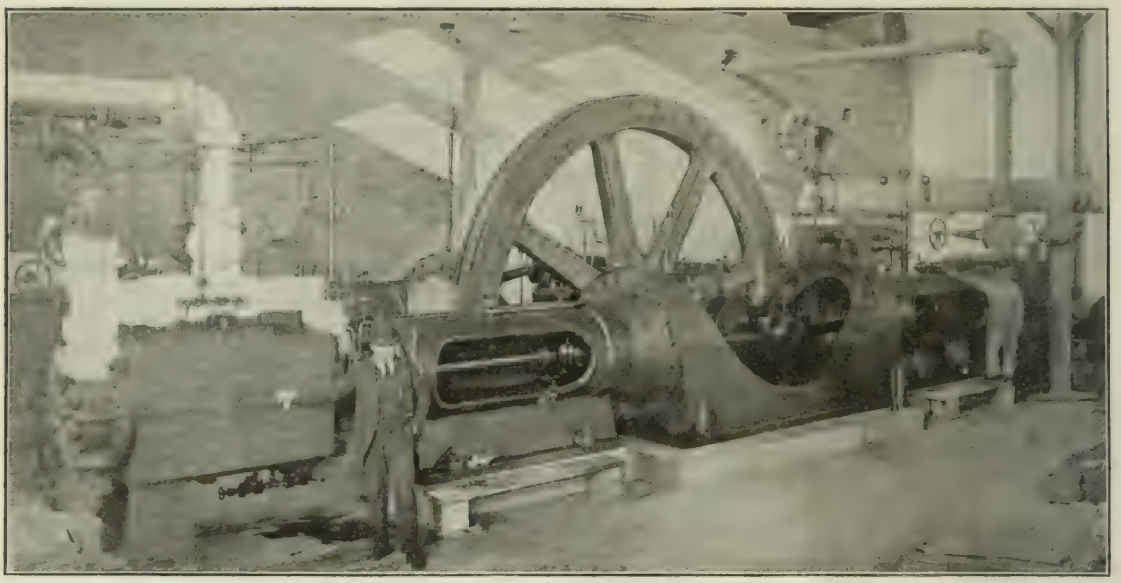


FIG. 4. VIEW OF NEW SIX-HUNDRED-TON ICE MACHINE

Water from the hotwell is delivered also to a spray pond located on the roof over the ammonia condenser. The sprays, twenty-four in number, will be used normally to cool 2,200 g.p.m. within three to five degrees of atmospheric temperature, although they have capacity to handle 2,800 g.p.m., and this in a floor space measuring 74 x 30 ft. From Fig. 3 it will be seen that the nozzles are arranged twelve on either side of the pond and spray toward the center. They are supplied by headers reducing from 8 to 4 in. in diameter as they progress toward the far end of the pond. The centers of the headers are within 7 in. of the concrete spray deck, but the nozzles rise to a height of 4 ft. above the floor and are set at an angle of 55 deg. with the horizontal.

To keep the spray within bounds, the louvers are set at a greater angle than usual and comparatively close, the inside edge of any board being one inch lower than the outside edge of the board below it. Near the outer edge of each board is a grooved recess to catch the spray and turn it back. Under the louver construction is a 51-in. baffle having the double function of keeping back the spray and of directing a current of air along the jets from the nozzles.

During the colder months this water gravitates over the ammonia condenser, through the jet condensers and is returned to the hotwell to be used as previously described. In summer it is impossible to cool city water below 100 deg. F. Consequently, deep-well water having a temperature of 65 deg. is passed over the ammonia condenser and is discharged to the sewer. City water from the spray pond is passed through the jet condensers and on to the hotwell as before. A cold well fed from the city mains under float control maintains the plant service and supplies makeup as needed for the hotwell.

As an addition to the refrigerating capacity a 500-ton horizontal cross-compound compressor has been installed in the new plant. The steam piping has been arranged so that in the event of either ammonia cylinder becoming incapacitated, the other side of the machine can be operated at reduced capacity; for example, the low-pressure side can be supplied with steam through a reducing valve at 60 lb. pressure. The condenser serving the unit just referred to is of the atmospheric type. It contains 60 stands, 24 pipes high of 2-in. pipe, 20 ft. long.

As in every other packing house, there is a great demand for steam in the various manufacturing processes and large quantities of hot water are required. It is economical to utilize exhaust steam from which mechanical energy has been derived, and it requires careful planning to balance the supply against the demand. To give some flexibility in this regard, mixed-pressure bleeder turbines drive the generating units, of which there are two, one rated at 2,000 kw. and the other at 1,000 kw. Both machines are served by jet condensers.

At the works they are beginning to change over a portion of the motor load to alternating current, and until this change is completely effected a temporary 750-kw. rotary converter set will be operated in conjunction with the new 2,000-kw. alternator that is now in operation. The new distribution system is designed for operating at 8,300 volts with transformers at the respective stations to convert to 440 volts three-phase 60 cycles for power and 110 volts single-phase for lighting. The present power current is 550 volts d.c. and the present lighting is 1,100 volts a.c. The old 550-volt d.c. generators will be retained for emergency purposes and will work in conjunction with the rotary converter, which is designed for reverse operation when required; that is, from direct current to alternating current, to take care of the new installation of alternating-current motors.

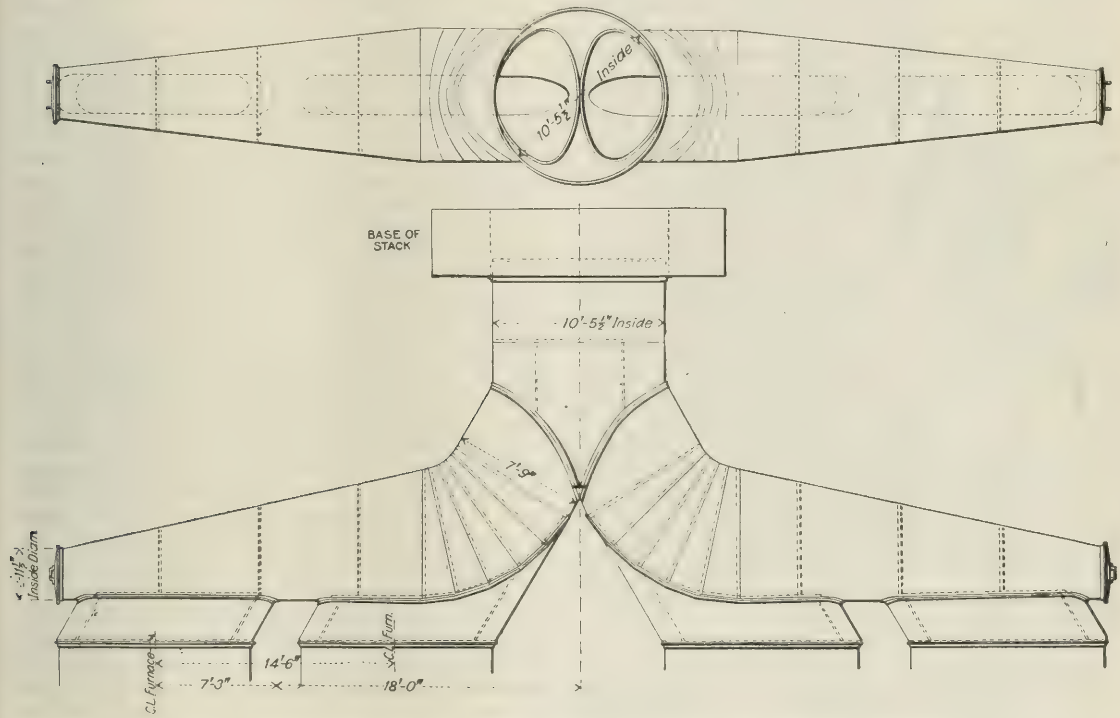


FIG. 5. BREECHING FOR THE NEW BOILER HOUSE OF THE ARMOUR COMPANY

Cooling air for the generators is washed, an air washer being provided with each unit. Outdoor air enters the intakes and the discharge is to the basement. Two 35-kw. turbine-driven exciters have been installed, although one machine will supply sufficient excitation for the two units.

It will be noticed that practically all of the auxiliaries in the plant are turbine-driven, and as they operate non-condensing, there is considerable exhaust steam available. While the 500-ton ammonia compressor is equipped with a jet condenser, it discharges normally in conjunction with the auxiliaries mentioned into a common exhaust main 24 in. in diameter, making the entire circuit of the plant and supplying all requirements for low-pressure steam. In this exhaust line a pressure of 5 lb. gage is maintained. If this pressure tends to drop, steam is bled from the turbines to make up the deficiency, and when the pressure in this line exceeds 5 lb., the flow is into the turbines, so that power that would otherwise be wasted may be recovered from the exhaust steam. All this takes place automatically, so that within the limits of the turbines there is no difficulty whatever in maintaining an exhaust balance.

From the turbines the steam is exhausted to jet condensers, and the heat in the mixture of condensation and cooling water is conserved by pumping the condenser discharge to the hotwell. To effect the balance desired, it will be evident that at times the generating units will operate as extraction turbines, sometimes as condensing units and at other times as low-pressure turbines, or as combination units using both high- and low-pressure steam. It will be realized that supplying the feed-water heater with sufficient exhaust steam for its requirements is one of the functions of the exhaust line.

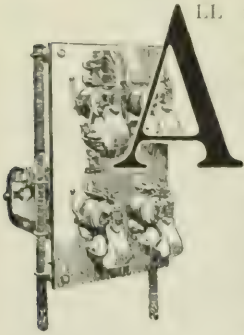
Complete utilization of exhaust steam in this way makes for efficiency, and in this regard a packing house, with its large steam requirements, possesses a decided advantage over the average industrial plant. The new plant is now in operation, and from all indications is showing marked economy in the generation and use of steam. All engineering was done by the motive-power department of Armour & Co., of which A. McKenzie is superintendent.

The Diesel engineer should study his engine and the method and theory of operation as closely as does the steam engineer. Considering the length of service necessary as an oiler or helper, Diesel engineering offers far more opportunity than does steam engineering.

Speed Control of Direct-Current Motors in Ventilation Service

By WILLIAM H. EASTON
Industrial Engineer, Westinghouse Electric and Manufacturing Company

The purpose of this article, which supplements one by the author on "Motors for Driving Ventilating Fans" (Power, May 11, 1920), is to discuss the various types of speed control for direct-current motors in ventilating service and indicate a method for determining the most economical type of control for a given installation.



ALL methods of controlling the speed of a direct-current motor are based on the fundamental formula of the motor, which can be written:

$$E = e + IR$$

in which E is the applied electromotive force; e, the counter-electromotive force generated by the motor; I, the current passing through the armature; and R, the resistance of the armature circuit. In other words, a part of the energy received by the motor is absorbed as losses due to the resistance of the armature circuit, while the greater part of the remainder is balanced by the energy generated by the motor, which of course acts as a generator when it is in operation. The motor maintains this relation of forces automatically, changing its speed to correspond with any changes in the other factors.

Speed Adjustment by Armature Control

It is evident that if the losses in the armature circuit are increased by increasing its resistance, the counter-electromotive force needed to form a balance will decrease and the motor will slow down. This is the principle of armature control, which is carried out in practice by connecting, in series with the armature circuit, resistance that can be varied by turning a regulating handle.

The method is, however, inherently wasteful, and in applications where the load remains constant at all speeds, as with printing-press drive, the energy lost in resistance at low speeds may considerably exceed that used for actual work. But with a centrifugal fan the load falls off very rapidly as the speed decreases (varying, in fact, as the 2.5th power of the speed), so that the energy losses at low speed with this method of control are much less than those with a constant-load drive. The maximum loss occurs at a speed reduction of 57 per cent and amounts to about 19 per cent of the motor's full-load input, and though this loss is fairly large, it is not prohibitive for many applications.

Armature control is essentially a method of speed reduction. If the speed of a motor is to be varied over a range of from 200 to 400 r.p.m. by this method, a machine with a normal speed of 400 r.p.m. is selected and the controller arranged for a 50 per cent speed reduction.

Speed Adjustment by Field Control

Since the counter-electromotive force generated by a motor is determined by the speed of its armature and the strength of its field, a decrease in the strength of the field necessitates an increase in the speed of the armature to maintain the balance indicated by the motor formula. By connecting an adjustable resistor in series with the field circuit of a motor the speed can therefore be varied at will within the limits imposed by the motor's design. This gives a method of speed regulation known as field control.

The operating efficiency of this method is high, for under all conditions the amount of energy lost in the field resistor is a negligible quantity. But on the other hand, the first cost of a motor to be operated over a given speed range by field control will be greater than that of a motor of the same horsepower to be operated over the same range by armature control. This is accounted for by the fact that the fields of the former must be larger than those of the latter in order to produce the necessary horsepower when the field current is weakened to produce maximum speeds. Motors to give a wide range of speeds by field control must, in fact, be specially designed for this purpose. The standard ranges are 1 to 2, 1 to 3 and 1 to 4.

Field control is regarded as a method of increasing the speed of a motor. Hence, when a speed range of from 200 to 400 r.p.m. by field control is required, a motor with a normal speed of 200 r.p.m. and a controller giving a 100 per cent increase in speed are selected. Care must, of course, be taken to select a motor capable of producing the horsepower desired at its maximum speed.

Combined Field and Armature Control

The objection to armature control is, therefore, its wastefulness at low speeds, while the objection to field control is the higher first cost of a motor to operate at increased speeds. In order to provide a compromise between these objections, controllers can be arranged so that part of the speed range is effected by field control and part by armature control. Thus, to obtain a speed range of from 200 to 400 r.p.m., a motor with a normal speed of 300 r.p.m. can be used, with a controller that will provide the 300 to 400 r.p.m. range by field control and the 300 to 200 r.p.m. range by armature control. With this method the first cost of the motor will be less than with straight field control, and the energy losses less than with straight armature control.

The following conclusions are obvious from the foregoing discussion:

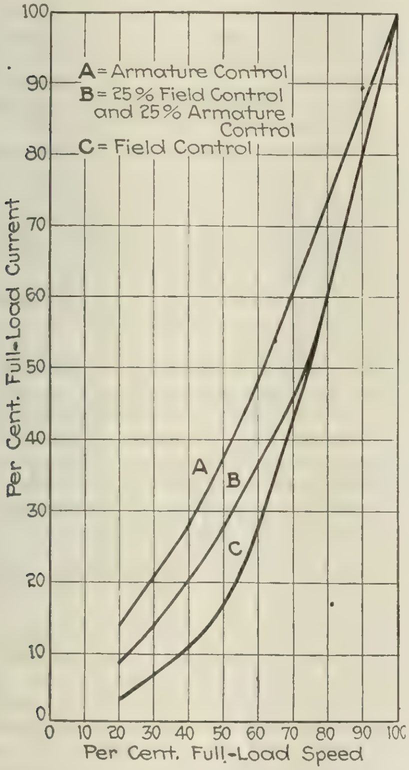
1. If the motor operates at its maximum speed practically all of the time, with only occasional periods

of operation at slightly reduced speeds, armature control should be selected.

2. If the motor operates mainly at low speeds but is occasionally operated at much higher speeds, field control should be selected.

3. If the motor's speed is being constantly varied over a wide range, combined field-and-armature control will probably prove the most economical method.

But in order to determine accurately the most economical method for a given application that does not clearly fall into either of the first two classes, it is necessary to calculate the cost of the power consumed by motors under each of the three methods of control for a period of, say, a year and compare these costs with the interest and depreciation costs of the motors and controllers.



VARIATION IN POWER, CONSUMPTION OF MOTOR OF 10-KILOWATTS NORMAL INPUT

The calculation of the current consumed can be facilitated by reference to the accompanying curves, which show the percentages of full-load power taken by a motor when driving a centrifugal fan at various speeds under each of the three methods of control. Assume the following simple example:

A motor of 25 hp. normal rating, at maximum speed, is required to drive a ventilating fan 365 days a year, 12 hr. at 400 r.p.m. and 12 hr. at 200 r.p.m. each day. The installation is expected to be operated at least ten years; cost of current is one cent per kilowatt-hour; and the motor manufacturer quotes price on motors and controllers as follows: For armature control, $990; for armature-and-field control, $1,130; for field control, $1,300. Which method of control will be the most economical in the long run?

The first step is to calculate the cost of the current consumed. The full-load power consumption of the motor will be $\frac{25 \times 0.746}{86.5} = 21.6$ kilowatts, where 0.746 is the factor to change 25 hp. into kilowatts and 86.5 is the per cent efficiency of the motor according to the manufacturer. As there are 8,760 hours in a year, the motor will operate 4,380 hours at full speed and the same number at reduced speed.

By all three methods of control the amount of power consumed at maximum speed will be the same; namely, $21.6 \times 4{,}380 = 94{,}608$ kw.-hr. But as shown by curve *A*, the current consumed during the 50 per cent reduced-speed period will, under armature control, be 39 per cent of this, or $94{,}608 \times 0.39 = 36{,}897$ kw.-hr.; at reduced speed curve *B* shows that the current under field-and-armature control will be 28 per cent, or $94{,}608 \times 0.28 = 26{,}490$ kw.-hr.; and as shown by curve *C* the current with field control will be 17 per cent, or $94{,}608 \times 0.17 = 16{,}083$ kw.-hr. Then the total kilowatt-hour use for armature control is $94{,}608 + 36{,}897 = 131{,}505$; for field and armature control, $94{,}608 + 26{,}490 = 121{,}090$; and for field control, $94{,}608 + 16{,}083 = 110{,}691$. Therefore the total cost of power per annum at one cent per kilowatt-hour will be: With armature control, $1,315; with field-and-armature control, $1,211; with field control, $1,107.

MOST ECONOMICAL TYPE OF CONTROL

By comparing the cost of a motor for armature control with that of a motor for field control, it is found that although $310 first cost will be saved by using armature control, a saving of $208 a year will be effected in power costs by using field control; and by comparing combined field-and-armature control with field control, a saving of first cost of $170 is found in favor of the former and a saving of $104 per year in favor of the latter.

Hence in both cases the difference in first cost would be saved in less than two years by using field control, so that for this installation this method is evidently the most economical. And if the cost of current were more than one cent per kilowatt-hour the advantage in favor of field control would be proportionately greater.

The curves given were drawn for a certain motor of 10-kw. input, therefore will not of course apply with complete accuracy to motors of other types and sizes; but the error for the average standard ventilating motor of good characteristic should not be so large as to prevent the use of these curves for ordinary purposes, especially since the number of hours during which the fan will operate at various speeds is usually difficult to determine exactly. For very accurate work the motor manufacturer should be requested to make the foregoing calculation, using the actual performance data and prices of the motors under consideration.

To keep in touch with the operation of the plant and to determine if it is working at the highest efficiency, it is necessary that a correct log be kept of all departments. This log of itself has no value unless it is carefully analyzed from day to day to determine whether the plant did maintain the highest efficiency on each particular day under the conditions at which it was necessary to operate.

The Proper Selection of Fuel for the Oil Engine

By ALLEN F. BREWER

ENGINEERS, power-plant managers and purchasing agents, today, who have to do with the selection of oil fuel for internal-combustion, heavy-oil engines are met with the ever-prevalent question: How is it possible to choose an oil most adaptable to the engines and at the same time most economical? Gradually, we are beginning to realize that fuel-oil specifications and builders' recommendations are but a means to an end, based on the more or less ideal conditions of the testing floor. Any worth-while test is made under somewhat more exacting conditions and requirements than are expected for normal operation of the apparatus, yet it is impossible for the testing engineer to obtain all the abnormal factors that may be met with after the engine has been actually delivered and put into operation by the owners. These may be, altitude, climate, intelligence of labor, fuel oil storage and heating facilities, etc.

It is evident that to follow blindly a set of builder's recommendations or a hard-and-fast fuel-oil specification may frequently result in the purchaser being severely handicapped when it actually comes to burning the oil he has selected. Let it not be understood for a moment that the engine builder's fuel recommendation or the oil manufacturer's fuel specification should be disregarded in any way. By no means. On the other hand, they should be given as great consideration as ever, but with ample thought as to the conditions under which the engine must operate.

THE BASIS OF PURCHASE

The day of purchasing fuel oil by the barrel or B.t.u. content alone is fast passing into history. More and more must economy of operation be considered, as well as economy in fuel. So, the selection of the fuel must be more carefully made, because the results derived from any oil engine will hinge to a large extent on the grade of fuel. We would not purchase any other commodity in half as haphazard a manner as many engineers have bought their fuel oil heretofore. Whatever the article, it is the inherent impulse of the intelligent man to look carefully into quality, physical properties, durability and ability to do the work required according to actual conditions of use. In other words, we buy for wear or service. So must the selection of fuel oil for the Diesel or semi-Diesel engine be made hereafter if we are to most effectively consume oil.

The heavy-oil engine is perhaps the most sensitive piece of apparatus today, wherein a petroleum product is used. The efficiency derived will depend most acutely on climate, altitude, conditions of operation and the intelligence of the operator. For example, an engine that would show excellent efficiency in New York when tended by an expert engineer, might perhaps fail utterly on the same fuel oil if in operation in a mine in the Andes Mountains, where the labor employed is of the ignorant native type.

The prime object in operating any power-generating equipment, such as the Diesel engine, is to attain the utmost economy under the prevailing conditions of operation. The chief demand of economy is that suitable fuel, to burn under these conditions, may be obtained whenever and wherever required and in the quantity required, at the cheapest price per barrel. The chief requisite for efficiency is that the engine can be properly made to burn this fuel by the labor at hand and under the peculiar conditions that may be present. Wherever possible, an effort should be made to use the heaviest fuel thus available, since the heavier the oil the greater heating value it will have per barrel and the cheaper it will be.

PHYSICAL AND CHEMICAL PROPERTIES

Whatever the grade of fuel oil to be burned in a Diesel engine, there are certain physical and chemical properties or characteristics, as already referred to, which must be given due consideration by the purchaser in making his decision as to a fuel best adapted to meet his operating conditions. General properties that should prevail, whatever the oil, are: That it should be free from incombustible solids such as dirt, grit, etc.; that it should not contain more than one per cent water; that it should be sufficiently mobile at operating temperatures as not to require excessive preheating.

The more varying physical and chemical characteristics are classified here, and briefly discussed, in order of their importance.

1. Range of Boiling Points—Of all characteristics perhaps the most important guide to the purchaser is the range of boiling point, since it indicates the degree of vaporization possible, the burning power of the oil and the extent to which it will gasify. The greater the proportion of distillate between 400 and 750 deg. F., the better will be the properties mentioned. A statement of range of boiling points set forth in 10 per cent fractions of distillation is therefore of utmost importance to the purchaser and should be furnished by the oil manufacturer.

2. Water Content—This is detrimental for three vital reasons: There is danger of water slugs carrying over to the fuel valves causing faulty firing; the danger of chemical action with sulphur in the oil, to cause ultimate corrosion within the engine by formation of sulphurous-acid gas; the fact that water lowers heating value and entails fuel consumption for its evaporation. Water content in Diesel or Semi-Diesel engine fuel oil should not exceed 0.3 to 0.5 per cent normally; or 1 per cent at an outside maximum.

3. Ash Content—Ash to any extent in a fuel oil will cause abrasion of cylinders (necessitating frequent cleaning of the engine) and excessive wear. No such oil should contain above 0.01 per cent of ash as determined by actual evaporation test.

Sediment Content—In general, sediment content will have the same effects that high ash content would; that is, abrasion, excessive wear, etc. As a rule sediment or dirt will contain a large percentage of silicates, which will tend to become incorporated with the lubricating oil and cause abrasion and scoring. It is commonly agreed that there shall be practically no such foreign matter in a Diesel fuel oil; it can be removed by proper straining, and this should be done always, prior to use in the engine. The opportunities for entry of dirt during handling, transit, etc., are great, hence as a safeguard never draw an oil below one foot from the bottom of the storage tank, and sample and test frequently.

5. Sulphur Content—The ultimate effects that high sulphur content in a Diesel fuel oil may have on the engine has been the subject of varied discussion recently. The common belief is that sulphur in the presence of water vapor will oxidize and react to form sulphurous acid. To what extent this may occur will, of course, depend on the amount of water in the oil. With a low water-content oil sulphur as high as 3 to 4 per cent should have no detrimental effects as regards corrosion. The reaction prevalent between sulphur and the lubricating oil is, however, of considerable importance, whatever the percentage of the former, owing to the fact that a gummy substance will result, reducing the lubricating properties of the lubricating oil and necessitating frequent cleaning of the engine. It is generally assumed that a fuel oil for Diesel-engine use should contain less than 3 per cent sulphur in order to be satisfactory from the foregoing points of view.

6. Coke Content—The coke content is of particular interest because it involves the presence of a practically non-combustible solid in the oil, and ultimately in the engine. Using an oil of high coke content, only the petroleum hydrocarbons will be effectively burned, the coke residue remaining in the cylinders to a major extent, adhering to valves, seats and liners, fouling the valves, scoring the wearing surfaces, counteracting the effects of the lubricating oil and increasing the need for cleaning and repair. In a Diesel-engine fuel oil 5 per cent coke is generally considered as the maximum working limit, although the less the coke content the less, of course, will be the detrimental effects.

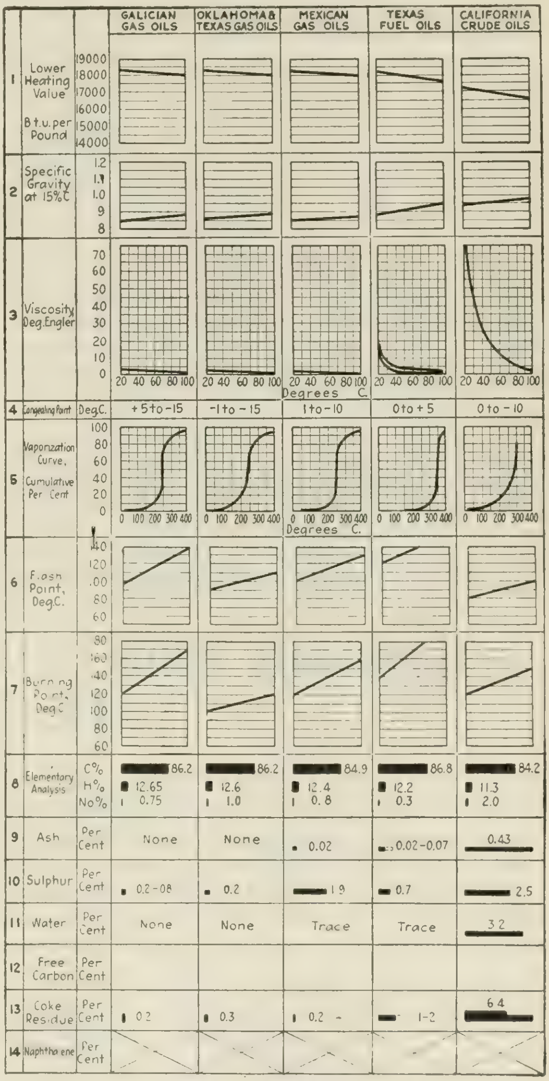
7. Acidity—Acidity, in general, should be entirely absent in any engine fuel oil. The objectionable feature is, of course, that excessive corrosion would result.

8. Flash Point—The flash point is of most importance to the consumer as a guide to the safe storage properties in the oil, it being the temperature at which the latter will give off vapors to form an inflammable gaseous mixture with air. The higher the flash point the lower the content of excessively volatile constituents. A flash temperature of 150 deg. F., by closed cup test, practically assures a sufficiently low content of high volatiles to allow of free handling and safe storage; it is generally taken as the minimum flash temperature in the trade today.

9. Viscosity—Viscosity, or more plainly, the relative fluidity of the oil as compared to a water standard usually is of particular interest to the purchaser where he may encounter difficulties in flow due to excessive cold weather or sudden temperature drops, coupled with lack of heating facilities in storage tanks, excessive length of piping to be pumped through, or insufficient pump capacity. The oil, by actual test, should prove itself of sufficient mobility to flow properly at the lowest atmospheric temperatures under which it is to be pumped to and burned in the engine. Owing to the fact that viscosity decreases with temperature, it is also a general guide to the consumer as to the extent that he must preheat the oil in question in order to insure proper and continuous flow.

10. Gravity—Although a fuel oil is generally spoken of in terms of its Baumé gravity, the latter is not a particular guide as to the fuel properties of the oil. It is, however, of interest to the consumer as a general indication of the relative fluidity of an oil at 60 deg. F.; that is, the lower the gravity the greater will be the viscosity, and hence the resistance to flow. Gravity is also a guide as to the calorific value; that is, the lower the gravity and the heavier the oil, the more heat units will it contain per unit volume.

11. Calorific Value—The calorific value is of little importance to the purchaser as an indication of the suitability of the fuel oil in question for his engine. Of course, the higher the heat content in British thermal units or calories, the more desirable the oil from an economical point of view. On the other hand, other more important properties should never be sacrificed to obtain a fuel of highest calorific value. In general, there is little variation between 18,000 and 19,000 B.t.u. per lb. for any fuel oil on the market today.



PROPERTIES OF TYPICAL OILS

Having at hand, and considered, the physical and chemical properties of the fuel oils available, the next step is to review conditions under which the oil most favored is to be burned. Assuming all the chemical properties to be satisfactory, viscosity essentially is the guiding physical factor, inasmuch as the problem of flow will be most pertinent in nearly every case. Prevailing temperature, dependent on both altitude and locality, must be the first consideration, along with the location of storage tanks, length of oil transmission pipe therefrom to the engine, the manner of laying or burying such pipe, extent of frost, etc. It is perfectly evident that in the tropics a far heavier-gravity oil will flow freely through the pipe line under average temperatures than would be the case in more frigid localities.

Preheating facilities in the storage tank is the next point of importance. Preheating will be a practical necessity in a cold climate to effectively burn an oil below about 30 deg. Baumé gravity. In the absence of such heating coils the maximum low atmospheric temperature should always be ascertained before the fuel oil is finally selected. If necessary, cold and pour tests should be run to note the extent of mobility of such an oil. An otherwise suitable oil, able to meet builder's recommendations, may frequently have to be rejected for a lighter, more expensive oil, solely for the reason that it will not flow freely from the storage tank to the engine under prevailing maximum low temperatures. Whether to take a chance on the heavier oil depends on the seriousness of impromptu shutdowns. If they are not of material account, the heavier, cheaper oil may well be used.

The question of elevation of the storage tank in respect to the engine and the capacity of the pump available is the third important factor. The heavier the oil, particularly if flow is against a material head, the greater must be the capacity of the pump. It is quite evident that it would be folly to purchase an oil of so low a gravity as to put a constant overload on the transmission pump or so heavy as not to flow to the engine in sufficient quantity to meet consumption. Such an oil might amply meet recommendations, yet the logical course would be to purchase a lighter oil which would not involve the possible difficulties mentioned.

To burn a fuel oil of normally low gravity in the Diesel or semi-Diesel engine successfully will necessitate a certain degree of intelligence on the part of the operating engineer. Both in operating or repairing he must "use his head." So, we have the final important operating factor to consider before the oil is purchased. The lighter the fuel, the less danger will there be of sudden shutdowns or need for adjustment due to clogging of the fuel valve, cylinder deposits, carbonization, or imperfect flow of the oil.

In brief, then, to select a fuel oil for any Diesel or semi-Diesel engine plant in the most efficient and economical manner, we must consider:

1. The engine builder's recommendations.
2. The oil manufacturer's specifications of physical and chemical properties for the fuel oils available at the particular place and time when needed.
3. The peculiar conditions under which operation is normally carried on, including temperature, labor, pumping facilities, storage, and facilities for fuel transmission.
4. The extent to which an oil described under paragraph 2 and recommended under paragraph 1 above, will meet conditions existing under paragraph 3.
5. In making the selection, the purchaser should not ignore the heavy fuel oils which are offered on the Atlantic Seaboard at a price much below the distillates. Although the dirt and coke contents are objectionable, many engines have used 12 deg. Baumé Mexican oil.

Economic Value of Coal—III. Falling Off in Heat Content

By B. S. Murphy

A comparison of the relative value of anthracite and bituminous coal based on the effective heat content in each shows that anthracite not only costs less but is actually worth more.

The calorific value of all coals has fallen to a marked extent during the last few years, and this loss has been more pronounced, if anything, for anthracite. To show this falling off in the quality of the anthracite as received from 1911 to 1920 at one station, the table herewith has been prepared. All this coal was purchased from the same contractor, and though it did not all come from the same colliery, over 95 per cent originated in the same region. From 1911 to 1917 up to 30 per cent to possibly 40 per cent was No. 1 buckwheat, the rest being No. 3 with a small amount of No. 4, and this represents the purchase and consumption of some 1,200,000 tons of coal.

The maximum and minimum do not represent isolated samples, but are the maximum or minimum months for the period considered. To show just what a falling off as shown means, we will assume a station where the 100 per cent performance with 12,000 B.t.u. coal was 3 lb. per kilowatt-hour. We will also assume that the average calorific value of the coal supplied to this station from 1911 to date was the same as given in the table. Now referring to Fig. 1 we will first draw the standard performance curve assumed that for 12,000 B.t.u. coal the station will turn out a kilowatt-hour for 3 lb. of fuel, or the first point will be 12,000 B.t.u. against 3 lb. For the other point on this straight line take 10,500 B.t.u. and referring to the curves showing calorific value vs. relative plant economy in the second article of this series (Dec. 14 issue), we find this is 57.5 deficient, or makes 57.5 + 100 = 157.5 per cent of coal, or 1.575 × 3 = 4.725 lb. Plotting this and connecting the two points by a straight line, we have the standard performance curve for this particular station that we have assumed. Then plotting the average

CALORIFIC VALUE OF ANTHRACITE COAL AS FIRED

Year	Maximum	Average	Minimum
1911	11,750	11,523	11,250
1912	11,650	11,428	11,050
1913	12,025	11,741	11,420
1914	12,060	11,912	11,560
1915	11,900	11,712	11,470
1916	11,880	11,563	11,150
1917	11,350	11,170	10,850
1918	11,257	11,070	10,780
1919	11,249	11,044	10,844
1920*	11,105	10,847	10,504

* January to June, inclusive.

calorific value of the coal as fired against the year, from the table, we have the actual B.t.u. curve. From this curve, in conjunction with the curve for standard performance, we find what the standard consumption would be and plot this against the year. Of course, in reality, this curve should not give the actual results, as it is standard practice and not actual practice, and the plus or minus variations would give the actual station performance.

We will now assume, as before, that the station output was 6,000,000 kw.-hr. per month, or 72,000,000 per year, and we will figure the standard coal that may be used per year for electric generation by multiplying the output of the station by the unit consumption, which we have already arrived at from the calorific value and the percentage deficiency of the coal corresponding. This has been plotted at the top of the graph and shows an allowable increase of 40,300 tons for the year 1920 over the year 1914. This is one phase; more coal made necessary by the lack of heat necessitating a greater money outlay, but at the same time the price of this inferior coal per ton has also gone up greatly, so that we not only use a greater quantity, but pay more for what we do use.

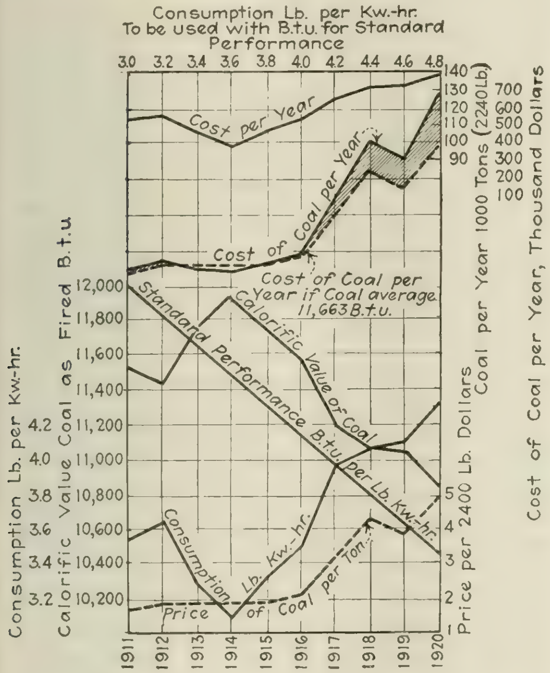


FIG. 1. EFFECT OF PRICE PER TON ON CALORIFIC VALUE OF ANTHRACITE

In Fig. 2 has been plotted the relative price of anthracite received at one station from 1911 to 1920, including the latest freight rate in 1920. Based on this current rate as 100 per cent it shows that in 1911 the price per ton was but 34 per cent of that now. Returning to our hypothetical station again and assuming that the anthracite No. 3 now costs $5 per 2,240 lb. at the boiler room and using these same relative values, we would have the price per ton for each year; this has been plotted on Fig. 1 and shows an increase of from $1.69 in 1911 to the $5 of 1920.

We will now compute what the coal cost was per year on these prices and plot these values in Fig. 1, giving us the yearly station cost for fuel. It will be noticed that from 1911 to 1916 there was not a very great difference in the total cost, but that since 1916 it has increased very rapidly. We will now attempt to approximate what has been the total additional money spent directly chargeable to the falling off in calorific value of the coal, allowing the price per ton to vary as already given. To do this, we will average the calorific value for the first five years; that is, from 1911 to 1915 inclusive. This was 11,663 B.t.u., which is equivalent to 3.37 lb. per kw.-hr. Then with this consumption we should burn for our 72,000 kw.-hr. of output per annum 108,300 tons. Then taking the price per ton for each year by this total tonnage, we have the cost per year if the coal had averaged the same for the whole period as for the first five years. The space between these curves has been cross-hatched to represent the additional money spent owing to the falling off in calorific value. This totals for the ten years $411,000 directly chargeable to lack of heat in the coal, or 12.2 per cent of all the money spent for fuel.

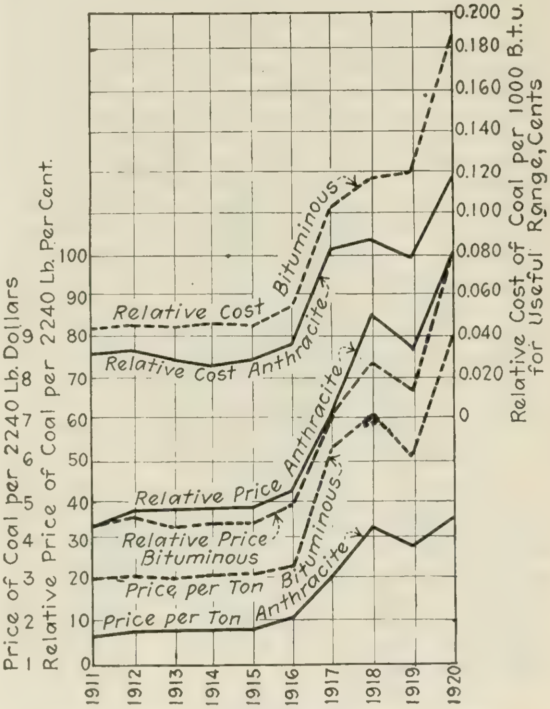


FIG. 2. RELATIVE COST OF ANTHRACITE AND BITUMINOUS COAL

In Fig. 2 has been plotted the relative cost per ton for No. 3 anthracite for a particular station, but from the foregoing analysis of the fuel cost of power we can easily see that, though the price per ton governs the actual money that has to be expended, it tells but little of the relative value of the particular fuel to the plant.

For a proper comparison we must use a figure based on the expected or standard performance of the coal itself or, expressing it another way, how much useful heat we may buy for a dollar. This term may be called the "relative cost of coal," or the cost per 1,000 B.t.u. in cents, of the heat in the coal above the low limit of its usefulness, or for an anthracite above 9,000 B.t.u. This may be expressed as

Relative cost = price of coal per 2,240 lb., in cents ÷ 2,240 [(B.t.u. per lb. of coal as fired — 9,000) ÷ 1,000].

On Fig. 2 we will now transfer the "price of coal per ton" curve from Fig. 1 for the hypothetical station under discussion, calculating this price from an assumed present-day price of $5 from the relative cost curve for an existing station. From this curve we will take the price per ton, and from the calorific-value curve on Fig. 1 the heat in the coal as fired, and with these figures in the aforementioned formula calculate and plot the relative cost of the coal, or the cost per 1,000 B.t.u. for the useful range, in cents.

We will now figure for bituminous coal on the same assumption as before that in 1920 we had to pay $9 for 2,240 lb. Using actual figures for a large soft-coal central station, we have plotted on Fig. 2 the relative prices, as compared to $9 for a base price, in per cent; this curve is a dotted line, using the dotted lines for the *B* coal values and the solid lines for the *A* coal. It will be noticed that the price variation follows along parallel with that for anthracite and also that the increase during the war, 1918, was not quite so rapid. We will now compute from these relative percentage figures what this soft coal would have cost with the present price of $9 as a base. The next step will be the derivation of the relative cost for this bituminous coal in a manner similar to before and to plot this as a direct comparison with the cost of the anthracite. To do this we will take for the low limit 11,000 B.t.u. and still keeping a range of 3,000 B.t.u., have 14,000 B.t.u. for the upper limit. The formula would then become:

Relative cost, or cost per 1,000 B.t.u. above 11,000 B.t.u. = cost per 2,240 lb., in cents ÷ 2,240 [(B.t.u. per lb. of coal as fired — 11,000) ÷ 1,000]

Substituting the values in this formula of the calorific values for the several years and the price per ton, we have a curve that from 1911 to 1917 is essentially parallel with that for anthracite, but from that time on it varies somewhat. A noticeable feature is that the anthracite not only costs less per ton, but is actually worth more, or we do not have to pay as much for 1,000 useful heat units.

It is never advisable to use thin free-flowing automobile oil on a semi-Diesel. The latter engine requires an oil with a heavier body. It is usually good practice to purchase the oil recommended by the engine manufacturer. To detect a leaky injection nozzle, remove it from the cylinder and reconnect it to the fuel pump. Give the pump handle a few quick jerks. If the check valve in the nozzle is in good shape, the blast of oil will be cut off cleanly without any dribble. The atomizer tip often fills with carbon. An extra one can be used while the old one is being soaked in lye water. A darning needle will be of help in cleaning the oil passage. If the fuel pump has ball-check valves which leak, a few light blows on a hardwood stick or a brass pin placed against the ball will renew the seat. Certain oils carrying much sulphur will attack the balls, giving them a rough surface. Such balls will leak and should be replaced.

Some Ice-Tank Defects

By Gilbert Cox Sellers

Upon visiting an ice plant under construction recently, the writer did not expect to find an establishment built exactly in accordance with the latest requirements for efficiency, but an installation as near to that standard as the unsettled conditions of present-day commerce would permit. The factories cannot secure the material, the railroads cannot deliver, and with the present labor conditions it is not possible to assemble as formerly, even after the material is at the factory. For these reasons we do not build in these times as we know, but we build as we can.

Of course these troublesome conditions bring on unfavorable results, and many defects are brought out. Many of these defects are but exaggerations of faults in construction that have caused trouble ever since ice plants have been built. There is an advantage in the present-day makeshift constructions. The old faults have been shown in their enlargement. Ridicule is the most cutting weapon of logic, and there is nothing that makes a fault more ridiculous than the placing of that fault before us in an enlarged form. The old-time plants had their defects, but we did not see them. The new plants, built from the commercial débris of a score of wars, and from the social unrest of a world's readjustment, necessarily have those faults so enlarged that we *do* see them.

Composite Construction of Plant

In the plant visited, the construction was a real composite outcome of present-day conditions. The builders, nevertheless, skillfully built to completion, putting in substitutes where possible, omitting here a non-essential and leaving a space there for a later installation, portraying in the whole the craftiness of a resourceful designer. However, there were things that could have been done to avoid some of the trouble that is sure to come.

Coils for the brine tank could not be obtained. The engineer, therefore, was forced to do without coils. A shell cooler was substituted. They could not secure oak can covers, so they substituted with soft wood. Throughout the entire tank construction the engineer was forced to follow his own resources. As a result, the tank is a makeshift, to say the best, and the chief is going to have his hands full from the day he harvests his first ice. The first trouble he will find will be in the brine level as compared with the level of the cans. The builders have nailed cleats in the framework for each can. Upon these cleats it is intended the cans shall rest to prevent them from sinking too low in the brine. The brine is supposed to stand immediately below the cleats, which were all placed at the same level. This arrangement would lead one to believe that they expected the brine to maintain a common level. Here is where the trouble will arise. The brine cannot stand at a common level throughout the tank.

To extract heat from the water requires brine circulation and to move the brine there must be a greater head at some part of the tank, such as is imposed by the agitator. At this point the brine will pile up and run down hill. The ice cans will stand low in the brine immediately before the agitator and high above the brine level at the other end of the tank. Besides, a shell cooler had been placed near the agitator, and the cans at this point will be in the coldest brine in the tank.

Over at the other end of the circulation the cans will be suspended out of the brine several inches right where the brine is the warmest and where every square inch of radiation should be brought into play.

Upon mentioning this defect to the owner, he made the remarkable statement that the brine would not pile up if it was forced fast enough. An examination of the tank showed the brine rushing out of the tubes of the cooler against the first cans it came in contact with, doubling back, lapping around the cans and going ahead a few inches, to be dammed up again and escaping only by falling forward to a lower level. It was apparent that the brine must stand so high before the agitator that the cans will lift the covers off of the framework before the cans at the lower end of the tank will be deep enough to freeze in proper time. Knocking the cleats off of the deck frames and arranging the frames so as to adjust the cans to the lowering of the brine level will eliminate part of the trouble, but even then only a part.

LITTLE CHANCE FOR SUCCESS WITH SHELL COOLER

There is little possibility for success with the shell cooler in ice making in this plant. An improvement might be made by placing the cooler outside of the tank and connecting the chilled brine line to several openings located in the bottom of the tank. The brine might be made to overflow into troughs located along the sides and perhaps down the center. In this manner the brine would not have a long travel before it again reaches the shell cooler and is rechilled, and the efficiency would approach more nearly that of the coil system so generally used. At least the level in such a tank would be uniform. Heat would not be passed from one ice can to another, and the tipping of cans due to agitation would not result.

If the unequal distribution of chilled brine were all of the trouble to be encountered, it could be eliminated later by installing brine coils. But there are other defects. The tank was built on a cinder foundation well packed and covered with a layer of concrete. But the cinders may become soaked at any time. Accidents may happen to the sewer, catch basin or water trap, so that the cinder bed below the tank will be flooded with water. If this happens a few times, or even if the rainy season raises the water level through the sand below, it will mean the loss of thousands of dollars.

Ice will form in the cinders, and the nearer to the center of the tank the thicker will be the ice. This means expansion from below, and the tank will bulge in the middle, lifting the cans out of the brine and causing a loss of efficiency.

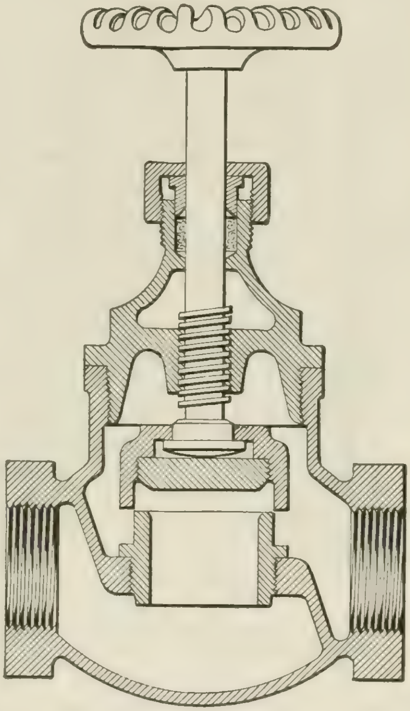
Such a defect is common in tank construction. When a tank is placed on the second floor it can never occur and should not take place on any floor. That it is entirely too common is demonstrated by the fact that of seven tanks that were inspected three were bulged in the center.

DEFECTIVE CONSTRUCTION DUE TO LACK OF FORESIGHT

Such construction is the result of a lack of foresight, if not a lack of experience. It is unnecessary to build on such a foundation. The tank should be insulated from moisture at the bottom the same as at the sides. No one would think of allowing water to stand about the walls of a tank to freeze even if there were a thickness of five inches of nonpariel cork board to hold off the moisture and to prevent the transmission of heat. There is no need either to allow water to approach the frost line from below the tank. Lay a cinder foundation for the tank with a concrete surface and place on this foundation concrete piers at least ten inches high and close enough to sustain the weight of the tank. On these piers lay a board floor and on the floor place the cork board. Build the tank on this foundation and drain the entire floor to the sewer through a water trap situated beyond the frost zone. With this construction the tank will never bow in the middle. If objection is made to the cost of construction, it would be well to begin figuring on the ultimate cost of reconstruction.

B. & O. Protected Seat Valve

In the protected seat valve manufactured by the Protected Seat Valve Co., Peoples Bank Bldg., Pittsburgh, Pa., the seat is protected from the flow of liquid or gases before the valve disk seats. This is accomplished by sleeves that telescope when the valve is being closed, thus reducing the velocity of the fluid to a minimum. The seats are self-cleaned by this low velocity before they make direct contact. When opening, the valve disk is raised above the zone of circulation before the telescoping sleeves disengage. If the sleeves are slightly disengaged the high velocity of liquid or gases cannot mar the seat.


SECTION THROUGH PROTECTED SEAT VALVE

The distance between the ground seats is several times greater than the area of the opening when the sleeves are slightly disengaged. The valve is adaptable for use with muddy water, etc. The seat and disk are easily removed, but the disk construction is such that it cannot become loose from the stem. Pressure may be applied from either side of the seat, but it is recommended that it be applied from the top.

The Development of Low Level Multi-Jet Condensers

By C. R. May* and N. E. Taylor*

THE multi-jet condenser was first described in *Power* in the issue of Sept. 14, 1909. Since that time notable strides have been made in the development of turbine and condenser practice. The condenser described in 1909 is illustrated on this page, Fig. 1, and the fundamental principles remain the same in the condenser built today. Until recently the general impression has been that multi-jet condensers were suitable only for small installations and moderate vacuums. The facts are that modern multi-jet condensers are suitable for all sizes of turbines up to units of 10,000-kw. capacity or even more, and in commercial operation are maintaining vacuums of 28 to 29 in. referred to a 30-in. barometer. The low-level multi-jet condenser was designed and developed by Koerting. His original idea was the elimination of an inefficient hot-water removal pump operating under conditions corresponding to a suction lift of 30 feet. In its earliest form his condenser had neither a removal nor an injection pump. Water was projected across the condensing chamber in a single jet by the force of atmospheric pressure against the vacuum within. This was called the ejector. An injection pump was added to overcome friction losses, but the result was still relatively inefficient. This condenser, called the "Eductor," has been in general use in England, on the Continent and in this country, but only in smaller installations where efficiency could be sacrificed to simplicity and low original cost.

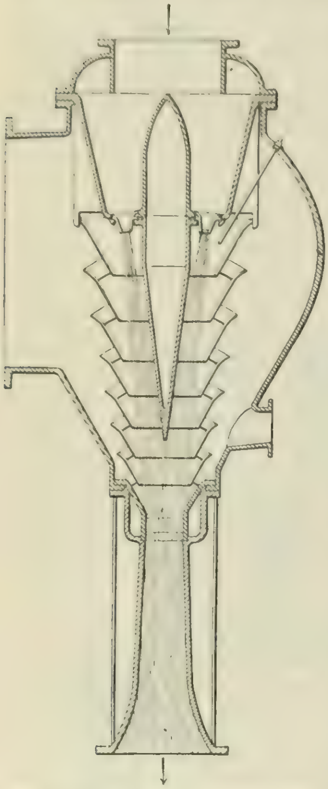


FIG. 1. ORIGINAL DESIGN OF MULTI-JET CONDENSER

The next step was to increase the number of jets in order to obtain greater efficiency of contact between steam and water. This condenser, Fig. 1, was built in small sizes only. Gradually details of construction were changed. The early condenser had the water inlet at the top and a central, torpedo-shaped body dividing the water as shown. This latter has been eliminated and the water brought in at the side, with the steam inlet either at the top or at the side of the condenser to suit either bottom or side outlet turbines. In the earlier installations a standpipe was used to steady the injection pressure. This was an inheritance from reciprocating pumps and is, of course, unnecessary when centrifugal injection pumps are used, as is the case in these days.

The final result is the low-level multi-jet condenser of today. This machine while retaining its inherent simplicity has been so developed that the power required to produce a high vacuum compares more than favorably with low-level condensers operated with separate air- and water-removal pumps.

During the war a number of these condensers were installed with turbo blowers, and the performance records that are given in detail herewith demonstrate that this type of condenser is not only simple and reliable in operation, but is an economical jet condenser for high-vacuum work.

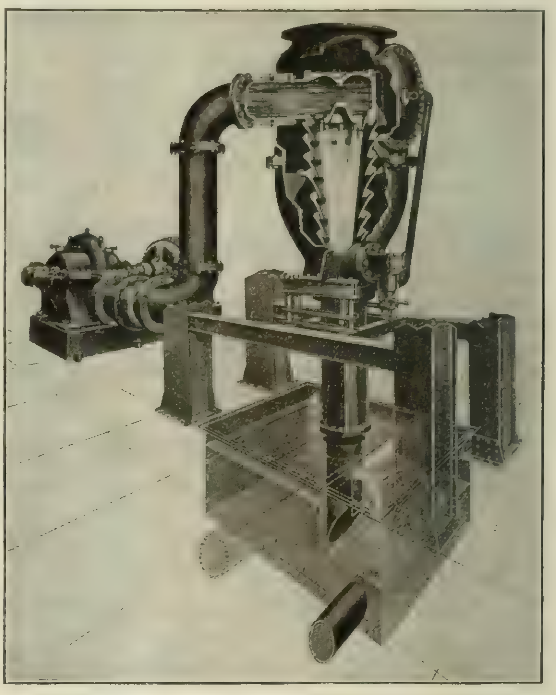


FIG. 2. SHOWING MULTI-JET CONDENSING PLANT WITH INJECTION PUMP; CONDENSER IN CROSS-SECTION

Fig. 2 shows a sectional view of the modern low-level multi-jet condenser. Water is projected through the condenser in multiple jets resembling small fire streams, which meet in a venturi-shaped diffuser, where their kinetic energy is converted into pressure, which ejects water, condensed steam and non-condensible to the atmosphere. Although this type of condenser requires more water than well-designed low-level jet condensers of the usual type or counter-current barometric condensers, no air pump or water-removal pump is needed to maintain vacuums of 28 to 29 inches.

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*Engineers with Ingersoll-Rand Co.

Where the actual quantity of water required is the prime criterion the low-level multi-jet condenser is never used. But the quantity of water is usually important only as it affects the total power consumption. When this is the case the high efficiency of the standard injection pump working with cold water and the saving in power due to the elimination of an air pump result in a relatively low total power requirement for the low-level multi-jet type.

Fig. 3 illustrates the condenser installation at the plant of the Alan Wood Iron and Steel Co., Swedeland, Pa. The condensers, of approximately 3,000 kw. size, are serving two turbine-driven blowers. The entire equipment consists of the condensers and two centrifugal pumps of 14,000 g.p.m. total capacity.

The readings tabulated herewith, taken on the two units when in commercial operation, show the performance of the condensers at different times of the year.

The chart, Fig. 4, shows the relation between vacuum and water temperatures, plotted from winter, spring and summer readings.

At this plant casts are made every four hours, and at these periods a low air delivery is obtained by closing a hand-operated throttle valve which slows down the turbine. This is practically a no-load condition and results in a vacuum throughout the entire turbine casing, back to the high-pressure end and including the shaft packing. Excessive air leakage occurs because the steam pressure on the seal is adjusted for full load.

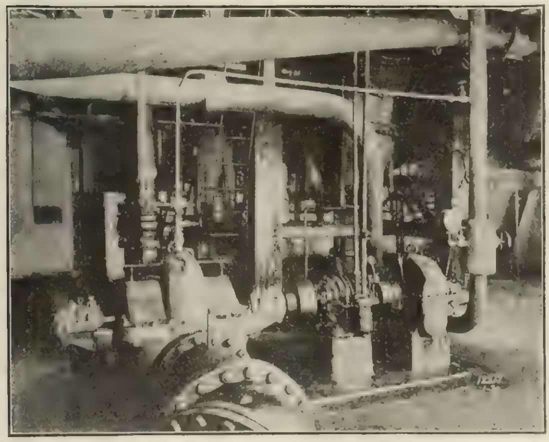


FIG. 3. INJECTION PUMP INSTALLATION AT PLANT OF ALAN WOOD IRON AND STEEL COMPANY

This has been verified in similar plants where the turbine is served by other types of condensers with reciprocating vacuum pumps. The chart, Fig. 6, shows the surprising stability of the low level multi-jet condensers when subjected to this air leakage. The vacuum drops to about 15 in., where it is maintained, and as soon as normal full-load operation is resumed the vacuum is instantly restored. This is possible because the injection of water into this type of condenser is independent of the vacuum, a feature that adds greatly to the reliability of the condenser.

In this connection it may be added that factory tests have recently been made on large units to determine exact air leakage capacity. Air was admitted by standard nozzles such as are used for testing vacuum pumps, and it was found that there is a straight-line law between vacuum and amount of air admitted. This fall in vacuum with air leakage seems to be slower than that which occurs in low-level jet condensers with independent vacuum pumps of either water-jet or steam-jet type.

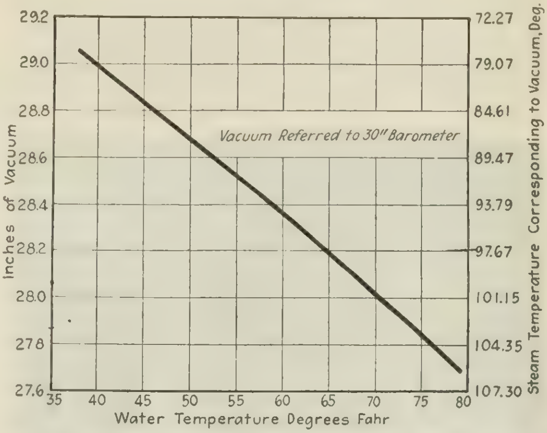


FIG. 4. CHART SHOWING RELATION BETWEEN VACUUM AND WATER TEMPERATURE

At the Alan Wood plant the condensers are spring-supported and are bolted directly to the turbine exhaust nozzle. This construction eliminates the expansion joint in this installation. The spring supports are simple and are shown in detail in Fig. 2.

The discharge of the two condensers is piped to a single well about thirty feet distant, instead of the more common arrangement of an independent well directly under each condenser. A sliding joint at the bottom of the tail pipe takes care of the vertical motion due to expansion and contraction. This movement is very slight and might even be taken up by the flexibility of a long-sweep elbow and short pipe section.

PERFORMANCE OF TWO LOW-LEVEL MULTI-JET CONDENSERS AT PLANT OF ALAN WOOD IRON & STEEL CO

Unit	Run	Date	Vacuum	Barometer	Injection Water Temperature	G.P.M.
No. 1	1	1-26 20	29 72	30 75	35	7,000
	2	1-27-20	29 30	30 25	38	7,000
	3	1-27-20	29 30	30 25	38	6,730
	4	5-29-30	28 40	30 30	68	7,000 approx.
	5	8-26-20	27 78	30 00	79	7 000 approx.
	6	1-27-20	29 25	30 34	37	6,770
No. 2	7	1-27-20	29 15	30 26	37.5	6,550
	8	1-27-20	29 15	30 26	38	6,440
	9	5-29-20	29.35	30 30	68	7,000 approx.

Fig. 2 shows the more common hotwell. It is divided into two chambers by a wall forming a weir. The bottom of the tail pipe is cut at an angle of 45 deg. with the top of this opening on a level with the bottom of the weir. In case of pump failure the maximum quantity of water that can flow back into the condenser is somewhat less than the volume above the level of the bottom of the weir, because some of this water will flow away. This volume is less than that of the condenser body, therefore water cannot be drawn into the turbine even though the vacuum breaker should fail to operate. The vacuum breaker consists of a copper float which, in case the water should rise in the condenser body, opens a pilot valve and thus balances the main valve. The continued pressure of the float opens the main valve, admits air to the top of the condenser and breaks the vacuum.

Fig. 5 shows a large condenser for a 5,000-kw. turbine on test at the factory. The factory test consists in pumping the rated quantity of water at rated pressure through the condenser when blanked off; that is, without steam load. Under this condition it must show a vacuum within 0.1 in. of that corresponding to the water temperature. For example, if the water is at 70 deg., which corresponds to a vacuum of 29.26 in., the condenser must show at least 29.16 in. vacuum. This test, together with the factory test of the water pump, insures the performance of the complete condensing plant when put in service.

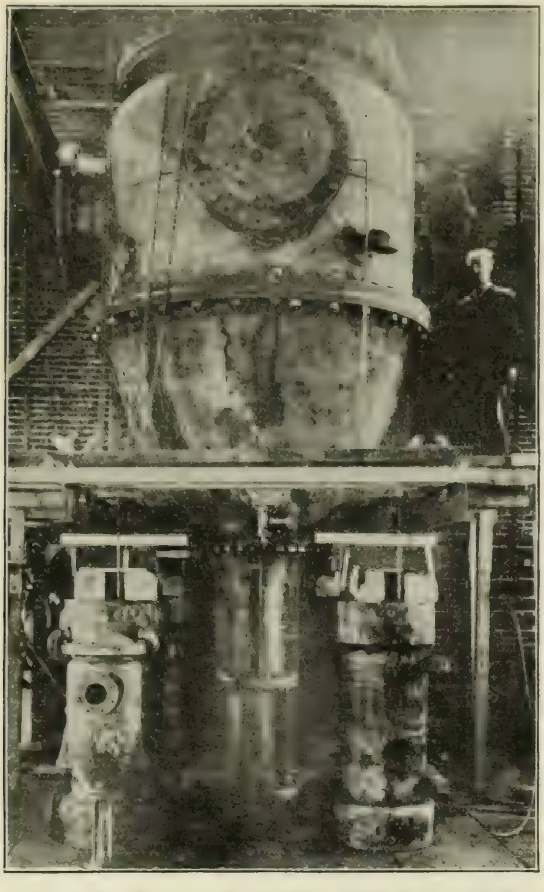


FIG. 5. CONDENSER FOR 5,000-KW. TURBINE ON TEST AT FACTORY

Multi-jet condenser installations of still larger capacity are nearing completion. For example, two large-sized condensers are being installed as a twin arrangement to serve a 7,500-kw. turbine in a large central station. These twin condensers are served by separate injection pumps, a feature that adds greatly to the reliability and flexibility of the installation as a whole. For partial loads or for cold-water operation in the winter time one of the pumps and one of the condensers may be shut down. Under these conditions the injection valve and the valve on the discharge of the condenser are closed.

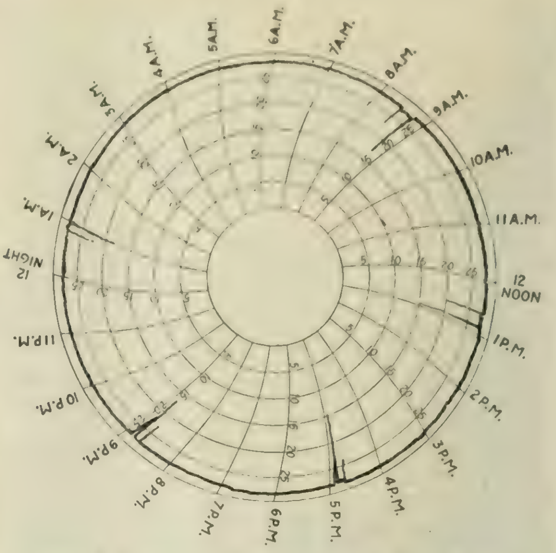


FIG. 6. RECORDING VACUUM GAGE CHART FOR MULTI-JET CONDENSER

The single unit can carry full load at good vacuum o partial load at high vacuum.

The kindness of Mr. Black and the engineers of the Alan Wood Iron and Steel Co. in permitting access to their plant at different times, and for photographs, test data and charts, is hereby acknowledged.

Some Diesel-Engine Pointers

If a crankpin bearing runs warm and scores the pin, a light coating of white lead placed on the pin when reassembling will usually smoothen up the bearing and prevent further heating.

The piston rings should be cleaned every six months. If the top rings are gummed fast, strong lye will loosen them; kerosene and a brass scraper will do the work if the ring is not too tight.

If a piston ring is broken, usually there is a click as the piston reaches the ends of the stroke.

In rebabbitting a bearing clean out all the old metal. The housing should then be tinned. The mandrel should be smaller than the shaft to allow boring to size. Don't peen the babbitt.

When a piston head shows fire-cracks, it can be repaired by welding providing the burned portion along the edges of the fracture does not extend any great distance into the iron. Sewing slight fractures is by far the easiest process.

In replacing a piston, a heavy cord wrapped about the piston ring will compress it so that the piston will enter the cylinder very easily.

In removing piston rings for cleaning, do not put any great stress on the ring or it may snap into pieces.

It is always advisable to round off the upper edge of a piston ring. The lower edge should be square but not sharp.

W. R. Combustion Indicator

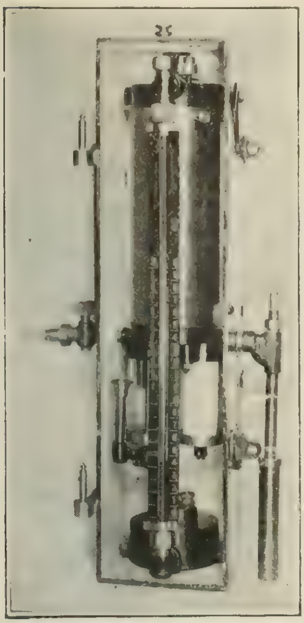


FIG. 1. W. R. COMBUSTION INDICATOR

The instrument shown in Fig. 1 is a continuous flue-gas analyzer which indicates CO_2 percentages by means of the application of a principle that has resulted in a practical, serviceable and accurate CO_2 or combustion indicator. There are no liquid chemical solutions used in its operation—dry reagent cartridges are supplied by the manufacturer, the Chadburn (Ship) Telegraph Co. of America, Inc., Troy, N. Y., for this purpose. Fig. 2 shows the construction of the indicator. The chemical absorbent in the form of a dry cartridge is placed within a porous vessel concentric with and within a metal cylinder. The upper end of the porous vessel is closed by means of a suitable cover after the cartridge is inserted. The top end of a gage glass connects with the inside of the porous vessel, and the bottom end of this glass connects within a small tank the sole function of which is to contain colored water to supply the gage glass. This colored water is subject to the pressure of the flue gas streaming into the instrument and surrounding the outer surface of the porous vessel. This pressure remains practically constant. The variable pressure occurs within the porous vessel. This is due to the affinity of the dry chemical composition of the cartridge for the CO_2 content of the flue gas which diffuses through the walls of the porous vessel and is absorbed by the dry cartridge, but in this action the pressure within the porous vessel becomes lighter, therefore the colored liquid within the gage glass rises accordingly. It has been found that a definite percentage of CO_2 in the flue gas passing over the porous vessel causes a definite rise of the colored liquid within the gage glass; therefore the water-column indicator is calibrated accordingly and attached to the gage glass so that direct readings of CO_2 percentages are easily seen.

The instrument should be placed in the boiler room, preferably near the boiler with which it is connected. A special aluminum preliminary filter is provided for the cleaning of the flue gas before it reaches the instrument. As a general rule this filter is placed as near as possible to the point where the flue-gas samples are drawn off; the gas samples, after passing the filter, flow continuously through a pipe line to the instrument itself. This continuous flow of gas to the instrument is maintained by means of a suitable steam aspirator, the steam consumption for this operation being negligible; but where the main flue or chimney has a minimum draft equal to $\frac{5}{8}$ in. water column, a simple venturi arrangement is supplied. This is connected to a suction-pipe line, the other end of which connects with the regulating tap on the side of the instrument and thus provides continuous aspiration without the use of steam or other agent.

The field of usefulness for the instrument is wide, as it is suitable to indicate combustion efficiency obtaining in coal-, oil- or gas-fired furnaces. In its application to the Scotch marine type of boiler it has been proposed to provide a control for each separate oil burner of the boiler so that each separate burner may be independently adjusted with regard to its oil and air supply to give maximum efficiency. When the individual burners are each so adjusted to give a high reading, then samples of the combined flow of the products of combustion from all the burners pass through the instrument, thus indicating the average percentage of CO_2 produced by all the burners in action. In practice this is effected in a very simple way by means of a special multiple-way valve control.

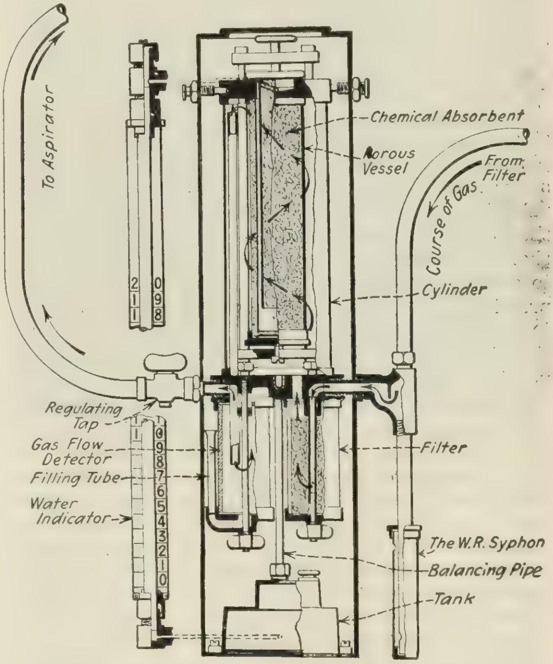


FIG. 2. SHOWING DETAILS OF THE INDICATOR CONNECTIONS

In starting a semi-Diesel engine, the torch should be forced to cause the ignition plug to be heated in the shortest possible time. Slow heating causes the entire cylinder to become hot. Since no cooling water is flowing, the cylinder-head gasket is often ruined by this. The proper temperature of the ignition device, whether it be a bulb or plate or pin, depends on the compression pressure carried. In engines having a pressure of 70 to 90 lb., the bulb must be cherry-red. Higher pressures require lower temperatures; in engines of 160 to 200 lb. compression, the bulb or plate need never be other than black in color. Never flood the cylinder walls with lubricating oil. Use no more than will show a stain on a cigarette paper.

Maintenance of Hydraulic Elevators

By ROLAND L. TULLIS

INSUFFICIENT air in the accumulator of a hydraulic elevator will invariably cause trouble. It will decrease the speed of the car owing to the fact that the air is compressible and acts as a reservoir of reserve power. When the elevator cage starts on its upward flight, it draws water from the accumulator tank faster than the elevator pump can supply it. If there is sufficient air in the accumulator, it will expand and tend to smooth out any sudden fluctuations in pressure caused by the sudden stopping and starting of the car. Remove all the air from the accumulator and the elevator will travel very slowly and will lose its buoyancy and ease of handling. There is also danger of serious trouble in the form of water hammer caused by sudden closing or reversing of the control valve.

A Case of Trouble from Insufficient Air

I have in mind a case of elevator trouble in a six-story factory building. The machine was of the upright plunger type, used for both freight and passenger service. As is usual with freight elevators, the control valve is operated by a hand cable which passes through the car floor and extends the length of the hatchway or shaft. Through negligence all the air had been allowed to escape gradually from the accumulator until it was practically void of air. There was no regular operator in charge of the machine, and the laborers employed in the plant who had occasion to use the elevator knew nothing about handling it and cared less. If they happened to be going up and suddenly decided that they had gone one floor too high, they would give a sudden jerk on the cable and reverse the control valve. Suddenly reversing an elevator while in motion is something to be avoided at all times, still many operators do this every day. In the plant of which I am speaking, this was done when the accumulator was void of air, and water hammer ripped the elevator supply line apart and seriously strained the head on the accumulator, causing it to leak at the seams. To repair the damage cost about five hundred dollars. Thereafter the engineer was careful to keep the proper amount of air in the pressure tank.

An overabundance of air in an hydraulic-elevator system is as bad as an insufficiency. If air gets in the elevator cylinder, there is the liability of the car exceeding the speed limit coming down. The governor may release and set the safety under the car and when the car eventually comes to a stop, the passengers may be badly shaken.

Packing an Elevator

Packing an elevator plunger or piston should be carefully and conscientiously done. The material used should be a good grade of hydraulic packing cut to the proper length and should fit the gland perfectly. Usually, there will be but a slight expansion of the packing under the cold-water pressure; consequently, very little allowance need be made for the expansion of the packing. However, if the plunger is packed too tight, there will be excessive friction and more power will be required to run the car. There will be more wear on the packing and plunger, and the speed of the car will be diminished. On the other hand, if the packing is too loose or improperly fitted, it will leak and the car will have a tendency to creep or sink while standing at the floors; also, the operator will experience difficulty in keeping the cage level with the floor while the passengers are entering or leaving the car. This may cause a serious accident and a consequent damage suit against the company operating the elevator.

Creeping Should Be Carefully Guarded Against

Creeping of the elevator cage in either direction while the operating lever is in its central position is a serious condition and should be carefully guarded against. If the cage refuses to stand at the floors while the passengers are entering or leaving the car, the operator will be compelled to shift the control lever slightly to raise or lower to hold the cage level with the floor. A slight slip of the lever by a nervous or inexperienced operator and the car will suddenly start up or down. If someone happens to be stepping in or out at this moment, it means trouble, and many serious accidents can be attributed to this cause. If space permitted, a number of cases where passengers have been seriously injured and killed in this manner could be cited.

Creeping of an elevator may be due to a number of different causes. Badly leaking plunger packing will cause the trouble; the pilot valve may leak and allow sufficient pressure to pass and move the control valve, which in turn will allow sufficient pressure in the cylinder to move the car; lever or pilot-valve control gear under the car may have slipped. If the pilot valve is set properly and there is no leakage, the car will stand still with the lever in the central position. The pilot valve may be leaking; these are usually all-metal valves machined to fit the casing. The only remedy is a new valve. Cup leathers on control valves may leak and allow pressure to pass, and move the car. Usually, it will be found that the cup leathers are worn until there is a small hole in the lip of the leather. If the leakage is bad, it can be heard by placing the ear to the valve casing when the lever is in a central position. Small pieces of packing from the elevator cylinder may clog the small port-holes that lead from the pilot valve to the control valve. These small pieces will cause the pilot valve to stick; then when the operator pulls on the lever, he is liable to twist the gears under the car, causing no end of trouble. This can be remedied by placing a suitable strainer in the line that connects the pilot with the main valve.

Care of Elevator Cables

The elevator cables are a vital factor in the safe operation of the car. They should be carefully watched and periodically inspected. In most large cities there are qualified city inspectors who periodically examine the elevator and cables and pass on their condition. Cables may be tested for broken wires or strands by holding a soft piece of pine wood against the cable while it is in motion. If any wires are broken, they will snag the wood. Cables should be protected from moisture and properly lubricated by the use of a suitable cable compound. Moisture and consequent rust will destroy a new cable in a short time. Hydraulic-elevator cables are more likely to be subjected to moisture than those of electric machines, owing to leaky packing, etc., and the use of water as a motive power. All lifting cables should be equipped with equalizers, so that their length may be adjusted and the proper proportion of the load carried by each one.

TREATMENT OF ELEVATOR WATER

Water used in the hydraulic-elevator systems should be given more consideration than it usually receives. There is no doubt that much trouble and expense could be avoided by the proper treatment of elevator water, taking into consideration the unnecessary wear on cylinder, valves and packing by the presence of fine grit and impurities held in suspension in the water; also there are the pump cylinders, plunger packing and valves which handle this water continuously. The presence of a small amount of fine grit or other impurities in the water will greatly increase the wear and tear on the machine.

There is a question whether it would be advisable to use chemically pure or distilled water for this service, as it is a well-known fact that water that has been distilled has a corrosive action upon iron or steel. Therefore such water is liable to attack the metal parts of the elevator machinery and fittings with which it comes in contact.

USE OF SOAPS OR COMPOUNDS

However, there could be no objection, and it would undoubtedly be beneficial, to use water that has been properly treated in some sort of water softener for this service. If the water is treated properly, all trace of grit and scale-forming and hardening properties will be removed. The same idea will hold true in the treatment of boiler-feed water. In the treatment of water for power-plant purposes it is not the first consideration to get a chemically pure water, but to get a non-pitting, non-corroding and non-foaming water.

In plants where it is impossible to obtain properly treated soft water for elevator service, it is advisable to use some form of elevator soaps or compound which is especially prepared for this purpose. The compound consists of a combination of fat and alkali. The fatty portion of the compound acts as an emulsion and when circulated through the system imparts considerable lubricating value to the cylinder, plunger and packing. If sufficient quantity of the compound is used, most of the mineral impurities in the water will be precipitated to the bottom of the surge tank, where they can be removed at an opportune time, or by the use of a drain pipe at the bottom of the tank.

No More Coal

Power is ever ready and willing to help along a good cause, and if in so doing it can at the same time aid its readers in obtaining a fortune, so much the better. Hence, at the risk of incurring the bitter enmity of our less benevolent and enterprising contemporaries we hasten to divulge the result of an investigation undertaken at the suggestion of a correspondent who sends us a clipping from the advertising columns of a New York evening paper, headed "No More Coal."

It seems almost incredible that under the very shadow —well, anyhow, within shooting distance—of the Engineers' Building there should exist a machine which, according to the inventor, "harnesses gravitation 100 per cent," but such is the astounding fact, and moreover, stock may now be purchased at ten cents a share, par value $100, in the Perpetual Motion, Power, Heat and Light Co., capitalized at $25,000,000. "Blue Sky Law your protection."

We are not quite sure as to the merits of the "Blue Sky Law," and the Legal Editor is on a vacation; but as according to the inventor's statement, "there are already a hundred and twenty stockholders," the injunction, "Investigate at once—act quick before this stock is sold," seems quite in order.

Fig. 1 shows the working (?) model of the "gravitationpower" machine in all its startling simplicity, and Fig. 2 (which looks like the larva of a Jersey mosquito, but isn't) represents the "innards," which swing, oscillate or gyrate on a "frictionless bearing" and thus "revolutionize the power of the world."

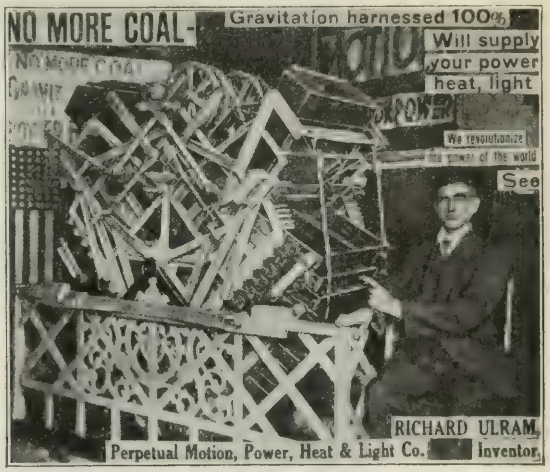

NO MORE COAL-
Gravitation harnessed 100%
Will supply your power heat, light
We revolutionize the power of the world
See
RICHARD ULRAM, Inventor
Perpetual Motion, Power, Heat & Light Co.

FIG. 1. THE INVENTOR AND THE MACHINE

The inventor states frankly that the present and first (¼-hp.) machine is not quite perfect, and as "gravitation" is obliged to struggle along with water as an operating medium instead of mercury or molten lead in a vacuum, the "perpetual motion" feature is not yet quite obvious to a casual observer, but as only fifteen hundred dollars' worth of mercury (which "runs rivers in Russia") is required, this should be forthcoming at an early date, when "with a few slight changes" we'll see—well, just watch the quotations on public service securities, that's all! Furthermore, when you stop to think that "a machine 10 times as big as the present one will have 279 times the power, 100 times as big, 144,591 times, etc."—Oh, well, what's the use? And no wonder the inventor says, "I urge, request and demand an investigation and an inspection of my machine by the United States Senate, and all or any Engineer, for the benefit of the People."

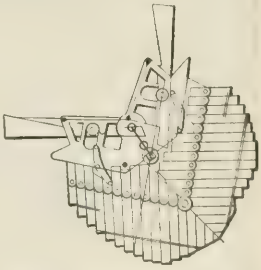


FIG. 2. DIAGRAM OF WORKING (?) PARTS

Edwin S. Carman

New President of the American Society of Mechanical Engineers

The selection of E. S. Carman as president of the A. S. M. E. was a natural one, for Mr. Carman may be regarded as a typical engineer. He was born in Prairie Depot, Ohio, in 1878. When in high school he commenced his engineering studies through special instruction at the Central Manual Training School at Cleveland, Ohio.

His practical experience began in the shops of the Sun Oil Co., of Toledo, where he remained for four years. At the end of that time he took a position with the American Machine and Manufacturing Co., of Cleveland, and in two years was made chief engineer. His work here included the designing of electric traveling and forge-shop cranes and hoists, billet rotators, wire-fence machinery and general rolling-mill equipment. Upon the consolidation in 1908 of this company and the Johnston & Jennings Co., of Cleveland, he became the chief engineer and manager of the new engineering and machine department.

Very soon afterward the Osborn Manufacturing Co., of Cleveland, decided to take up the manufacture of foundry molding-machines, and handed over to Mr. Carman the task of designing and manufacturing this line of machinery. It was a case of starting with nothing but ideas and building up and developing a complete line of apparatus, and Mr. Carman's success at the job is indicated by the fact that in 1913 he became chief engineer, in 1916 director and secretary, and in 1917 works manager of the machine and brush divisions of the Osborn company.

His experience in foundry work has enabled him to write a treatise on "Foundry Molding Machines and Pattern Equipment" and to prepare a number of papers on the subject for the A. S. M. E.

Although Mr. Carman did not become a member of the society until 1917, he made up for lost time by enthusiastic participation in its activities, especially in committee work. An example of his deep interest in engineering affairs is his recent activity as a delegate to the Washington Conference which formed the Federated American Engineering Societies.

EDITORIALS

Direct-Current Motors in Ventilating Service

ARMATURE control of direct-current motor speed is in general considered uneconomical, but this is not always true since the characteristics of the load have a marked influence. If the load requires practically a constant torque at all speeds, then the current will remain constant and the losses due to connecting resistance in series with the armature are approximately proportional to the decrease in speed. At half speed fifty per cent of the energy taken from the line is lost in the armature resistance. However, with a centrifugal fan, where the load varies approximately as the cube of the speed, a somewhat different condition exists.

As pointed out in the article, "Speed Control of Direct Current Motors in Ventilating Service," by W. H. Easton in this issue, the maximum loss occurs at fifty-seven per cent speed reduction and is about nineteen per cent of the motor's total full-load input. Although this loss will amount to considerable if the machine operates for long periods at this speed, nevertheless it is not prohibitive for many applications. When armature control is considered for smaller reduction in speed of fans, the losses are materially reduced and conditions may be such that it is more economical to install a high-speed motor, which, when operating at normal speed, will drive the fan at its maximum, and then obtain lower speeds by armature control.

What percentage of the total period of operation the motor has to operate at the reduced speed will have a marked influence. Therefore the method of working out this problem given by Mr. Easton will be of special interest. In this treatment all three methods of control—armature control, field control and combined armature and field control—are considered. The application of these data will undoubtedly prove useful in checking up installations that are in operation, as well as in proposed installations.

A Warning Against Exaggerated Propaganda

"DISTILLATION of Fuel as Applied to Coal and Lignite" was the subject of a paper read by O. P. Hood, of the United States Bureau of Mines at the annual meeting of the American Society of Mechanical Engineers. In this paper Mr. Hood calls attention to some of the extravagant hopes for a cheap fuel which have arisen in the popular mind in connection with coal distillation and points out how unlikely is the realization of these hopes. His conclusions, in brief, are that the distillation of coal is an expensive process which, while it produces certain valuable products, cannot, and should not be expected to, entirely replace the burning of raw fuel.

This paper points out only one example of the extravagant enthusiasm with which the public welcomes any apparently new idea that is presented in an attractive form. Public interest in any improvement, especially when in connection with fuel conservation, is an extremely valuable asset. The danger lies in leading the laymen to expect too much. When the extravagant promises are not fulfilled, the public becomes disgusted with the whole thing and valuable developments are delayed or sometimes permanently stopped.

The distillation of coal or lignite is so valuable a process that it should not be handicapped. It is not a new idea, as Mr. Hood shows, but its commercial development is still far from complete, and popular disapproval brought about by disapointed hopes would seriously interfere with this development.

Another danger from extravagant popular expectations lies in the direction of too rapid development along unprofitable lines. A certain semi-public institution at one time maintained a small and admittedly inefficient power plant to supply light, power and heat to its buildings. Local popular clamor practically forced the dismantling of the power plant and the purchase of power from a near-by hydro-electric station. The expected saving in fuel was hailed as a great benefit. When the first year was up, however, the records showed that practically as much coal had been burned for heating as had previously been needed for both heat and power, and the additional cost of purchased power had to be met.

The number of similar examples that might be quoted is almost unlimited. It should always be remembered that public opinion is an extremely powerful force. Once set in motion along the wrong lines, it may easily do more harm than good, and the use of exaggerated statements to arouse popular interest is likely to prove a dangerous game.

Practice in Power-Plant Control

WE ALL have much to learn from one another and we can undoubtedly learn much from European countries in the matter of power-plant design, and they from us. In many lines, particularly in control and protection, our tendencies seem to be diametrically opposed to those of French, Swiss and German practice. Whereas we are every day tending toward more elaborate protection and making the operation of our plants more nearly automatic and foolproof, many of the newest plants in western Europe are being laid out on extremely simple lines and their control and signal wiring reduced to a few telephone lines and remote control of the simplest type for the oil switches. Recently, on the other hand, there was put in operation in this country a one-hundred-thousand kilowatt station requiring only three men per shift for its operation. Although this was a hydro-electric station, it nevertheless indicated the tendency in this country in power-plant equipment control.

In the field of lightning protection the divergence is still more marked. Few European plants are equipped with more than condensers and water-jet arresters;

many have only horn-gap arresters; while some plants of over one thousand kilowatts in western Germany and a number of substations on overhead transmission systems have no other protection than choke coils.

The opinion of many European engineers, which was strengthened by our methods of making war, seems to be that we are an amazingly extravagant people in our private life as in our power practice; that, inasmuch as we need tiled bathrooms and hot and cold water to wash in, whereas a small basin and jug of water fill their needs equally well, there is no reason for doubting that their simpler designs will answer their purpose as well as our more elaborate ones.

Which of the two points of view is correct, we are neither of us in a position to decide separately, and discussion, co-operation and comparison of operating statistics will do much to settle the question.

There are several fundamental causes for the divergence of the two practices. First, European plants are almost universally of smaller capacity than ours, and our experience has taught us the disastrous effects of breakdowns in large power circuits. Secondly, distributing networks fed from several interconnected plants are much less frequent, and some of the most involved problems in protection arises from disturbances in such systems. Thirdly, we lay more stress on continuity of service than any European country, and in this respect obtain much better results. Fourthly, the greater scarcity and higher cost of skilled labor in this country is driving us more and more toward automatic operation.

It is interesting to note that several plants in western France clearly show American influence, whereas most eastern plants follow the most rigidly simple lines. No doubt when power systems in Europe grow to the same proportions, and continuity of service is of the same importance as in this country, they, too, will find more elaborate systems of protection and control an absolute necessity.

Oil-Engine Fuel Supply Adequate

THE engineering public has been warned of the shortage that threatens the world unless the consumption of petroleum products is decreased. The public at large cannot be too strongly urged to use every precaution possible toward the lessening of the consumption of all distillate, especially of gasoline. The demand for gasoline has caused the refiner to "cut" more deeply into the crude in the endeavor to supply the market. The consequence is that the price of boiler oil has been increased both because of this reduction in supply and because of the demand for marine use both in the navy and the new shipping board vessels where it has a decided advantage over coal. Coal is essentially the boiler fuel for stationary practice, and economic pressure will probably cause many plants now using fuel oil to return to coal; in fact, in certain sections of the country some power plants have already done so.

Any such problem of fuel-oil shortage should not and does not affect the Diesel or semi-Diesel engine plant. Since the thermal efficiency of these engines is so much superior to that of a steam plant, the oil-engine plant can always secure a fuel supply, being able to offer a higher price than the boiler plant is justified in offering. There will always exist a supply of gas oil and fuel oil, since there is a limit to the maximum percentage of crude that can be converted into light distillate, the fuel oil ranging from 25 per cent to 50 per cent, dependent upon the quality of the crude that is used.

For some time during the summer months tank cars were unobtainable, consequently it was difficult to secure a fuel-oil supply. The same difficulty or greater ones existed as to the coal supply. The present prospective owners of a Diesel or semi-Diesel plant need not worry about the probabilities of a fuel shortage. It is claimed by all who are familiar with the situation that a fuel-oil supply is, and will be for generations, available for the requirements of the oil engine, both stationary and marine.

In comparison with the consumption of other petroleum products the present demand for oil-engine fuel is small, not exceeding six million barrels a year. The fuel-oil output for 1919 totaled over two billion gallons, a large proportion of which was burned under boilers, used in gas works and in industrial processes.

There is no logical reason why the oil-engine owner need ignore the heavier Mexican topped oils. Many Diesels are using the heavy oil with success. The slight operating difficulties can be overcome, and if the domestic fuel-oil price becomes high there should be no hesitancy about purchasing the Mexican oils, which are considerably below the former in price.

As a further source of supply it is well to take cognizance of the immense shale-oil deposits in the West which in time will undoubtedly be placed under development. A conservative estimate places this oil supply at seventy-five billion barrels, or enough to supply the United States for one hundred years if the rate of consumption is maintained at the high rate of 1919. In the distillation of coal there exists a source of oil-engine fuel. In Europe at the present time the light coal-tar oils are successfully used in oil engines.

Trend of The Times

THE newspapers recently reported a meeting "to co-ordinate Americanization work of the American Legion and other patriotic organizations." It was decided at this meeting to work for a congress of delegates from patriotic and civic organizations in all parts of the country.

The November thirtieth issue of *Power* told of the formation of the National Council of State Boards of Engineering Examiners at Chicago on November eighth and ninth. This council was formed to secure co-operation among those who have charge of the licensing of civil engineers in the states that have license laws.

Similarly, the boiler inspectors of states which have adopted the A. S. M. E. Boiler Code are shortly to bring into action the National Board of Boiler Inspectors. Although this board is already in existence, the first meeting has not yet been held; it is expected to take place before long and to be a big success.

Then there is the Federated American Engineering Societies, which is at last a reality. Although hampered by a reactionary spirit among some engineers, vigorous support of other more progressive engineers under the leadership of Herbert Hoover promises a great future for the organization.

Straws show which way the wind blows, and the get-together spirit is assuming the nature of a cyclone.

CORRESPONDENCE

Protective Relays—Reverse-Power Type

Having read the article "Protective Relays—Reverse-Power Type" in the Nov. 2 issue of *Power*, written by Victor H. Todd, there are several things I would like to have the author explain.

The diagram in Fig. 6, reproduced here in Fig. 1, shows single-pole relays without external resistance. I am not very familiar with the Westinghouse type of relay, but I notice that this diagram shows the potential coil of the relay connected to potential transformers which are connected to one leg of the same line from which the current coil is receiving its supply. Diagram Fig. 10, reproduced here in Fig. 2 shows a relay with external resistance which is similar in all respects to a type with which I am better acquainted. The potential element on this relay, as represented in the diagram, is connected to the opposite two wires from which the current coil is receiving its supply.

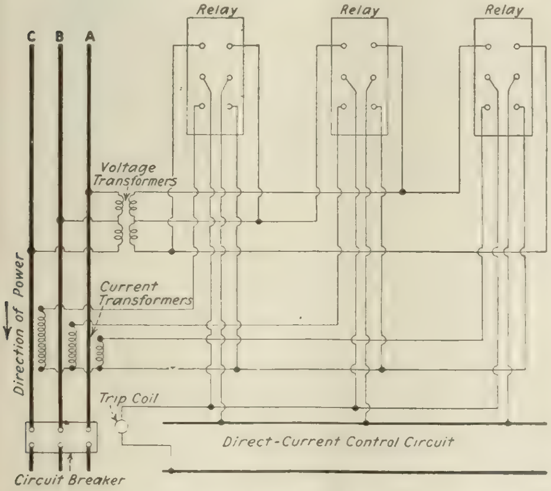


FIG. 1. CONNECTIONS OF RELAYS TO CAUSE THE CURRENT TO LEAD THE VOLTAGE ON NON-INDUCTIVE LOADS

Also at the bottom of page 691 Mr. Todd speaks of using a single-phase indicating wattmeter to locate the proper connections, and he selected a pair of voltage leads which gave the highest reading. This may apply to diagram Fig. 6, but I fail to see how it applies to diagram Fig. 10, when the power factor is above 87 per cent. In Fig. 10 the current flowing in the potential coil will be in phase with the drop across the resistance, which I should think would make it about 40 deg. out of phase from what it would be if the potential coil was not in series. This would give the maximum torque of the relay with the line current for that element at approximately a 70 per cent lagging power factor.

If we test this element with a single-phase wattmeter using potentials across the terminals which would include the resistance and the potential coil, and the power factor was above 87 per cent, I would expect that the wires giving a minimum reading would be the proper connection for this relay. **L. A. Fitts.**

Turners Falls, Mass.

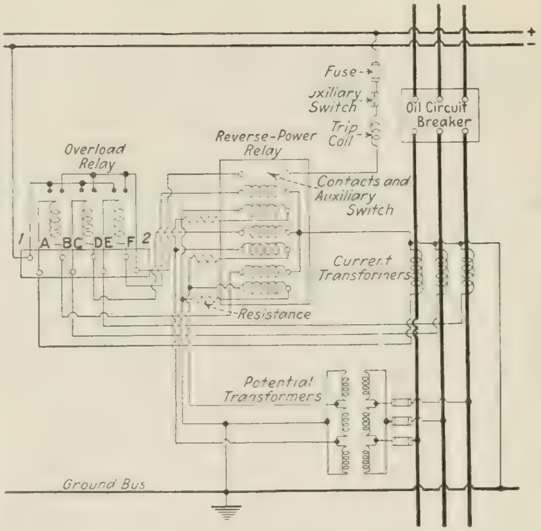


FIG. 2. CONNECTIONS FOR PROTECTING A THREE-PHASE CIRCUIT WHEN THREE-ELEMENT RELAY IS USED

[The foregoing inquiry was submitted to Mr. Todd and the following explanation received.—Editor.]

To discuss the why and wherefore of the connections of reverse-power relays under all possible conditions of electrical abnormalities as viewed from both theoretical and practical standpoints would require a voluminous discourse involving higher mathematics and vector diagrams far beyond the scope of the present discussion. This, however, has been attempted by the engineers of several large electrical companies, whc have arrived at the following conclusion, quoted from the *A.I.E.E. Proceedings* of June 24, 1919, on "Transmission-Line Relay Protection."

In order to secure the operation of the directional relays under bad power-factor conditions, the connections are made so that maximum torque is obtained with lagging power factor. This may be accomplished by several schemes of connections of the potential and current elements, which schemes may not be interchangeable with different types of directional relays.

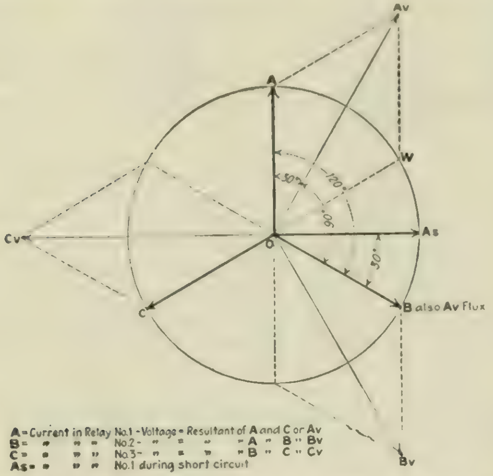

Av
A
W
Cv
As
O
C
B also Av Flux
Bv
30°
60°
A = Current in Relay No.1 - Voltage = Resultant of A and C or Av
B = " " " No.2 - " = " " A " B " Bv
C = " " " No.3 - " = " " B " C " Cv
As = " " " No.1 during short circuit

FIG. 3. CURRENT AND VOLTAGE RELATION, FIG. 1

The difference, then, between Figs. 6 and 10 in the original article on relays in the Nov. 2 issue (Figs. 1 and 2 in Mr. Fitt's letter) is necessary to secure the correct operation of the respective relays. Consider the vectors in Fig. 3; A, B and C represent the currents in the three relays, Fig. 1, while it is evident from the connections of Fig. 1 that the voltage vectors are A_V, B_V and C_V, showing that the current in each of the relays leads its voltage by 30 deg. when the line power factor is 100 per cent. But the internal flux in the potential magnetic circuit lags 90 deg. behind the voltage as represented by line OA_V (flux angle A_VOB). The internal flux produced by the current is in phase with the current and therefore is 120 deg. away from the potential flux, angle AOB. Now, should a short-circuit cause the current to lag to a position approaching line OA_S as a limit, or 90 deg., then there is still 30 deg. (angle A_SOB) internal flux displacement between the current and potential fluxes.

In the other arrangement, Fig. 4, the vectors 1, 2 and 3 represent the currents in the relay elements, Fig. 2, but it will be noticed that the current in any element leads its voltage by 90 deg. instead of 30 deg. But, owing to a resistor being placed in series with the potential coil, the internal magnetic flux does not lag 90 deg. behind the impressed voltage, therefore its direction is line $O2$. As before, there is 120 deg. internal flux displacement between the current and voltage magnetic circuits at 100 per cent line power factor, while if the current lags 90 deg. (line $O1_S$), then there is 30 deg. flux displacement as before. There is, therefore, no difference in the internal-flux displacements and consequently the relay torques, in Figs. 1 and 2.

Why is the preference then? The General Electric Co. claims that during a heavy short-circuit on one phase, the voltage drops so low that it will not operate the relay and therefore the connecting of the voltage coils to a phase opposite the current results in always having voltage except should all three conductors be short-circuited simultaneously. The Westinghouse company claims that there is always at least 1 per cent of voltage, which is sufficient to operate a relay, and that the cross-connection results in additional phase-displacment errors which cannot be accurately predetermined. Actual practice, however, has demonstrated that both schemes are very effective in their protection.

Regarding the use of a wattmeter to pick out the proper lines, it is quite evident that the same method cannot be used to pick out lines where the current lags 30 deg. and also those where there is a 90-deg. lag. The method described, however, should have referred specifically to the 30-deg. connection as used by the Westinghouse company. Again referring to Fig. 3, place the current coil in phase with OA. We have six possible voltage connections. Connection to OC_V will not give any deflection, while connection to OB_V or OA_V will give equal readings; so this method will not pick out OA_V when the line power factor is 100 per cent. But let line OA lag a little; now connection to line OA_V gives the greatest deflection. This is the case until line OA lags to position OW, which corresponds to 50 per cent line power factor, when connection to either OA_V or OC_V will give equal readings.

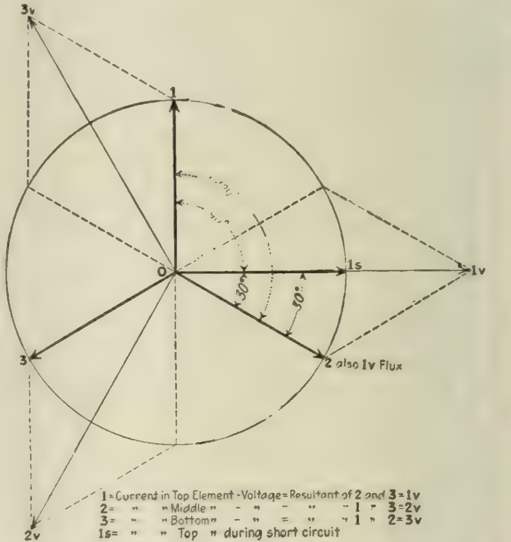

3v
1
O
1s
1v
3
2 also 1v Flux
2v
30°
60°
1 = Current in Top Element - Voltage = Resultant of 2 and 3 = 1v
2 = " " Middle " - " - " " 1 " 3 = 2v
3 = " " Bottom " - " = " " 1 " 2 = 3v
1s = " " Top " during short circuit

FIG. 4. CURRENT AND VOLTAGE RELATION, FIG. 2

If it is desired to use this method for the connection in Fig. 2, then, according to Fig. 4, if the current coil is in phase with line $O1$, and it is desired to pick out line $O1_V$, as this is at right angles to $O1$, we would pick out the line giving zero deflection when the line power factor is 100 per cent. It will also be noticed that the current $O1$ may lead 30 deg. or lag 30 deg. and still line $O1_V$ will give the minimum deflection. This method in this case is applicable when the line power factor falls between 86.6 per cent lead and 86.6 per cent lag. **VICTOR H. TODD.**

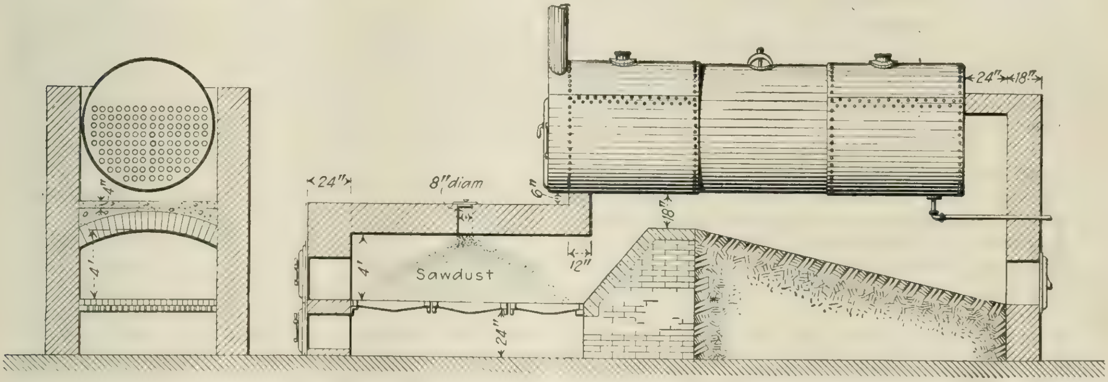
Orange, N. J.

Design of Hog-Fuel Furnace

The discussion that has been going on in the columns of *Power* recently regarding burning hog fuel has suggested that a description of the furnaces of the boiler of my plant may be of interest. The illustrations show the setting of a 6-ft. diameter by 18-ft. return-tubular boiler equipped with a dutch-oven furnace for burning hog fuel and sawdust. The walls of the setting are of the ordinary kind, 18 in. thick, but the front wall of the oven is 24 in. thick. The brickwork should be well supported with buckstays.

The grates are in three 3-ft. sections, or 9 ft. over all and 6 ft. wide. They are set 4 ft. from the top of the grate to the highest point of the curved arch, and the ashpit is 24 in. deep. An 18-in. space is allowed between the top of the bridge wall and the boiler shell, and the boiler is set so that the dry sheet is 6 in. above the concrete top of the furnace. The dry sheet extending out over the furnace is shown in Fig. 1. The arch should extend back far enough under the dry sheet to support the end walls at the boiler setting.

The fuel hole in the top of the furnace should be placed 6 in. nearer the end of the grate next to the boiler from the center of the grate, as that end of the fire should be the heaviest. This kind of setting will give good results with hog fuel, and it can be used on various types of boilers.



END AND SIDE ELEVATION OF FURNACE FOR BURNING HOG FUEL AND SAWDUST

The conveyor should be arranged so that in case the fuel comes too fast for the fire it can be stored for night and Sunday use or deposited at one side of the fireroom. In using coal for fuel a large combustion space behind the bridge wall is required, but with hog or sawdust fuel it is not necessary. I have tried both ways and find that filling in at the rear of the bridge wall gives better results. The fuel should be fed to the furnace steadily as it comes from the hog or saw and allowed to build up in a conical pile, as shown.

When starting the fire, first put a few slabs on the grates before admitting sawdust. If the fires have to be forced, pass wood just through the firedoor. The grate should not be allowed to get plugged with sawdust next to the door, as this will prevent the air from coming up through the grates. Do not use a poker or hoe on the fire, as that will put out the fire around the edges, but just allow the sawdust to feed in from the conveyor or carrier to the feed hole in the top of oven. A fireman will have some difficulty in running a sawdust or hog-fuel fire for a few days if he is not used to it, but he will soon get the knack of it. On opening the rear clean-out door and looking in, a large flame will be seen rolling over the bridge wall if the fire is running properly. A sawdust fire requires a good draft. The ashpit should be cleaned out every day, for if the ashes are allowed to pile up too near the grates there is a danger of burning them. It is a good idea to have a live-stream jet in the stack or to pipe the exhaust from the engine so that it can be turned into a stack in order to force the draft in case the fire gets logy.

Millsite, Vt. G. L. BALDWIN.

Pounding of Semi-Diesel

I have read the several letters appearing in *Power* offering suggestions as to methods of eliminating the trouble I mentioned in my letter in the issue of Sept. 28. In my original letter, however, I forgot to say that the water we used for cooling was very bad, containing a considerable amount of lime. In taking off the cylinder head, I found the water jacket almost choked with deposits, especially on the top of the cylinder. This lime had greatly impaired the water circulation and caused the engine to overheat. Undoubtedly, the pounding was due to lime deposits; the increased feed of lubrication caused the engine to smoke.

I do not believe the trouble can be attributed to the engine itself; in fact, any engine would do the same under such extreme conditions. We are putting in a cooling tower so that soft water can be used. This was recommended by the manufacturer's service man. So impressed are we with the belief that the semi-Diesel engine is suitable for our work and that the cooling water only was at fault that we have purchased a 75-hp. engine of the same make. A. C. GABLER.

Winside, Neb.

The Air Lift—A Correction

The following corrections should be noted in regard to the article, "The Air Lift," page 818 of the Nov. 23 issue: Formula (1) should read $h_w - h'_w = 2.3 (p_2 - p_1)$. The coefficient of formula (3) should be 0.64 instead of 0.62. The factor 212, in formula (5), should be 6.8.

Wilkinsburg, Pa. A. H. BLAISDELL.

Engineers' License Laws

In the Nov. 6 issue of *Power*, George T. Bromley criticizes W. F. Lockwood's article in the issue of Oct. 19 entitled "Engineers' License Laws." Mr. Lockwood states that he has a Massachusetts license, and I don't think he had any idea that his meaning would be taken as Mr. Bromley has taken it, as he was evidently speaking figuratively. Any engineer knows that it is impossible for an engine to pound so that it can be heard a mile away and that the valves would not be neglected until they got so bad that the engine would not run or speed up so as to cause the flywheel to explode.

I visit power plants every day and meet all kinds of engineers and firemen, good and bad, whether licensed or not. Most engineers keep their engines and engine rooms in good condition, but give little thought to the most important part of a power plant—the boiler house and its equipment.

Few engineers spend much time on the boiler-house equipment. In the estimation of most engineers the boiler is nothing but a kettle with a fire under it for the purpose of making steam to run their engines, and all it requires is someone to throw coal on the fire. They go along from day to day without a thought as to what condition the boiler is in or what the consequences will be should it explode.

In changing a boiler from natural draft to forced draft I asked the engineer, who has a chief's license, if the boiler was clean on the inside. He claimed that it could stand any amount of heat. One week later it was necessary to put in a new sheet on account of scale which was anywhere from $\frac{1}{16}$ to $\frac{1}{2}$ in. thick. It was found later that this engineer had never been inside of this boiler. The fifty or one hundred questions this man had to answer and the engine or other apparatus that he had to adjust before the examining board when procuring his license certainly did not make him an engineer.

How many operating chief engineers go inside of the boilers under their charge to ascertain their condition? Very few, I think. Then how can they know that their boilers are in a condition to withstand the pressure carried. Mr. Bromley speaks of the danger of an engine pounding and the strain that is put on the frame. Can he or anyone in the State House at Boston figure a more destructive force in the pound of an engine than there is in a steam boiler when it is under pressure? I have never heard of an engine leaving its foundation and going up through the roof or through the sides of a building, causing loss of life and destruction of property. I have seen four cases where flywheels have exploded, and in all but one the damage was confined to the engine room and the loss of life was one man. When a flywheel explodes, there is generally a warning given by the engine speeding up, and sometimes the engine can be stopped, or when equipped with automatic stops the accident can be avoided; but when a boiler explodes it gives no warning, and in many cases there are a number of lives lost and a great destruction of property.

I had charge of a 10,000-hp. steam plant a few years ago and had several engineers under me who were all licensed and first-class steam men who could be trusted in any part of the plant, but I was never afraid to take off my white collar and don a pair of overalls and go through my boilers every time they were washed, to make sure that everything was right. I never had to lie awake nights thinking that something might happen to them, or had to answer to the manager at the end of the month for large fuel bills. Besides my boilers and auxiliaries, I had twelve engines ranging from 200 to 900 hp. I kept these engines in the best of condition without neglecting my boilers.

Mr. Lockwood says the employer takes a chance when he calls in an efficiency engineer. I am glad that all the engineers and employers are not of the same opinion as he. If they were, a great many power plants would have had to close their doors in the past year, and it is the efficiency engineer that teaches the operating forces the efficient ways to operate their plants. It may be that Mr. Lockwood is operating his plant at such a high efficiency that he does not need expert advice from these engineers; if so, he is one of a thousand.

I hold a chief engineer's unlimited license in two cities, and I am a strong advocate of the licensing of engineers, but there has never been and never will be an examination or a license that will make a man a first-class engineer, or that will protect the public, the employer or the engineer. C. J. MILLER.

North Tonawanda, N. Y.

Hotel Plant Experience

The hotel power plant of which I am chief engineer is the only one I have ever seen housed in a separate building and all above ground. It is much more comfortable than a basement plant. In the engine room are two 11 x 10-in. engines direct-connected to 110-volt direct-current generators. These machines have been in use seven years and still have the original carbon brushes. Seven years for brush service is surely a good record.

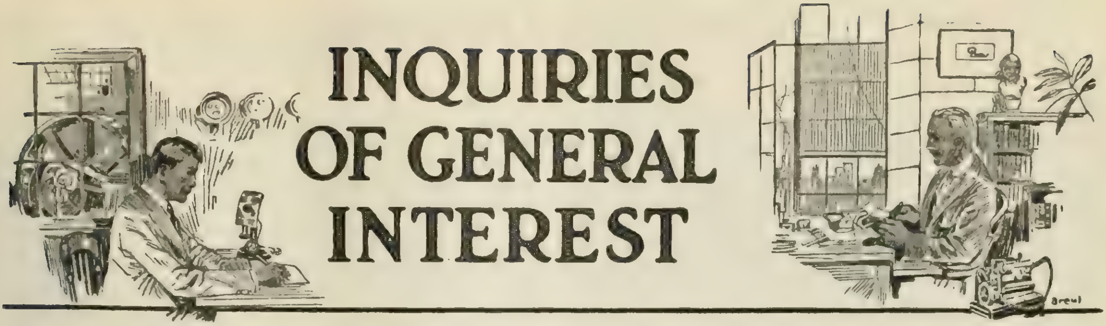
The heater used for heating service water is thermostatically controlled. The city water pressure is 100 lb. and this is reduced to about 40 lb. for the heaters. A low-pressure reducing valve was in this line, and everybody, from manager down, wondered why it wouldn't reduce; all it did was to slam. A high-pressure valve made everything right. We use live steam for the hot-water service and carry no back pressure on the engines, which I believe saves coal, although there may be a question regarding this.

The heater carries less than five pounds pressure most of the time. The condensation from this heater was trapped to a bucket trap, but all it did was to fill, and as there was no pressure to dump it, it did not dump. I removed the trap and ran the line direct to the house return pump in the boiler room which is a trifle lower than the engine room. In winter we carry from three to five pounds on the heating system. This is the only time we use exhaust steam.

A ten-ton can raw-water ice plant is electrically driven. Water from the ammonia condenser and compressor jackets goes to a boiler-feed heater. When the ice plant was shut down, we had to leave this water running in order to get boiler water. On the other side of the heater was an old balanced float valve. No reducing valve had been used ahead of it and as a result it was "shut," and so this line had been disconnected instead of repairing and putting in a reducing valve. As the condenser water keeps the float in the heater up and the valve closed most of the time, it bypasses through a relief valve into the sewer. I intend to put this water into a tank on the roof for laundry purposes.

Geneva, N. Y. R. A. SUMMERS.

INQUIRIES OF GENERAL INTEREST



Unreliability of Lead Gaskets—What is the objection to the use of sheet lead for gaskets between flanges of a steam lines? J. C.

On account of their softness and the extremely low elasticity of the material, sheet-lead gaskets are very unreliable for making up flanged joints, especially when subjected to variable stresses caused by alternations of expansion and contraction of pipes and fittings.

Belt Drive Less Loss of Power Than Direct Connection—A direct-connected machine is found to require less power when belt-driven than when direct-connected to a motor. Why should this be true? H. A. G.

More power could be required when direct-connected, on account of greater friction due to imperfect alignment or failure of a 'flexible" coupling to entirely compensate the imperfect alignment without increasing the pressure of the journal bearing. Under ordinary circumstances the greater friction would be indicated by higher temperature of the bearings.

Leakage of Cylinder-Head Joint—Since opening the cylinder of an 18 x 36-in. Corliss engine for making repairs to the piston, there is a leakage of steam from the ground joint of the cylinder head. How can the leak be stopped without refinishing the surface? S. L. G.

The leakage undoubtedly results from not replacing the cylinder head just as it was before removal. Carefully clean off the faces of the ground joint, removing all traces of gum or scale with kerosene or gasoline, and prepare a gasket made of uncrumpled manila or drawing paper coated both sides with clean machine oil. Then replace the cylinder head with the paper gasket in the joint, being sure to take up the nuts on the studs by screwing up one after another only a very little at a time.

Preheating Feed Water in Boiler Combustion Chamber—Most of the steam generated in our four 72-in. boilers is used in dye kettles, and we have very little exhaust steam for heating boiler-feed water. Would there not be a saving of coal if we ran a bypass from the feed-water line through pipe coils placed in the boiler combustion chambers and returned the water to the feed lines? J. R. M.

Coils placed in the combustion chambers could be of no advantage except as a makeshift equivalent to increasing boiler capacity by increasing the heating surface. Whatever heat might be absorbed by the feed-water coil would be just that much robbed from the original boiler-heating surfaces. Greater boiler capacity would be obtained only at expense of more fuel, and unless such auxiliary pipe surfaces are designed and constructed to admit of frequent interior and exterior cleaning and receive the same care and attention that should be accorded to water-tube boilers, they soon become inefficient as heating surfaces and are sources of danger from rupture, either by burning out or explosion from becoming clogged with scale and corrosion.

Resistance of Hollow Cylinders to Collapse—What is the formula for computing the pressure required to collapse a cylindrical vessel? J. W. M.

The theoretical formula for resistance to collapse of thin sides of circular cylindrical vessels is the same as for their resistance to an internal pressure, substituting crushing strength of the material in place of tensile strength, viz.,

$$p = \frac{f \times t \times c}{r}$$

in which p is the collapsing pressure, lb. per sq.in.; f, the crushing strength of material, lb. per sq.in. cross section; t, the thickness of the material in inches; c, the percentage of efficiency of the longitudinal joint; or if there is no longitudinal joint the value of c is 1; r, the radius of the hollow cylinder in inches. The formula would be true, however, only for assumption of a perfectly cylindrical shape, and it would have to be assumed also that for external pressure there would be no departure from true cylindrical shape, neither of which conditions could be realized in practice. Actual tests made on tubes and riveted flues have shown that they fail by buckling for considerably less collapsing pressure than they should withstand for perfectly cylindical form maintained to the point of failure.

Size of Wire for Motors—For installation of a 50-hp. 230-volt direct-current motor which will be located 325 ft. away from the switchboard, what size wire should be used for the feeders, the conductors to be run in conduit? M. R. T.

The size of wire will depend upon the allowable voltage drop in the feeder and upon the size that will meet the fire underwriters' requirements. If a 3 per cent drop is allowed in the line, then the volts drop is 230 × 0.03 = 6.9. The size of the conductor in circular mils is determined by the formula,

$$circ.\ mil. = \frac{22 \times DI}{E_d}$$

where D equals the length of line one way, I the total current in amperes, and E_d the volts drop in the line. For a 230-volt motor the current per full-load horsepower is approximately 4 amperes; then for 50 hp. the current will be 50 × 4 = 200 amperes. The National Board of Fire Underwriters' regulations call for a conductor that will carry 110 per cent of the nameplate current rating of the motor. If in this problem the nameplate current is 200 amperes, then the conductor will have to be of a size to carry 220 amperes, and the size of the conductor would be

$$circ.\ mil. = \frac{20 \times 325 \times 220}{6.9} = 207{,}000$$

The nearest standard size conductor to this value is No. 0000 B. & S., which has a cross-sectional area of 211,600 circ.mil, and is rated at 225 amperes for rubber-covered wire, therefore will meet the fire underwriters' regulation. If the calculations had shown that a smaller wire could be used, it would be necessary to use No. 0000, since this is the smallest size that will meet the underwriters' requirements. Of course the conductor can be made as much larger as desired.

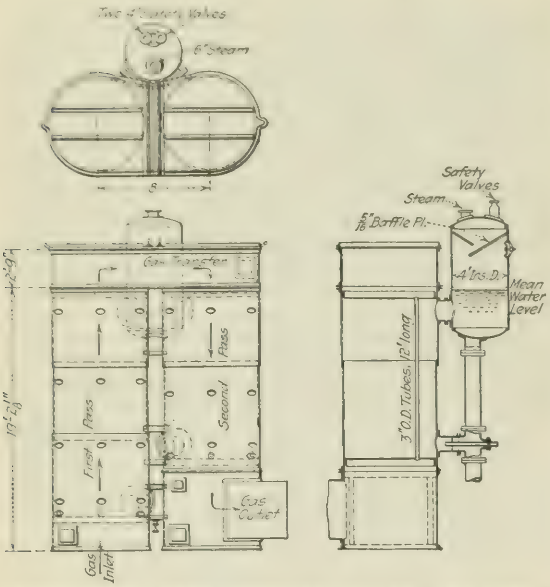
[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Waste-Heat Utilization*

By G. R. McDermott and F. H. Willcox

Furnaces employing regeneration or recuperation commonly have left in the gases of combustion leaving the furnace from 35 to 55 per cent of the total heat available in the fuel fired. Non-regenerative furnaces may have as high as 80 per cent. Kilns, oil stills, gas tanks, water-gas sets, etc., all present, on account of the amounts and temperatures of escaping gases of combustion, quantities of waste heat that is not only recoverable but that gives returns that will net from 25 to 75 per cent in one year on the installation cost of the equipment.

In 1910 the first successful application of waste-heat boilers for open-hearth furnaces had been effected in South Chicago, and discoveries made at this plant led to rapid development. Prior to this time waste-heat boilers utilized waste gases at temperatures of 1,600 deg. F. and higher, as it had been considered impractical to generate steam commercially with gases below this temperature. The accepted deviation from hand-fired types was an increase in the gas-passage area. With the installation previously referred to, C. J. Bacon, formerly steam engineer of the Illinois Steel Co., South Chicago, demonstrated that for gas temperatures under 1,600 deg. F., the gas passages should be decreased and the velocity of the gases increased.



BACON WASTE-HEAT BOILER, 82 IN. DIAM., 5,700 SQ.FT. OF SURFACE

Waste-Heat and Direct-Fired Boilers Compared

Other interesting data were presented, giving the origin of the gases and the amounts of waste gases from a typical 75-ton heat. The temperature of the waste gases from the checkers was 1,300 deg. F. and the total weight of the gases 11,100 lb. At 1,300 deg. F. there were 26,000,000 B.t.u. in the waste gases, as against 60,000,000 B.t.u. in the coal charged; this represented 43 per cent of the total heat charged and was equivalent to 2,400 lb. of coal per hour. Of this 1,270 lb. of the coal equivalent could be recovered per hour from the waste-heat boilers.

Before giving the boiler design required to utilize the foregoing quantity of gas at the given temperatures, the authors reviewed the heat and absorption phenomena obtained in a direct-fired boiler and in the considered case of the waste-heat boiler. Experiments have shown that the heat absorbed by radiation is proportional to the fourth power of the absolute temperature difference between the radiating surfaces. Contrasting a stoker-fired boiler with a combustion temperature of 2,700 deg. F. and waste-heat boilers at 1,300 deg. initial temperature, the absorption by the radiation factor would be:

$$\left(\frac{Tc}{Tw}\right)^4 = (2{,}700 + 460)^4 \ : \ (1{,}300 + 460)^4$$
$$= 3{,}160^4 \ : \ 1{,}760^4 = 10.5 \ : \ 1$$

Thus the absorption by radiation in the case of the direct-fired boiler is over ten times as great as in the waste-heat boiler.

Ordinarily, about 65 per cent of the total evaporation is by radiation and 35 per cent by convection, so that on a 600-hp. boiler, 7,025,000 heat units are absorbed by convection and 13,050,000 heat units by radiation. In the waste-heat boiler but 1,300,000 heat units can be absorbed through radiation, leaving 18,700,000 to be absorbed by convection. Obviously, the rate of heat transfer by convection must be for the waste-heat boiler, 2.75 times greater per square foot of heating surface.

Even this hypothetical ratio does not state the handicap imposed upon waste-heat boiler heat absorption, because the heating surface exposed to the direct heat of the furnace is less than in the case of a direct-fired boiler. Obviously, for a given gas weight, starting in with initial temperatures of 2,700 deg. F. and 1,300 deg. F., respectively, passing through or past identical heating surfaces of the boilers and having identical exit temperatures, the net amount of heat absorbed by convection by the heating surface must be much greater for the waste-heat boiler with an initial temperature of 1,300 deg. The heat transferred by convection per square foot of heating surface of the boiler, therefore, must jump to a figure hitherto considered impracticable. This point of view is not always appreciated. It is not infrequently felt that since a low-temperature waste-heat boiler gives but 70 to 80 per cent of the builders' rating the heat transfer rate is low. Actually, it is very high.

Formulas Used in Making Comparison

An increase in heat-transfer rate is accomplished by an increase in velocity. Consideration of the formulas governing this phenomena will develop the reasons. The rate of heat transfer for either fire-tube or water-tube boilers may be expressed in the form,

$$R = \frac{H}{T - t} = a + b\,\frac{W}{A}$$

Where $R =$ B.t.u. per hour per degree mean temperature difference per square foot tube surface swept by gases:

$H =$ B.t.u. transferred per hour per square foot;
$T =$ Mean temperature of gases (logarithmic);
$t =$ Temperature of tube wall, usually taken as temperature of water in boiler;
a and $b =$ constants;
$\frac{W}{A} =$ Mass velocity, usually expressed as pounds of gas per hour per square foot of area for passage of gases.

In general the constant a is greater for water tubes than for fire tubes of the same size, is greater as the diameter of the tube decreases and is greater as the space between the water tubes decreases. Similarly, constant b is greater for water tubes than for fire tubes, is greater as the diameter of the tube decreases and is greater as the temperature difference between the steam and water increases.

For the constants a and b values may be assigned that are sufficiently accurate for all ordinary engineering applications as they are derived from reliable tests and investigations conducted by boiler companies and independent observers. The following formulas will serve to illustrate the relative heat-absorbing characteristics of the two types of boilers.

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*Abstract of Paper read before Western Society of Engineers at Chicago.

Outside Diameter of Tubes — Inches	Fire Tubes	Water Tubes
1	$R = 3.5 + 0.0013 \frac{W}{A}$	
2	$= 2.0 + 0.0008 \frac{W}{A}$	
3	$= 1.5 + 0.00065 \frac{W}{A}$	
4	$= 1.1 + 0.0005 \frac{W}{A}$	$R = 2.0 + 0.0014 \frac{W}{A}$

These values apply for 400 deg. F. mean temperature difference, corresponding approximately to waste-heat boiler conditions.

The two most important requisites in proportioning boilers for a given amount and temperature of waste gas are high rate of heat transfer and a low draft loss. Both depend on mass velocity, but the latter varies as the square of the velocity. A boiler arrangement designed for attaining a high transfer rate must be compromised to keep the friction loss within economical limits.

It so happens that whereas the water-tube boiler at a given mass velocity and tube diameter has a higher heat-transfer rate than the fire-tube type, nevertheless the friction loss in the fire-tube boiler is much less. Because of this low friction loss the mass velocity may be raised, and consequently the rate of heat transfer may be so increased as to exceed that obtained in the water-tube type, while keeping the friction loss the same. To illustrate this point, figures are here presented showing that a fire-tube boiler may be designed that will have less than one-half the heating surface of a horizontal cross-baffled water-tube boiler and still give the same performance under the same operating conditions. As a basis for comparison an average size of standard type of water-tube boiler and operating conditions are taken from actual practice.

RESULTS OF TESTS ON WASTE-HEAT BOILERS

Published results of tests on seven waste-heat boilers, all of similar horizontal water-tube type with 4-in. tubes and cross-baffling, show the following averages:

Rate of heat transfer, B.t.u.	5.32
Draft loss, in. water	1.45
Heating surface, sq.ft.	5,030
Weight of gas, lb. per hr.	68,330
Initial temperature, deg. F.	1,330
Stack temperature, deg. F.	470
Boiler horsepower	400

These figures indicate in a general way what may be expected from specially adapted types of water-tube boilers as ordinarily installed and operated. The mass velocity corresponding to the average heat-transfer rate given, as computed by the formula, $R = 2 + 0.0014 \frac{W}{A}$, is 2,370 lb. per hour per square foot of passage area.

For the sake of comparison consider some fire-tube boilers so proportioned that the same amount of gas will cause the same loss of draft; namely, 1.45 in. Tube sizes are assumed as 1, 2 and 3 in. diameter, as this selection illustrates the superior advantages of using small tubes. Three cases are worked out as follows:

Type of Boiler	Horizontal Water-Tube	Double-Pass Fire-Tube	Single-Pass Fire-Tube	
Size of tubes, outside dia., in.	4	3	2	1
Number of tubes	...	282	525	1,830
Length of tubes, ft.	...	28	14	5
Heating surface, sq.ft.	5,030	5,700	3,400	1,960
Weight of waste gas, lb. per hr.	68,000	68,000	68,000	68,000
Mass velocity, lb. per sq.ft.	2,370	5,900	8,000	8,500
Rate of heat transfer, B.t.u.	5.32	5.34	8.40	14.60
Draft loss, in. water	1.45	1.45	1.45	1.45
Initial temperature, deg. F.	1,330	1,330	1,330	1,330
Stack temperature, deg. F.	470	470	470	470
Boiler horsepower	400	400	400	400

Inasmuch as the rate of heat transfer at high mass velocity varies almost in proportion to the mass velocity, it is obvious that the number of tubes may be decreased without materially affecting the evaporation. This greatly reduces the first cost, and the only disadvantage is the increase in friction loss. For example, the evaporation obtained in the boiler with 1,830 1-in. tubes, 5 ft. long, may be equally well obtained with only one-half the number of tubes by increasing the length to 5.25 ft., as follows:

Size of tubes, o.d., in.	1
Length of tubes, ft.	5.25
Number of tubes	915
Heating surface, sq.ft.	1,130
Weight of gases, lb. per hr.	68,000
Mass velocity, lb. per sq.ft.	17,000
Rate of heat transfer, B.t.u.	25.5
Draft loss, in. water	6.15
Initial gas temperature, deg. F.	1,330
Stack temperature, deg. F.	470
Boiler horsepower	400

The greater friction loss may be compensated for by increasing the length of tubes so as to obtain sufficient additional evaporation to carry the greater load on the fan.

The point is often raised that tubular boilers are not so efficient as water-tube boilers. This is perfectly natural when only the usual types of tubular boilers and methods of using them are considered. As a matter of fact the heating surface of tubular boilers can be made as effective, or even more so, than that of water-tube boilers. The trouble with the usual fire-tube boiler, especially when used for waste-heat applications, is that the area for the passage of gases is too large and there is not sufficient length of travel for the gases. These objections are, of course, overcome by making a long boiler of small diameter or, what amounts to the same thing, dividing the boiler into two or more passes. The matter of tube size is also a large factor, and if the question of cleaning were not of such real importance the tubes could to great advantage be as small as locomotive tubes, or even smaller. Waste-heat boilers used in Europe in connection with gas engines have tubes of only an inch or so in diameter. By increasing the velocity of gases over the heating surface the rate of heat transmission may be raised to a point as high as or even higher than exists in the case of water-tube boilers. Velocity is usually expressed as weight of gas per hour divided by the area of gas passage in square feet.

CONSIDERATIONS OF DESIGN

It is evident that for the same mass velocity the water tube gives the higher rate of heat transmission, but the important point is that the mass velocity in the fire-tube boiler may be much higher without an increase in draft loss. For example, the average of tests on nine waste-heat boiler installations, using cross-baffled water-tube boilers having 4-in. tubes, shows: mass velocity, 2,440; rate of heat transmission, 5.42; draft loss, 2.07. If a two-pass fire-tube boiler with 3-in. tubes were used, the conditions would be: 7,630, 6.45 and 2.07 respectively. It is thus evident that for the same draft loss, the fire-tube boiler may have a higher mass velocity and give a higher rate of heat transfer than a water-tube boiler of the type previously mentioned.

It is frequently assumed that any type of boiler that gives good results when fired with coal or other fuel will likewise be a good one for waste-heat utilization. In most instances, however, this is not the case. There are certain conditions that are more or less characteristic of the operation and construction of industrial furnaces which make it uneconomical and otherwise inadvisable to use standard boilers for such a purpose.

A special boiler known as the Bacon waste-heat boiler, designed to utilize at maximum net economy the heat in waste gases, was described by the authors. The initial installations of this boiler were in conjunction with open-hearth furnaces in steel works where the operating conditions and other limitations interfered with obtaining satisfactory results from standard types of boilers.

To keep the first cost low and still maintain a desired evaporative capacity, the design of the boiler is such as to condense the heating surface into the smallest possible space, which requires that the rate of heat transmission through the heating surface be proportionately high. The three conditions conducive to high heat transfer rates are high velocity of gases, small size of boiler tubes and clean heating surface on both the water and gas sides.

As usually built, the Bacon boiler consists of two vertical cylindrical shells, between the heads of which are rolled and electrically welded a large number of small tubes in a similar manner to vertical fire-tube boilers. The diameter of tubes is kept as small as permits cleaning, and the length is determined mainly by the space available and the friction loss. The object is to insure that the gases have a long travel at high velocity. In some cases it is found desirable that the average velocity exceed 100 ft. per second for the purpose of preventing dust from lodging and to give a high rate of heat transmission. The waste gases enter the gas box at the bottom of the first pass, whence they pass upward through the tubes and into the transfer flue, which directs the flow downward through the second pass, and in the case of an installation now under construction a third pass, which will act as an economizer.

In some forms of construction of the Bacon boiler a single shell is set horizontally and the two passes are obtained by suitable baffling in the steel-plate gas boxes at the ends of the shell. For application to small furnaces this is a better arrangement than the double vertical shell design.

Boiler-scale trouble is minimized on account of feed water being admitted at the bottom of the second, or "cold," pass. Here it becomes gradually heated and rises to the top of the pass. The water then flows from the second pass through an exterior water-circulating connection to the bottom of the first, or "hot," pass. As but one-third of the heat is utilized in the second pass, where gas temperatures at the bottom are not over 560 deg., the sludge deposited is not hard and may readily be blown off through the several blowoff connections. Forced water circulation on a counter-current principle gives a high rate of heat transfer. Liberal handhole access is provided and blowoff valves are arranged to drain the bottom toube sheets.

As a rule natural draft is not sufficient, because the gases leaving the boilers have been cooled to 450 or 500 deg. in the attempt to recover as much of the heat as possible. On this account and because of the intensity of draft required for operating the industrial furnaces and for drawing the gases through the boiler, it becomes necessary to use induced-draft fans. When properly installed and driven, the fans prove an advantageous accessory from the standpoint of better control of the operation of the heating furnaces, and with correctly selected turbine drive the exhaust steam suffices to heat the boiler-feed water.

Foundations for Machinery

By N. W. Akimoff

In a paper before the American Society of Mechanical Engineers at the annual meeting in New York, N. W. Akimoff gives an interesting explanation of the cause of vibration in machinery and offers a decidedly novel solution of the problem.

In putting in a foundation for an engine or like machine, the underlying motive is to so tie it to the earth that the amplitude of the vibration of the machine will be reduced to zero since the mass of the earth may be, for practical purposes, considered as infinite. Even with a massive foundation the designer frequently places a layer of felt or rubber between the concrete and its base with the idea of avoiding vibration. In this way the advantage that might be gained by tieing the machine to the earth is lost.

It would seem that a rational basis upon which to work is lacking, and the author proceeds to point out a rational theory for foundation or superstructure design. Vibration in machinery is due to one of two causes—it may be the result of unbalancing, or from causes other than unbalancing. The first is easily avoided if care is taken to secure a running balance. Even with a perfectly balanced machine whipping of a light shaft, water in a turbo-generator, etc., may produce extensive vibrations. If these latter exist, then the substructure must be designed to be as free from response to these vibrations as possible.

The author then proceeds to point out that any force may be resolved into six separate motions, about the three axes and along the three axes. A free body is said to possess six degrees of freedom. If a body is locked so that no displacement can take place, all six degrees of freedom are suppressed. By fixing two points in a body, there is the effect of rotation about an axis, and only one degree of freedom exists.

To secure stability, there must be a remoteness of the operating speed from any of the several synchronous speeds at which the frequency of the operative speed would be nearly equal to the frequency of the free oscillation of the system. The number of synchronous speeds depends on the number of degrees of freedom. An absolutely free system, such as with an elastic subfoundation, has six degrees of freedom and six synchronous speeds. Even a massive foundation may have six speeds, since it is more or less free. If these synchronous speeds be controlled to avoid appproaching the machine speed, then vibration would be eliminated.

The author then cites the fact, giving as an example an unbalanced revolving weight mounted on a pendulum suspended at *A*, Fig. 1, that the speed which is synchronous with one degree is no longer synchronous if a second degree of freedom be given by the insertion of a second free point. The oscillations will thus be reduced practically to zero, not by steadying the system by something without it, but by an adjustment wholly within the vibrating system. Furthermore, the second degree of freedom lies in the plane of the figure and not at right angles to it, as in Fig. 1, *B*.

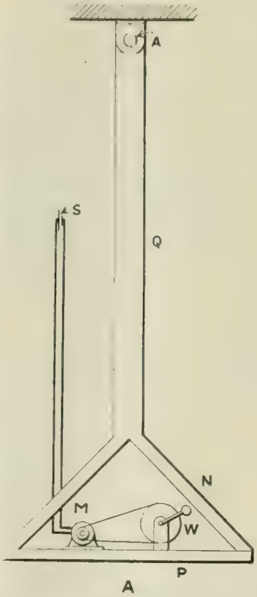


FIG. 1. PENDULUM

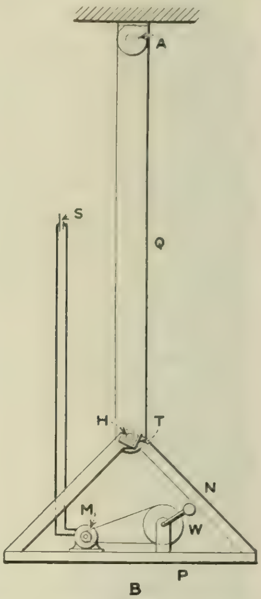


FIG. 2. DESIGN OF TURBINE SUPERSTRUCTURE

The Basis of Foundation Design

This, then, will be taken as basis for his further discussion. In contemplating the design of a foundation he states that we should always separate those directions (or axes of instantaneous rotation) about which the system cannot (or at least is not likely to) oscillate from those directions (or instantaneous axes) about which the system is more or less certain to vibrate. We should next select a "steady" point from purely practical considerations, and finally devise such means of controlling the "free periods" of the system as will secure the desired degree of remoteness from synchronism under the actual operative speed. Such means could be springs, exceedingly heavy, and not in the least calculated to allow of any free wabbling of the system. They should also be adjustable so that the desired periods may be readily varied within the wide limits and, in general, structurally arranged to introduce as few changes as possible in the arrangement as a whole.

The author feels that to submit too many particulars as regards the detailed designs of such an arrangement would certainly defeat the purpose of this paper, which is merely to introduce the broad idea and not any one of the scores of individual designs that might readily suggest themselves to the engineer confronted with the problem of designing a foundation for a given machine. Considering, therefore, only one type of apparatus, a turbo-generator (Fig. 2), we must start out with the selection of the steady point. We will naturally place it as near the steam main as possible (not to the exclusion, of course, of a suitable expansion joint), as under all conditions, should there be a choice of position, preference should be given to that point as far as possible from the center of graivty of the system, so that any static unbalance (whipping, etc.) would be made to act not as a force *upon*, but as a moment *about* that steady point. Such point should actually be made as steady as possible and no trouble should be spared in providing suitable piling or digging down to the solid ground and constructing suitable footings.

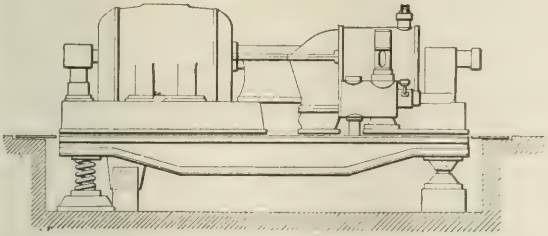


FIG. 2. DESIGN OF TURBINE SUPERSTRUCTURE

The next problem is to design a substructure adapted to receive the bedplate of the apparatus and made stiff enough so as to eliminate any "periods" of its own. This bedplate may be made of structural steel or of reinforced concrete, in which latter case the ends thereof may be made of cast iron. The substructure is supported upon the steady point either by a ball-and-socket arrangement, or is simply bolted at that point to the floorplate underneath by a bolt which need not necessarily be very light, but which must be arranged in a manner to secure the minimum area of actual contact.

Remembering that in apparatus of this sort the tendency to oscillate about the longitudinal axis is always rather negligible, we have practically only two degrees of freedom and only two periods to adjust so as to have them well out of the limits of the operative speed; hence the two sets of springs, one to take care of the period corresponding to oscillation in the vertical plane, the other to control motion in the horizontal plane. It should not be imagined, however, that these springs will necessarily be very light. They will always have considerable stiffness, but their function is that of being the only members that can yield, and the whole situation is controlled by the proper choice of these yielding elements.

The Heat-Insulating Value of Cork and Lith Board

In a paper prepared for the annual meeting of the American Society of Mechanical Engineers by A. A. Potter, J. P. Calderwood, A. J. Mack and L. S. Hobbs, a description was given of the apparatus used and the methods employed in determining the insulating value of cork and lith board. These tests consisted essentially of placing a small cubical box containing a number of electric lights in a refrigerator and measuring the amount of heat conducted through the cork and lith board sides of the cube. Tests were made on both the conductivity and transmission characteristics of each material. From the data secured formulas and tables were prepared. Table I gives the results of the tests on cork board, while Table II gives those of lith board.

The results of these tests are of special interest because of the low value of the external temperature, the average for all tests being approximately 10 deg. F. The mean temperature of the materials tested was approximately 40 deg. F.

The tests indicate that the heat-insulating property of cork board is slightly better than that of lith board. For the samples tested, the lith board has a conductivity approximately 5 per cent greater than that of cork board.

The conductivity and heat transmission of the materials tested increase with the temperature. The change is small, however, between the temperature limits employed in this investigation.

TABLE I. RESULTS OF TESTS ON 3-IN. CORK BOARD, SERIES NO

Test No.		1C	2C	3C	4C	5C	6C
Temperature at thermocouples, deg F.	1	36.95	53.69	64.94	79.79	93.20	104.53
	2	36.68	53.97	64.04	78.53	91.84	103.93
	3	33.86	50.90	60.08	75.02	87.80	100.22
	4	8.33	12.65	11.20	14.18	17.96	20.12
	5	4.82	8.06	5.90	7.52	10.60	12.27
	6	4.86	7.70	5.54	7.07	10.40	11.93
	7	48.36	70.25	85.55	104.18	121.37	133.16
	8	5.66	9.40	8.14	10.27	14.00	16.16
	9	29.86	45.14	53.78	67.64	78.80	90.85
	10	6.56	10.40	9.23	11.30	14.90	17.39
	11	33.86	50.90	61.16	75.38	88.16	100.26
	12	6.09	10.04	8.24	10.94	14.18	16.68
B.t.u. per hr. supplied heater		70.62	100.00	136.26	166.16	197.69	226.56
Average conductivity, B.t.u per sq.ft. per deg. F. per hr.		0.102	0.098	0.105	0.104	0.108	0.109
Average conductivity, B.t.u. per sq.ft. per in. thickness per 24 hr.		7.34	7.06	7.56	7.49	7.78	7.85
Average temp. of cork, deg. F.		21.22	32.01	36.50	45.37	53.77	61.10
Transmission,* B.t.u. per sq.ft. per deg. per hr.		0.082	0.084	0.088	0.089	0.093	0.096
Transmission,* B.t.u per sq.ft. per deg. per 24 hr.		1.97	1.97	2.11	2.13	2.23	2.30

* Based on temperatures 2 in. from surface Density of sample, 11.8 lb. per u.ft

TABLE II. RESULTS OF TESTS ON 3-IN. LITH BOARD, SERIES NO. 2

Test No.		4L	3L	2L	2XL	1L	5L
Temperature at thermocouples, deg. F.	1	42.89	56.84	72.81	72.73	88.93	110.92
	2	42.80	56.66	72.37	72.50	88.16	111.38
	3	40.19	53.06	67.91	67.91	84.79	103.38
	4	11.03	14.00	14.90	15.35	16.34	16.07
	5	6.80	8.24	7.88	8.60	8.24	6.71
	6	6.53	7.88	7.70	8.33	7.79	6.62
	7	57.56	75.20	96.12	95.72	116.60	138.74
	8	8.00	9.92	10.39	10.80	11.39	10.49
	9	37.22	48.56	63.20	63.33	77.18	92.21
	10	8.60	10.69	11.66	11.75	11.75	11.75
	11	41.09	54.50	69.87	69.80	84.92	105.62
	12	8.60	10.54	10.99	11.64	12.20	11.75
B.t.u. per hr. supplied heater		87.85	116.66	153.70	153.98	199.16	249.85
Conductivity, B.t.u. per deg. per sq.ft. per hr. Method 1		....	....	0.112	0.118	0.126	0.109
Conductivity, B.t.u. per deg per sq.ft. per hr. Method 2		0.104	0.107	0.110	0.109	0.107	0.113
Conductivity, B.t.u. per deg. per in. thickness per 24 hr.		7.49	7.70	7.89	7.85	7.70	8.06
Transmission,* B.t.u. per sq.ft. per deg. per hr.		.....	......	0.090	0.090	0.092	0.094
Transmission,* B.t.u. per sq.ft. per deg. per 24 hr.		.....	.....	2.17	• 2.16	2.21	2.26

* Based on temperatures 2 in. from surface. Density of sample, 10.8 lb. per cu.ft.

The conductivities of the materials as determined in this investigation agree fairly closely with those obtained by other investigators. The United States Bureau of Standards, for example, gives the following values for the conductivity of cork board:

Conductivity, B.t.u. per in. per deg. per sq.ft. per 24 hr.	7.4
Density of material, lb. per cu.ft.	11.3
Mean temperature of material, deg. F. (25 deg. Cent.)	77.0

And They Claim Oil-Field Boilers Do Not Explode

Bluffton, Nov. 26—Due to a defective flue, the boiler at a drilling well on the Ewing lease of the Ohio Oil Co., east of here, exploded yesterday. The barrel of the boiler was hurled fifty rods from the engine house, passing over the heads of three woodcutters.

The dome and shell of the boiler were blown about 1,500 feet, passing over a clump of trees. The explosion was the most severe in the history of the Bluffton oil field. Loss is estimated at $1,000.—*Toledo News-Bee.*

A.S.M.E. Holds Annual Meeting

Fuels, Railroads, Design and Research Problems Are Among the Many Subjects Considered
Industrial Relations Discussed by President Miller—President-Elect Carman Introduced—1,926 Members Present

ENGINEERS from all parts of the country to the number of 1,926 gathered in New York City recently to take part in the forty-first annual meeting of the American Society of Mechanical Engineers, which took place on Dec. 7, 8, 9 and 10. Transportation was the keynote of the meeting, but numerous papers presented were more directly in *Power's* field, and several of the addresses heard were of great general interest. At the Tuesday evening meeting the incoming president, Edwin S. Carman, was introduced. Mr. Carman has the honor of being the youngest man who has ever achieved the presidency of the A.S.M.E. The most interesting speech of the evening was made by Fred J. Miller, the retiring president.

INDUSTRIAL RELATIONS AND PROFITEERING

Mr. Miller gave his ideas on industrial relations and the engineer's part in controlling them. He emphasized the thought that is coming to be more and more generally accepted nowadays—that the engineer must increase the effectiveness of labor, not by driving, by oppression or suppression, but by the application of brains in the industrial organization, and the management of men as well as of materials. His influence must be in the direction of constructive adjustment—such an adjustment as will show recognition of property rights as well as human rights.

Of course there are and always have been employers who have been fair to their employees and have been real leaders of men, but in many cases the most profound thought that seems to have been applied to industial problems has led to the conclusion that industrial management consists in hiring as cheaply as possible and driving as hard as possible. The day of that sort of thing is passing and industry is being conducted on a much higher plane of intelligence. We have been hearing frequently about falling off in production per man-hour, and it is true there has been a great deal of that; but the fact remains that many of our industrial establishments have been conducted upon a hire, drive and fire plan. Too often plants are conducted by financiers or others who know little or nothing about industrial matters and are far distant from the locality where the work is carried on. Unfortunately, morale and esprit de corps are not represented by any items on balance sheets, and some of the men at the head of large manufacturing concerns know little or nothing about manufacturing except balance sheets as reported by others who, in turn, know little or nothing about management science.

It is becoming generally recognized that the question of whether an employer shall confer with his men or their representatives upon their request is not simply a dispute within an independent business corporation, but is a matter that concerns the public as well. A corporation is created and exists by authority of the people; they depend upon it for imperative necessities and, consequently, have a right to demand that it be properly conducted.

Usually, where an engineer has acquired enough property to be termed well off, it is the result of services rendered. Mr. Miller compared Corliss and his early practice of selling so many engines upon the basis of a standard share of the saving of fuel for a limited time, with the usual absentee owner of the anthracite coal fields of Pennsylvania who creates no coal, digs and transports no coal, and does nothing except own the ground in which it had been placed ages ago for the benefit of mankind. Some of these owners recently have been doubling and more than doubling their royalties, the State of Pennsylvania helping them to retain their grip by applying taxes to the ridiculously low valuations of their property as unproductive farm land.

Corliss had for a limited time a monopoly of that which he himself had created; yet no man discarded the plain slide-valve engine for the improved Corliss engine except by his own free will. On the other hand, the anthracite coal owners have not produced that which they have monopolized, and yet the public must have coal at any price demanded.

After this address by President Miller the usual presidential reception and dance was given.

PROGRAMS OF GENERAL INTEREST

The usual committee reports were presented at the business meeting, held Wednesday morning; one, the report of the Committee on Code of Ethics, developed a lively discussion. A code was presented, but was referred back to the committee for improvement. The consensus of opinion seemed to be that the thoughts expressed by the code were admirable; the language used to express these thoughts, however, was very frankly and thoroughly criticized.

Another meeting of general interest was held on Wednesday evening, in memory of one of the society's most distinguished members—Dr. John Alfred Brashear, who died April 8, 1920. Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching, and for years a close personal friend of Dr. Brashear, entertained his hearers with a notable address on the great scientist and his work. The speaker's intimate knowledge of Dr. Brashear's life enabled him to paint a vivid picture of his early struggles against poverty and adversity of all kinds. He told how Dr. Brashear and his wife had built their first telescope in a little shop in back of their home; how for years he had toiled half the night, after his day's work in a rolling mill, to make a still more perfect lens. At the time of his death Dr. Brashear was famed throughout the world as a maker of precise astronomical instruments and had constructed some of the largest glasses in use. Dr. Pritchett gave a number of reminiscences of his friend, and dwelt at length upon the extraordinary kindness of the man, for which he was admired and respected as much as for his scientific achievements.

The Wednesday meeting of the newly formed management section was also somewhat in the nature of a memorial; it was devoted to consideration of the life and work of Henry L. Gantt, a member of the society, who died Nov. 23, 1919. Mr. Gantt is famous for his own efforts and for his work in collaboration with Dr. Frederick W. Taylor toward the elimination of waste in manufacturing processes and the establishment of just relations between employers and employees. Several papers were read, notably one by Walter N. Polakov, who made a very careful analysis of what he termed "Ganttian Philosophy." His paper, entitled "Principles of Industrial Philosophy," was a thorough and favorable study of Mr. Gantt's ideas and methods of securing results.

FUEL SESSIONS

What proved to be the banner session of the meeting was that on fuel. With an attendance that packed the capacity of the hall the session which was scheduled for Tuesday afternoon outgrew its allotted time and was continued over into Wednesday forenoon, and with a lively discussion still waging was again continued over to Thursday evening.

In his opening paper on the "Fuel Supply of the World," the chairman, Professor Breckenridge, pointed out that fifty years ago the total coal production of the United States was less than one ton per capita. Today it is slightly over six tons. The United States consumes 52 per cent of the coal used each year, and over two-thirds of the world's petroleum production. Moreover, the total coal consumed in tons about equals the estimated population of the world. The tables show the estimated coal reserve, including lignite, of the principal coal-producing countries of the world, also the annual coal production and one year's fuel requirements of the United States.

ESTIMATED RESERVE COAL AND LIGNITE SUPPLY OF PRINCIPAL COAL PRODUCING COUNTRIES OF THE WORLD

Countries	Supply in Billion Tons	Source of Information
United States ...	3,427	United States Geological Survey
China	1,500	Sec'y Bituminous Coal Trade Assn.
Great Britain....	180	British Royal Commission
Germany	164	Sec'y Bituminous Coal Trade Assn
Canada	100	Canadian Authorities
Japan	50	Sec'y Bituminous Coal Trade Assn.
Austria-Hungary...	30	Sec'y Bituminous Coal Trade Assn.
France	25	Sec'y Bituminous Coal Trade Assn
Belgium	20	Sec'y Bituminous Coal Trade Assn
Chile	2	Sec'y Bituminous Coal Trade Assn.

THE WORLD'S PRODUCTION OF COAL FOR A TYPICAL YEAR (1913)

Countries	Millions of Tons (2,000 Lb.)
United States (72 per cent from Pa., W. Va., Ill)	569
Great Britain	321
Germany......	305
Austria-Hungary....................	59
France....	45
Russia	35
Belgium......	25
Japan....	23
Total ...	1,382

ONE YEAR'S FUEL REQUIREMENTS OF THE UNITED STATES AND ITS COAL EQUIVALENT (13,000 B.T.U.)

Kind of Fuel	One Year's Fuel Consumption	Approx. Coal Equivalent (Tons-2,000 Lb.)	Conversion Factors
1. Peat........	25 thousand tons	12,500	2 tons = 1 ton coal
2. Natural gas	800 billion cu. ft.	27,000,000	30,000 cu.ft. = 1 ton coal
3. Wood......	80 million cords	40,000,000	2 cords = 1 ton coal
4. Water-power	7.5 million developed water horsepower	55,000,000	33% load factor 5 lb. coal per hp.
5. Petroleum..	360 million bbl.	100,000,000	3.6 bbl.= 1 ton coal
6. Coal.......	650 million tons	650,000,000	....
Total....		872,012,500	

According to the speaker the world's production of petroleum for 1920 would be approximately 525,000,000 bbl., of which the United States would produce about two-thirds. The continents, in the order of their wealth in oil, are North America, Asia, South America, Europe, Oceanica and Africa. However, with the oil fields of the United States perhaps 40 per cent exhausted, it is not reasonable to assume that 60 per cent of the world's output will continue to come from wells in the United States. Professor Breckenridge made the following suggestions of how to prevent waste of coal:

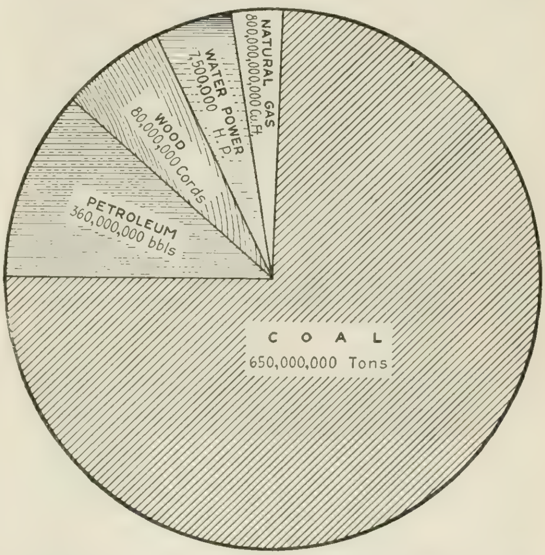
1. Extend as rapidly as possible improved methods of mining, inasmuch as under present conditions one-third the bituminous and one-half the anthracite coal is left in the mines under such conditions that recovery is practically impossible.
2. Extend improved methods of preparation of coal at the mines.
3. Reduce the hazards of coal mining.
4. Operate the mines a maximum number of days each year.
5. Use a large amount of mine waste.
6. Increase the use of byproduct coke ovens and increase the use of domestic coke from the local gas plants.
7. Extend the use of blast-furnace gas for power generation.
8. Extend the use of producer gas and the heavy-oil engine for power generation.
9. Extend water-power development.
10. Extend very generally the best known performance of locomotives. The better locomotives of 1920 use only two-thirds of the coal required twenty years ago to do the same work.
11. Encourage the tendency of the small industrial plant to purchase its power.
12. Furnish homes and public buildings with correct and simple instructions for operating the furnace.
13. Extend the use of coal storage.
14. Encourage electrification.

FUEL CONSERVATION

Following Professor Breckenridge, David Moffat Myers made a plea for fuel conservation and the prevention of waste by the application of well-known engineering principles.[1] A common-sense engineering program of fuel conservation would save over four dollars per capita for every man, woman and child in the United States.

During the war, by the adoption of very simple rules governing methods of operation alone in our power plants and railroads, an annual saving of 25,000,000 tons of coal per year was effected in twenty-five states for an average of less than four months. It was impossible at that time to adopt measures also affecting the design or equipment in connection with the use of fuel. A future program should include such measures. During the war, however, destructive conservation was also largely practiced, which meant the cutting off of coal supply to various industries and uses, with the consequent impoverishment of our industrial and social life. What we should have now is constructive conservation; that is, using fuel without reduction in the output of our manufactured products and without slowing down any of our national or social life. The speaker did not believe that mere financial incentive to stop the unnecessary waste of fuel is strong enough to do the work for the reason that the great bulk of coal and other fuel is consumed in industrial undertakings, where substantial profits are readily available without the trouble of economizing in the application of fuel.

In the speaker's opinion fuel conservation can never be satisfied by development of the central power-plant idea alone. The privately owned plant is essential to economy, and each has its special and appropriate field of service. Neither, as operated today in the average case, fulfills its duty, and the only solution is an adequate plan of co-operation between the two types of plants for the mutual advantage of both in the saving of money and for the advantage of the public in reducing the present enormous and needless waste of coal.



RELATIVE ANNUAL USE OF VARIOUS FUELS IN THE UNITED STATES

DISTILLATION OF FUEL

The distillation of fuels as applied to coke and lignite was discussed by O. P. Hood, chief mechanical engineer of the United States Bureau of Mines. The subject is by no means a new one, said Mr. Hood, but it is receiving growing appreciation by the layman, who is beginning to repeat some of the extravagant statements which he has read regarding it. While there are many advantages in the distillation of fuel it also has its limitations.

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[1] An abstract of Mr. Myers' address will appear in an early issue of *Power*.

Distillation of coal may produce coke, gas, pitch and a chain of oils, dyes and medicinals. It must not be supposed, however, that all coal should be made to yield these products, and there will always be much use for raw coal. The processing of coal is necessarily a large enterprise and involves a large expenditure of capital. Even on a large scale the tendency is to emphasize a single product rather than to enter a business involving the marketing of a chain of widely dissimilar products, and in this connection conservation of capital must have some consideration as well as the conservation of raw material. Nevertheless, fields are rapidly developing for the processing of coal. These are made apparent by the increasing cost of coal and the decreasing supply of high-grade fuel.

There is a popular hope that the production of higher valued elements will result in a supply of the residual fixed carbon or coke for the domestic fuel at a reduced price. Coke is one of the chain of products whose relative cost will depend upon market conditions, and so far the coke has been absorbed at a price that leaves little hope for cheap fuel.

Since the amount and quality of the distillation depends largely on the process a variety of results may be obtained. The low-temperature process (not 1,400 deg. F.) is attracting considerable attention on account of the high value of some of the products. The difficulties involved in low-temperature distillation, however, must be equalized by a greater refinement of its products, so that it offers little hope for a cheap fuel. The carbo-coal process is the leading example of this type, but the fuel it yields is a competitor of anthracite and certainly will not be cheap.

The distillation of coal in byproduct coke ovens is already the major process for the production of metallurgical coke. Its byproducts include gas, a tar that may be burned, benzol for motor fuel and ammonium sulphate for fertilizer. The increasing cost of gas oil is causing a tendency toward coal distillation again for city gas. This will insure a supply of coke for domestic heating service.

The lignite areas of the United States offer a field for distillation for the production of domestic solid fuel. In most regions the solid fuel would probably be the main thing sought and the other products wasted. The solid products from lignite distillation, however, must be briquetted for domestic use.

FORM VALUE OF ENERGY

Recognizing that resource energy as the source of power, heat and chemical work is the basis of industrial activity and social advancement, Messrs. C. G. Gilbert and J. E. Pogue presented a paper on "Form Value of Energy in Relation to Its Production, Transportation and Application." The authors pointed out that the conditions under which energy is brought into play in the United States are mainly an inheritance from a period when the character of energy resources was imperfectly known and the technology of energy employment was crudely developed. The production of coal is scattered, unco-ordinated and wasteful. The coal mines carry a variable but large idle capacity, accompanied by an uncertainty of operation, which is at once a menace to the stability of the labor supply. Transportation is the weakest link in our coal supply. Coal forms over a third of the country's freight, and the mining is dependent upon an unbroken movement of coal cars past the mine mouth. The number of cars has never been equal to the full capacity of the developed mines. Again, the present utilization of coal involves a very low recovery of the energy contents. The authors then showed a chart giving the comparative cost per million B.t.u. at unit prices of the various industrial fuels.

DISCUSSION OF FUEL PAPERS

The discussion seemed to emphasize the fact that conservation of heat units does not always mean conservation of dollars, and although much can be done to effect savings through proper design and operation, there are nevertheless bound to be many cases where the greatest conservation of heat units will not be effected until the cost of fuel reaches the point where the saving will more than offset the increased cost necessary to attain it.

Opinion was divided as to the desirability of further governmental supervision in the matter of fuel supply and practice, although it was generally conceded that something should be done to protect the domestic consumer, who cannot protect himself as to quality and price.

Again, one group of speakers was of the opinion that the greatest conservation lay in greater centralization of power to the exclusion of the independent plant. Those taking the opposite view believed that there was a distinct field for the independent plant when properly designed and operated with a view to the use of byproduct steam in heating and industrial service.

DECREASED EVAPORATION ACCOMPANIES POOR QUALITY

John W. Lieb, vice-president of the New York Edison Co., gave some pertinent figures showing the effect of the present coal situation on the public utilities. The latter, he said, used from 50,000,000 to 60,000,000 tons yearly. In 1916 the cost was $3 per ton f.o.b. tidewater, New York, made up of $1.50 freight and $1.50 coal at the mine. Now the freight alone costs more than $3. Moreover, it is at present impossible to get a satisfactory contract that will insure the company of an adequate supply. The operators, he said, were in the habit of reserving a large part of their output to sell as spot coal on the speculative market and were thus unable to meet their contracts for the rest of the coal. It is at present impossible to purchase coal on any quality specifications, and as a result the evaporation per pound of coal has fallen off in spite of the efforts of the operating force. Owing to the poor quality the pounds of coal per kilowatt-hour in the plants of his company have increased 20 per cent over that in 1916, and the cost at the switchboard has gone up from 0.29 to 0.76c. per kw.-hr.

Mr. Lieb strongly urged that the coal operators provide bin storage in order to stabilize their production over short periods when cars were not available. An adequate bin storage, he believed, would not add more than seven cents per ton of coal produced.

Questioned as to the possibilities of shale oil, George Otis Smith, Director of the Geological Survey, stated that this industry was about to be developed in Pennsylvania at the time oil was discovered. The latter was so much cheaper to produce that the shale-oil industry was immediately discontinued. There are great deposits, however, in the West, and these will be available when our present oil supply is nearing exhaustion. Shale oil, however, will be more expensive to produce, and to substitute it at present would be to duplicate much of the manpower of the coal industry.

DISCUSSIONS ON MACHINERY FOUNDATIONS

Discussion on N. W. Akimoff's paper, "Foundations for Machinery"[2] was very active, reflecting a somewhat incredulous relief at the prospect of deliverance from the method in use to this day, of blindly adding to the mass of foundations, in the hope of eliminating vibrations. Mr. Hecht emphasized the error of the old system, by bringing out the fact that the earth itself, of practically infinite mass, transmits vibrations to great distances. Mr. Slocum made the statement that if it were not for synchronism, we would never notice the vibrations in machinery. While this is somewhat exaggerated, it is perfectly true that resonance multiplies enormously the phenomenon and should be avoided at all cost. This was illustrated by Morris Deutsch, who told of a seven-story building which vibrated in tune with printing machinery 200 ft. away, to such an extent that a bucket of water placed on the top floor, and filled to within only five inches of the top, would spill over. M. D. Hersey proposed to better the author's scheme by adding a cushion or pad as well as the springs, to further dampen the vibrations and prevent their being transmitted to the foundations. This was in direct contradiction to Akimoff's principle that the machine must on no account be allowed to vibrate separately from its foundations. Perhaps the paper did not sufficiently emphasize this point and the important condition that the springs must be stiff enough to communicate all vibrations of the machine to its foundations, so that they will vibrate as a whole, though at two separate, synchronous speeds. By adjusting the compression of these springs, these synchronous speeds may be varied so that they will be remote from the range of the operating speeds employed.

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[2] An abstract of Mr. Akimoff's paper appears on page 994 of this issue.

The paper by A. A. Potter and others on "The Heat Insulating Properties of Cork and Lith Boards,"[3] was read by Mr. Potter. W. H. Carrier and Prof. A. J. Wood agreed in criticizing the methods employed by the authors and made some suggestions as to a better arrangement of equipment. Prof. H. B. Dickinson, of the Bureau of Standards, Washington, then described methods of testing employed by the bureau, especially the prevention of heat radiation, where objectionable, by use of polished surfaces. Mr. Potter closed for the authors, stating that he, personally, was not quite satisfied with the methods used or the results obtained and hoped that there might be an opportunity in the future of making further tests along the same line, when many of the suggestions offered by those who participated in the discussion would be adopted.

BOILER TUBES DISCUSSED

The paper by Albert E. White on the "Constitution and Properties of Boiler Tubes" was illustrated by lantern slides corresponding with the halftones in the paper showing etched surfaces of boiler-tube samples. Mr. White made a correction in his paper which affects the abstract printed on page 959 of *Power* for Dec. 14. In the 19th line of this abstract the phrase "sodium carbonate" should be changed to "calcium carbonate." F. N. Speller stated his opinion that the ghost lines referred to by the author were not due to phosphorus, as present practice allowed only 0.01 per cent of phosphorus at the outside.

E. B. Powell expressed his appreciation of the kind of work done and emphasized the difficulty mentioned by the author in identifying conditions involving hydrogen embrittlement. A. J. German did not agree with the author in regard to poor material as the cause of bagging of tubes, especially on the bottom row, which he attributed rather to impurities in feed water. The author in his closure emphasized the fact that failure was in many cases due to tubes being under a state of strain, because of careless and ignorant handling, stating that recrystallization was due generally to one or more of four conditions—deformation, time, composition and possibly temperature. He stated also that traces of blowholes were always present, even in material of the best quality. From the experiments made, he deduced that a higher-carbon steel was freer than low-carbon steel from blowholes. G. L. Warden told of an excessive amount of trouble his concern had been experiencing in failures due to poor feed water, adding that if any of the gentlemen present had occasion to use Delaware River water for boilers they could sympathize with him. He stated his belief that the quality of material was improving over war-time conditions, and also that sufficient attention was not being given by the average engineer to deformation as a cause of failure. He also asked if anyone could give information as to increased hydrogen absorption being due to use of oil as a fuel. In reply A. E. Foster stated that he had experienced considerable difficulty in an oil-fired plant in Oklahoma using Arkansas River water, but that conditions had been much improved by treating the water and opening the throat about thirty inches.

Dean E. Foster, in his paper, "The Effect of Fittings on Flow of Fluids Through Pipe Lines,"[4] advanced the new principle that, in computing pressure loss in pipe lines, the fittings may be replaced by a length of straight pipe of equal resistance. He derived simple formulas for water and steam from Konrad Meier's more complex expressions. He also expanded H. V. Carpenter's chart for the flow of steam, to cover both dry, saturated and superheated steam. This chart gave rise to considerable discussion which was entirely beside the subject of the paper, as it emphasized the much debated point that, for the same flow and pressure, superheated steam causes a greater pressure drop in the pipe line than saturated steam; though this is readily admissible if one considers that, at constant pressure and rate of flow, superheating the steam increases its volume, and therefore the velocity of flow through the line.

DEFECTS IN STEAM FORMULAS

Robert C. H. Heck started the investigations which are set forth in his paper on "Steam Formulas" with the single purpose of comparing existing experimental data, formulas and tables on the physical properties of steam. His object was more particularly to determine the trend of the different curves at the highest temperatures and pressures attained in experimental work, with a view to extrapolating into the unknown field beyond.

This comparison brought out certain defects in the latest and most universally recognized works on the subject. First, the Marks and Davis tables, published in 1909, though agreeing with experimental data, were thermodynamically inconsistent, the curves presenting marked irregularities between observed values. Second, the Goodenow equations and tables, published in 1914 and 1915, though thermodynamically consistent, did not agree with experimental data. This led Professor Heck to develop an entirely new set of purely theoretical formulas, for which he derived constants from the latest and most reliable experimental work.

The results obtained with these formulas give smooth curves, free from irregularities, over the range covered by experimental work; and, according to the author's contentions, a more rational trend at the limits of this range, thus insuring a fair degree of accuracy in extrapolation.

Professor Marks and Dr. Davis, of Harvard, Dr. Moss of the G. E. Co., and Mr. Buckingham of the Bureau of Standards, agreed that Professor Heck's work was most interesting and valuable, but questioned if there was enough difference between his values and the existing tables to warrant the production of a new set of tables at this time.

Professor Dennis stated that there was urgent need of experimental research on this subject, since common engineering practice had already reached the limits of pressure and temperature thus far investigated.

Professor Heck, in his final discussion, claimed that his tables could be accepted at once as more reliable than the older ones, inasmuch as they agree with the latest experimental work and, on the other hand, give a smoother curve between observed values, and are based on more rational formulas. He thoroughly agreed, however, that further experimental work should be performed.

FAULTY REGULATION DUE TO FLYWHEEL EFFECT

The paper by R. E. Doherty and R. F. Franklin on "Flywheel Design of Synchronous Motor Driven Reciprocating Machines" aroused intense interest. Owing to the many applications of synchronous motors and instances of faulty regulation occasioned by insufficient flywheel effect, the authors considered the subject from the standpoint of the electrical engineer, which is to give ample weight to the wheel, whereas the machine designer seeks to limit the weight to that which is absolutely needed.

In the discussion some comment was made as to the poor characteristics of the synchronous motor from the viewpoint of the machine user. The tendency for the motor to drop out in case of line disturbances seriously affects the operation of such machines as refrigeration compressors. F. L. Fairbanks stated that the sudden stopping of the synchronous motor when fully loaded, threw tremendous stresses on the flywheel. The stresses result not only from the inertia of the wheel but from a reaction within the motor. Mr Fairbanks estimated this electrical reaction or "buck" to be 400 per cent of the full-load torque. He contended that this was sufficient to stop a fully loaded compressor in three seconds. Continuing, he stated that he believe the flywheel weight should be embodied in the motor rotor, and rather doubted the advisability of using synchronous motors with separate flywheels.

Mr. Doherty in reply claimed that the reaction taking place when the motor circuit breaker tripped was only equal to the full load reaction and that no danger of excessive stresses existed.

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[3] An abstract of this paper may be found on page 995 of this issue.

[4] An abstract of Mr. Foster's paper will appear in an early issue.

Of the three papers presented at the Textile Section Meeting, the second, by Leo Loeb, on Power Application to Cotton Finishing Plants,"[5] was the only one of signal interest to *Power's* readers. After the paper was read the secretary of the committte read a communication from F. R. Low, which was the only written discussion submitted. In this, and in the oral discussion that followed, some of the author's statements and deductions regarding methods of obtaining thermo-balance were questioned, especially his comparison between engine and turbine operation in its effect on exhaust steam. One point which was emphasized was the great saving in floor space by the use of water-tube boilers instead of fire-tube, and turbines instead of engines. In the author's closure Mr. Loeb answered a question as to the relative operating economy of electrically driven and mechanically driven steam plants by saying that in one case which had come to his notice there had been a saving in fuel consumption of over 30 per cent by electrification.

POWER SECTION

The first meeting of the newly formed power section was held on Friday morning, with John A. Stevens presiding. In the opening paper covering "Policies of Future Power Development," J. P. Jackson made a plea for greater centralization, believing that this will prove the solution of conservation both in fuel and capital. Manufacturing establishments use, he said, 145,000,000 tons of coal per year, with an average of 8.4 lb. per hp.-hr., as compared with 56 million tons used by the central stations at an average of less than 4 lb. per kw.-hr.

The speaker then told of the work being done in England toward centralizing the power supply, the standardization of voltage and frequency and in the elimination of existing plants that are wasteful of fuel. While commending the work in general, he criticized its administration in that it savored too much of governmental control. As a general principle he was opposed to Government interference and urged that public-service commission decisions be governed by law rather than by opinion.

EFFECT OF LOAD FACTOR ON COST

In the absence of Colonel Junkersfeld, E. P. Powell read the former's paper on the "Effect of Load Factors on Cost." This paper, which will be abstracted in a later issue of *Power*, took up the relative cost of generation with various load factors, the author pointing out that loss will result if operation is carried on at a higher or lower load factor than that for which the station is designed. In the selection of a site the relation between load factor, supply of fuel, delivery of the finished product, and condensing water were discussed.

High efficiency is obtainable with high boiler pressure, but this entails increased cost which may not be warranted by the load factor.

When a new unit is installed in a power plant it is important to know approximately how soon another will be required. Each succeeding unit is frequently larger than the preceding one, and the increased size is usually accompanied by increased efficiency. The units of highest efficiency usually carry the bulk of the load. However, the extra price paid for the high efficiency sometimes results uneconomically, due to a larger unit being installed earlier than anticipated.

EFFECT OF SIZE OF PLANT ON COST

George A. Orrok discussed "The Influence of Size of Plant on Cost," pointing out that large prime movers are more efficient because, between the same temperature limits, leakage and radiation increase only about half as fast as the power and the friction less than one-quarter as fast. Moreover, closer attention is usually paid to operation in the case of large installations.

The author reproduced curves by various authorities, which by comparison showed the advance in economy during the last twenty years due to the use of large units. Of particular interest was a set of curves by R. H. Rice, compiled in 1917, showing the advance in performance of steam-turbine plants from a kilowatt-hour on 30,000 B.t.u. in 1903 to 17,500 B.t.u. in 1916. During this period the gas-engine performance had remained practically stationary at about 20,000 B.t.u. Turbine water rates have decreased from 15 lb. per kw.-hr. for 7,500-kw. units to 12 lb. for 30,000-kw. units.

While the cost of a complete power station depends upon so many local factors that general figures are often of little use, Mr. Orrok nevertheless presented some tentative figures which not only showed the decrease in cost with size but also the general rise during the last few years. In 1914 the cost of a central station varied from $120 per kilowatt for a 5,000-kw. plant to $64 for an 80,000 kw. plant. The estimated best average figures for 1920 are $130 per kilowatt for a 25,000-kw. plant to $108 for $50,000 kw., $93 for 100,000 kw., $85 for 200,000 kw. and $82 for 400,000 kw.

In discussing the preceding papers, W. S. Murray, chairman of the Super-Power Survey, spoke of the advantages of greater interconnection of power systems and told of the increased economies obtained through railway electrification. The steam locomotive, he said, burns five tons of coal and throws three away. Electrification on the New York, New Haven & Hartford R.R. with its Cos Cob power station, which has a relatively low thermal efficiency compared with some of the more recent stations, has shown an economy over the steam locomotive of as high as 2½ to 1.

The speaker was followed by T. K. Thomson, who outlined the plan for utilizing more power at Niagara by building a dam across the river below the rapids. Mr. Thomson endeavored to show that the cost of such a project considered in connection with the power thus made available would be only a fraction of the cost of that now under construction by the Toronto Hydro-Electric Commission known as the Chippawa Power Development.

J. W. Lieb, in discussing Mr. Jackson's paper, expressed the opinion that what the public demands is service at adequate rates and under proper supervision. If we are to have large centralization of power, we must have absolutely reliable service and transmission lines must be supplemented by steam stand-by plants. In this respect one of the benefits of interconnection is that one stand-by plant can be made to serve several companies. Moreover, interconnection should take care of regional and not alone district diversity factors.

Another speaker was Walter N. Palokov, who urged greater consideration of low-temperature distillation of fuel. Carl C. Thomas warned against the granting of too many permits for the development of what might prove small and inefficient water powers, and H. L. Doolittle told of the interconnection of power systems in California, whereby the whole state will be tied together by a 220,000-volt line. He mentioned a plan that has been laid before the state commission as a proposal to promote economy by having savings in operation accrue 50 per cent as a rebate to the consumers, 25 per cent to employees, and 25 per cent to stockholders in the company.

Ampere Centenary Celebrated

Over a hundred prominent men in the electrical field gathered at the little town of Ampere, N. J., on Dec. 4 to honor the memory of the great Frenchman who founded the science of electrodynamics. The town itself was named after the eminent scientist, and in 1908 a tablet was set up there in his honor. There is now hanging above the tablet a bronze wreath which was unveiled at the recent ceremony by the Prince de Bearn, Charge d'Affaires and Councilor of the French Embassy at Washington.

The celebration was conducted under the auspices of the Crocker-Wheeler Co. Its president, Dr. Schuyler S. Wheeler, who acted as chairman of the meeting, characterized Ampere as the discoverer of the electrical law of gravitation. Three speakers—the Prince de Bearn, Dr. M. I. Pupin and Dr. C. O. Mailloux—made interesting addresses in which they described the life and work of Ampere.

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[5] An abstract of this paper will be published in an early issue of *Power*.

New Publications

RECIPROCATING ENGINES AND TURBINES. Published by The Travelers Indemnity Co., Hartford, Conn. Paper, 4 x 6 in., 134 pages; illustrated.

This book is published in view of the fact that it is necessary to understand the principles that must be recognized and observed if the reciprocating engine and the steam turbine are to be operated safely and economically. The text matter contains a number of articles that have appeared from time to time in the *Travelers Standard*, but it has been edited, augmented and rearranged to unify the treatment, simplify the language and to bring out the facts with greater clearness. The first main division of the book deals briefly with facts and discusses accident causes, safeguards and safe practice in general. The second main division takes up the discussion on certain theoretical points that should be of interest to the thoughtful engineer, and in dealing with these matters an effort has been made to simplify the language so that it may be understood without any previous study of the subjects. This little volume is compiled in an interesting manner and contains illustrations of a number of the subjects treated, such as flywheel wrecks, safety guards, etc. This booklet is sent free upon application.

MACRAE'S BLUE BOOK FOR 1920. Published by MacRae's Blue Book Co., 18 East Huron St., Chicago. Cloth, 8 x 11 in.; 1,700 pages. Price, $10 postpaid.

This book is a buying guide, or directory of addresses, materials, trade names and prices. The "Catalog Section" consists of 250 pages of advertisements such as ordinarily are to be found in trade journals. The "Address Section" contains in alphabetical order names and addresses of about 30,000 manufacturers. The "Classified Material Section" contains names and addresses of various manufacturers of railway supplies, iron and steel products and building construction material, classified according to the product. The "Trade Name Index" lists a great number of trade names, giving the manufacturer's name and address in each case. This is for use in looking up companies whose products are known as "Agrippa," "Acme," "O. K.," etc. The "Miscellaneous Data Section" consists of tables such as might be needed by men who specify or purchase materials, and deals with a great variety of subjects, including weight per foot of iron bars, wire gages, conversion tables, square roots, etc. The "Standard List Price Section" gives prices of building materials and iron and steel products. A table of discounts is added to save figuring combined discounts such as 20-10-2½, etc. The book should come in handy to purchasing agents and others who need condensed data in a hurry.

Personals

B. W. Latham, previously chief engineer with Cass Gilbert, architect, has taken a position with Murrie & Co., consulting engineers.

Berkeley Williams, until recently chief engineer of the F. H. Lawson Co., Cincinnati, Ohio, is now general manager of the Chatham Manufacturing Co., Middletown, Conn.

C. A. Jackson has left the Pelton Water Wheel Co., of New York, and is now connected with Wm. Cramp & Sons Ship and Engine Building Co. of Philadelphia, Pa., in the hydraulic department.

Otto W. Fisher is now chief engineer for L. O. Koven & Bros., Jersey City, N. J. He was formerly with the Furman-Fisher Corporation.

Grenville A. Harris has resigned his position as chief engineer of the American Steel Export Co. and has opened an office in New York, where he will operate as export engineer, acting as consulting or advisory engineer on export to various manufacturers in this country.

E. C. Morse, whose task was to sell the Government's surplus war stocks, has been presented with the Distinguished Service Medal for performing his duties with "marked ability, energy and judgment." He will end his connection with the Government on Dec. 31.

Society Affairs

The Atlanta Section of the A. S. M. E. will meet in the Carnegie Library on Dec. 28. N. C. Harrison will make an address entitled "Impressions of the Annual Meeting."

The Chief Engineers' Association of Chicago, at the annual election in room 912, Masonic Temple, elected Charles J. Lehn, president; Walter D. Periera, vice president; Clifford Gilmore, recording secretary; W. H. Couch, financial secretary; and Charles Langs, treasurer.

Business Items

The Star Brass Works, of Chicago, announces that beginning Jan. 1 its name will be changed to "Binks Spray Equipment Co." This name will better describe the company's product, which is spray-cooling systems and painting and spraying machinery. The old plant at Chicago has recently been enlarged, and a Pacific Coast office has been established in charge of L. M. Page, Rialto Bldg., San Francisco.

The Erie Ball Engine Co., of Pittsburgh, is now making Ball engines in its large, newly equipped factory at Braddock, Pa. The foundry department still remains at Erie, where these engines were formerly built under the old name of the Ball Engine Co. The new arrangement was made necessary by the lack of adequate manufacturing facilities and will not affect local offices, the personnel of which will remain unchanged.

COAL PRICES

Current mine quotations, with interesting comparisons, are given in the following tabulation:

	Nov. 1919*	Aug. 5 1920	Dec. 2 1920	Dec. 16 1920
Pittsburgh steam	$2.30	$10.00	$5.00	$3.75
Pittsburgh screened gas	2.30	12.00	5.50	4.50
Hocking	2 50	9 00	4 50	3 75
Franklin, Ill	2.35	6.50	5.00	4 00
Indiana 4th vein	2 35	7 50	4 00	3 25
Eastern Ohio, No. 8	2.35	10.50	5.00	4 00
Fairmont	2.50	13.50	4.75	3 75
Kanawha	2.60	14.00	4.75	4.50
S. E. Kentucky	3.00	10.50	5.25	4.75
Western Kentucky	2.35	5.25	4.25	4.00
Clearfield	2.95	12.00	5.00	4.75
Cambria and Somerset	2.95	13.50	6.00	6.00
New River	2.70	14.00	5.25	5.00
Pocahontas	2.35			

* Government prices.

New Construction

PROPOSED WORK

Mass., Boston — The Selwyn Theater Corp., 229 West 42nd St., New York City, is having plans prepared for a theater here, including a steam heating system. About $500,000. H. W. Crane, 160 North Ashland St., Chicago, Ill., Archt.

Mass., Danvers — C. V. Burgess, Archt., 23 Central Ave., Lynn, is preparing plans for a 2 story, 55 x 120 ft. cold storage plant, here. A refrigeration system will be installed in same. About $75,000. Owner's name withheld.

Mass., New Bedford—The Bd. Educ. received lowest bid for two 2 story, 170 x 250 ft. schools on Mt. Pleasant and Rochambeau Sts., respectively, from J. W. Bishop & Co., 109 Foster St., Worcester, at $638,000 each. A steam heating system will be installed in same.

Mass., Oxford—A. G. Stanhope, 340 Main St., Worcester, plans to build a 2 story, 75 x 100 ft. cold storage plant, here. About $40,000. Archt. not selected.

Mass., Worcester — The Bd. of Library Directors plans to build a library. About $1,000,000. Archt. not selected.

Conn., Meriden — The Conn. School for Boys, Colony St., plans to build a new central heating plant. Archt. not selected.

N. Y., Brooklyn—The Dept. of Educ., 500 Park Ave., New York City, is having plans prepared for a school including a steam heating system on 4th Ave., here. About $650,000. C. B. J. Snyder, 28th floor, Municipal Bldg., New York City, Archt. and Engr.

N. Y., Dannemora—Dr. J. R. Ross, Medical Supt., Dannemora State Hospital, will receive bids until Jan. 5 for the installation of fan, motor, heaters, etc. in Ward Building D of the northwest wing of the Dannemora Hospital. L. F. Pilcher, Capitol, Albany, State Archt.

N. Y., Long Island City—The Dept. of Educ., 500 Park Ave., New York City, will soon receive bids for the installation of a heating and ventilating system in the Bryant High School, here. Former bids rejected.

N. Y., New York—The Dept. of Pub. Welfare, Municipal Bldg., will receive bids until Dec. 24 for a refrigerating plant and the installation of refrigerating and ice making equipment at the Metropolitan Hospital District, Blackwell's Island.

N. J., Atlantic City—The Elks' Lodge, C. Bacharach, Chn., 108 St. Charles Place, plans to build an Elks' Home. About $1,000,000.

N. J., Summit—The Bd. Educ. is having plans prepared for a 4 story school. About $500,000. Guilbert & Beteile, 2 Lombardi St., Newark, Archts.

Pa., Philadelphia — The Selwyn Theater Corp., 229 West 42nd St., New York City, is having plans prepared for a theater here, including a steam heating system. About $500,000. H. W. Crane, 160 North Ashland St., Chicago, Ill., Archt.

Pa., York — Jacob and Isaac Silverman, 1512 11th Ave., Altoona, and Nathan Appell, York, plans to build a 4 story theater including a steam heating system. About $500,000. H. C. Hodgens, 130 South 15th St., Philadelphia, Pa., Archts.

Md., Baltimore — The Union Protestant Infirmary, Division and McMechen Sts., is having plans prepared for a 6 story hospital including a steam heating system at Guilford Ave. and 33rd St. J. E. Sperry, 409 Calvert Bldg., Archt.

D. C., Washington—The Bureau of Yards and Docks, Navy Dept., has asked Congress for $180,000 for improvements to the central power plant at the Mare Island navy yard, Cal., and $50,000 for the central power plant at the Cavite naval station, Phillipine Islands.

Va., Fort Story—The United States Engineer, Custom House, Norfolk, will receive bids until Dec. 29 for furnishing material and labor for the installation of a steam heating system in the office-storehouse building, here.

Va., Richmond — Mercer & Tretten, 218 North 9th St., are in the market for one air compressor, gasoline pump and gasoline tank.

Fla., Jacksonville—The City Commission has approved of $2,000,000 bonds for remodeling old cotton warehouse into cold storage plant, build new cotton warehouse and pier, etc.

Fla., Oketchobee—W. W. Dunnicliff, City Clk., will receive bids until Jan. 18 for one engine and pump complete, capable of 350 g.p.m., against a total head of 140 ft., approximately 65 lbs. pressure.

Miss., Jackson—The State Bond Improvement Commission, here, plans to spend $600,000 for repairing old power plants and building new plants at the various state institutions. T. C. Link, care of the Commission, Archt.

La., New Orleans—H M. Janette, Room 712, Hennen Bldg., is in the market for one 120-hp. Semi-Diesel Skandia marine engine, new or used.

O., Cleveland — The American Steel & Wire Co., c/o H. R. Klepinger, Western Reserve Bldg., had plans prepared for a 1 story, 53 x 134 ft. boiler house at East 40th St. and Lakeside Ave. About $75,000.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., will receive bids about Feb. 15 for heating plant including two 250-hp. boilers for the proposed new school at Diana and Darley Aves. About $100,000. W. R. McCormack, above address, Engr.

O., Cleveland—M. Makof, 1533 Woodland Ave., plans to build a 15 story, 50 x 130 ft. office and theater building including a steam heating system at 1883 East 9th St. About $2,000,000. Archt. not selected.

O., Cleveland—The Mall Motor Co., M. Rohrheimer, Pres., 632 Superior Ave., has purchased a site for a 2 story, 120 x 160 ft. garage including a steam heating system. About $300,000. Christian, Schwartzenberg & Gaede, 1900 Euclid Ave., Archts.

O., Conneaut—The Bd. Educ. had preliminary plans prepared for a 2 story, 200 x 250 ft. high school on Watson St. About $350,000. H. M. McCullough, Ferguson Bldg., Pittsburgh, Pa., Archt.

O., Steubenville—G. Shofer, 1103 Chapline St., Wheeling, W. Va., has purchased a site here, for 3 or 4 story theater. About $300,000.

O., Youngstown—The Bd. Educ., S. R. Creps, Dir. of Schools, 14 Wood St., will soon award the contract for a heating and ventilating system for a 14 room unit at the Hayden High School. Plans allow for an additional unit of the same size to be built later. C. F. Owsley, 1301 Mahoning Bank Bldg., Mahoning, Engr.

Ind., Hammond—The Bd. Educ. plans to build a 2 story, 100 x 150 ft. school including a steam heating system. About $400,000. J. T. Hutton & Son, Archts.

Ind., Indianapolis—The Bd. of Works is having plans prepared for a 3 story, 88 x 175 ft. hospital including a steam heating system on Margaret St. About $400,000. W. E. Russ, 313 North Pennsylvania St., Archt.

Mich., Detroit—The Selwyn Theater Corp., 229 West 42nd St., New York City, is having plans prepared for a theater here, including a steam heating system. About $500,000. H. W. Crane, 160 North Ashland St., Chicago, Ill., Archt.

Mich., Detroit—The Palestine Assn., 510 Fort St., plans to build a 10 story, 150 x 180 ft. lodge house including a steam heating system on Charlotte St. About $2,000,000. A. E. Harley, c/o Committee of Architects, 2631 Woodward Ave., Archt.

Mich., Lansing—The Michigan State Industrial School for Boys, East Lansing St., plans to build 36 institution buildings including a power plant.

Ill., Chicago—The Chicago Telephone Co., 212 Washington St., is receiving bids for a 3 story, 100 x 150 ft. telephone exchange building including a steam heating system at 44th and Drexel Sts. About $250,000. Holabird & Roche, 104 South Michigan Blvd., Archts.

Ill., Chicago—The Hilton Co., Inc., 793 Broad St., Newark, N. J. plans to build an office building here. Cost to exceed $1,000,000.

Ill., Chicago—The North Beach Hotel Co., c/o J. A. Armstrong, 127 North Dearborn St., will soon award the contract for an 8 story, 100 x 170 ft. hotel including a steam heating system. About $1,000,000.

Ill., Chicago—The Union Liberty Co., c/o W. W. Ahlschlager, Archt., 65 East Huron St., will soon award the contract for a 15 story, 60 x 80 ft. office building including a high pressure steam plant. About $400,000.

Wis., Janesville—The Bd. Educ. is having plans prepared for the superstructure of a 3 story, 180 x 200 ft. high school. About $500,000. Van Ryn & De Gellike, Caswell Blk., Milwaukee, Archts.

Wis., Milwaukee—The Civic Comn., c/o Mayor Hoan, City Hall, is arranging to finance the building of a memorial building at 8th and Cedar Sts. About $1,500,000. Archt. not selected.

Wis., Two Rivers—The Bd. Educ. had plans prepared and will receive bids about Jan. 1 for a 3 story, 96 x 110 ft. high school including a steam heating system. About $400,000. J. D. Chubb, 109 North Dearborn St., Chicago, Ill., Archt.

Iowa, Davenport—The Odd Fellows' Lodge, 1420 4th St., plans to build a 3 or 4 story lodge hall including a steam heating system at 6th and Main Sts. About $350,000. Archt. not announced.

Iowa, Fayette—The Board of Trustees of the Upper Iowa University plans to raise $1,000,000 for campus buildings. Archt. not announced.

Iowa, Fort Dodge—Lutheran Congregations, c/o Rev. J. M. Herbst, Webster City, plan to build a 3 or 4 story hopsital, here, including a steam heating system. About $450,000. Archt. not announced.

Iowa, Shelby—The Bd. Educ., M. E. Clapp, Pres., received bids for a 2 story high school including a steam heating system from J. E. Wakefield Co., 750 Brandeis Theater Bldg., Omaha, Neb., $224,000; H. Neuman Co., 519 Hubbell Bldg., Des Moines, Iowa, $213,752; J. F. Cobler, Carroll, Iowa, $229,131.

Iowa, Washington—The Washington Hotel Co., J. M. Wilson, Pres., is having plans prepared for a 4 story, 60 x 120 ft. hotel including a steam heating system. About $350,000. C. A. Dieman & Co., 408 Granby Bldg., Cedar Rapids, Archt.

Minn., Albert Lea—C. G. and R. G. Lang plan to build a 3 story canning plant including a 30 x 30 ft. boiler room. Archt. not announced.

Minn., Minneapolis—The Civic Music League, F. J. Mueller, Pres., 2818 Oakland Ave., plans to build a 10 story Auditorium building including a steam heating system. Archt. not selected.

Minn., Minneapolis—The Orpheum Theater Corp., M. Beck, Mgr., 190 North State St., Chicago, Ill., rejected bids and is revising plans for a 3 story, 115 x 182 ft. theater here, including a steam heating system. About $600,000. Noted Feb. 16.

Kan., Coffeyville—The Chamber of Commerce will receive bids until about March 1 for a 5 story, 100 x 140 ft. hotel. About $300,000. Shepard & Wiser, Long Bldg., Kansas City, Mo., Archts.

Kan., Wichita—G. Theis, Jr., Schweitzer Bldg., plans to build a 14 story, 150 x 150 ft. office building at 113 North Lawrence St. Archt. and Engr. not selected.

Neb., Milford—The Milford Electric Light Plant is having plans prepared for additions and improvements including the installation of a generator, steam plant and a water wheel. Koenig, Hollister & Co., Lincoln, Engrs.

Wyo., Douglas—The city plans an election Dec. 28 to vote on $85,000 bonds for extension to the water system including a pumping plant. Prince, Dixon Engr. Co., Omaha, Neb., Engr.

Tex., Jewett—J. A. Dean and W. N. Martin plan to rebuild their electric light plant recently destroyed by fire.

Tex., San Antonio—A. B. Ayres, Archt., Bedell Bldg., is preparing plans and will receive bids until about Jan. 15 for a 4 story addition to hospital including a steam heating system on Houston St. About $400,000. Owner's name withheld.

Tex., Sweetwater—The City Commissioners plan an election to vote on bonds for a municipal electric light plant.

Utah, Salt Lake City—The B. P. O. E., No. 85, 59 South State St., plans to build a 6 story, 75 x 135 club house. About $400,000. Scott & Welch, Dooly Bldg., Archts. and Engrs.

Wash., Seattle—The University of Washington is having plans prepared for a 4 story, 75 x 225 ft. education hall. About $330,000. Bebb & Gould, Securities Bldg., Archts.

Cal., Los Angeles—St. John's Episcopal Church, Rev. G. Davidson, Pastor, is having plans prepared for a church including a steam heating system at Figeroa and Adams St. About $500,000. B. G. Goohue, 2 West 47th St., New York City, Archt. and Engr.

Cal., Pasadena—The Y. M. C. A., 721 South Hope St., is having preliminary plans prepared for a Y. M. C. A. building. About $350,000. J. Morgan, Merchants' Exchange Bldg., Archt.

B. C., Vancouver—The Coast Range Steel Co., 419 Metropolitan Bldg., incorporated by Mr. Landis and others, for $15,000,000, plans to build a steel works near here.

CONTRACTS AWARDED

Mass., Northampton—The Bd. of Pub. Wks. has awarded the contract for a 1 story pumping station, pipe line, etc., to D. A. Sullivan, Paradise Road, at $15,000.

N. Y., New York—The United Electric Light & Power Co., 130 East 15th St., has awarded the contract for a power plant at 134th St. and the East River to the U. S. Structural Co., 84 Bway., at $4,500,000. Noted Nov. 2.

Pa., Hog Island—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for a radio building here, to J. H. Pierce, 529 Law Bldg., Norfolk, Va., at $30,665.

Va., Cape Hatteras—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for a radio building here, to Donnell Zane Co., Inc., 350 Broad St., New York City, at $20,565.

W. Va., South Charleston—The Bureau of Yards and Docks, Wash., D. C., has awarded the contract for a distribution system here, to the General Electric Co., River Rd., Schenectady, N. Y., at $14,565.

N. C., Cape Lookout—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for a radio building here, to Donnell Zane Co., Inc., 350 Broad St., New York City, at $13,865.

N. C., Gastonia—The Akray Mills has awarded the contract for a cotton mill including a steam heating system to the Turner Constr. Co., 244 Madison Ave., New York City, at $75,000.

N. C., Poyners Hill—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for a radio building here, to Donnell Zane Co., Inc., 350 Broad St., New Yok City, at $11,802.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ. has awarded the contract for a 50 x 67 ft. power plant for school on Lee Road to P. Kirschner, 1008 Hippodrome Bldg., Cleveland, at $110,000. Two 220-hp. boilers will be installed in same. Noted Aug. 31.

O., Cleveland—The Glenville Hospital, 701 Parkwood Drive, has awarded the contract for a 2 story, 40 x 40 ft. addition to boiler and laundry building to Lehder Constr. Co., Engineers' Bldg., at $40,000. Noted Oct. 19.

O., East Cleveland (Cleveland P. O.)—The Natl. Lamp Wks. of the General Electric Co., Nela Park, has awarded the contract for two 250-hp. Sterling boilers to the Babcock-Wilcox Co., 1521 Guardian Bldg., Cleveland, at $25,000. Noted June 1.

Mich., Detroit—Frank & Seder, c/o Smith, Hinchman & Grylls, Archts., 710 Washington Arcade, has awarded the contract for an 8 story, 60 x 100 ft. mercantile building to Thompson-Starret Co., Lincoln Bldg. A central steam heating system will be installed in same.

Mich., River Rouge—The Bd. Educ., c/o A. R. Heuer, has awarded the contract for a high school on Dearborn Road to Bryant & Detwiler, 2336 Dime Bank Bldg., Detroit, at $1,000,000. Contract for steam heating and forced ventilating systems will be sublet. Noted March 9.

Ill., Area—The Catholic Archdiocese of Chicago has awarded the contract for several seminary buildings here, including a 1 and 2 story, 100 x 100 ft. power house, to the Thompson-Starrett Co., 175 West Jackson Bldv., Chicago. Est. cost $10,000,000.

Ill., Chicago—The Selwyn Corp., 229 West 42nd St., New York City, has awarded the contract for a theater and office building here, including a steam heating system to the Longacre Constr. Co., 127 North Dearborn St., at $1,000,000.

Iowa, Pocahontas—The County Aud. has awarded the contract for the installation of a steam heating and plumbing system and wiring in the proposed new court house to Carsten Bros., Ackley, at $36,000. Noted Nov. 16.

Mo., Maplewood (St. Louis P. O.)—The St. Louis Paper Can & Tube Co., 4400 North Union Ave., St. Louis, has awarded the contract for a 1 story, 200 x 540 ft. factory here, including a steam heating system to Widmer Eng. Co., Century Bldg., St. Louis, at $500,000.

Tex., Dallas—The Bd. Educ., Municipal Bldg., has awarded the contract for a 2 story high school at Haskell and McKinney Sts. to the American Constr. Co., 411 Gulf Bldg., Houston, at $648,000. A steam heating system will be installed in same.

Col., Ault—The Great Valleys Sugar Co., Central Savings Bank Bldg., Denver, has awarded the contract for a sugar factory here, to Schwarz Eng. Co., Mack Bldg., Denver, at $1,000,000.

Col., Denver—The School Bd. has awarded the contract for the installation of a heating and ventilating system in the Morey Junior High School to McCarty-Johnson Htg. & Engr. Co., 1440 Curtis St., at $90,075. Noted Oct. 5.

Ont., Pembroke—McGuire, Patterson & Palmer, Ltd., 343 West Dorchester St., Montreal, have awarded the contract for a match factory here, to Fraser, Brace & Co., 83 West Craig St., Montreal, at $5,000,000.

POWER

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THE HUMAN ECHO

By Rufus T. Strohm

LEM BILLINGS is the kind of cuss that highbrows term ubiquitous; that is, he's all too plenty. He likes to gossip, loaf and smoke and lead the life Italian folk call *dolce far niente.* This firing boilers, to his mind, is nothing but a weary grind to which he's forced to buckle, whereas, as everybody knows, he'd sooner wear his Sunday clo'es and dally with pinochle.

He plugs along from day to day, but always takes the easy way of tending to his duties. He scorns the colleges and schools and vows that he's got better rules—and say, they sure are beauties! For instance, if he needs more air to make the furnace seethe and glare and keep the stack from smoking, he swings the fire doors ajar in manner quite spectacular, and thinks that he is stoking.

HE SPRAYS his fuel with a hose until the mixture slips and flows like mud flats in a shower. He piles a half a ton of coal inside the yawning fire-hole and then he loafs an hour. He opens up the blowoff cock in one-tenth second by the clock nor lets an eyelash flicker, and when at length he yanks it shut, this perfect specimen of nut performs that action quicker.

So far as judgment goes, his head might just as well be made of lead, or stuffed with pulp or shavings; for when his friends try to be nice, he treats their kindly meant advice as nothing more than ravings. By modern firemen he's classed as but an echo of the past; he apes his predecessors, who modeled all their ways by guess, and so Lem's practice is a mess, for they were rotten guessers.

Remodeling Old Power Stations—Boiler-Plant Improvements

BY L. R. LEE*

To meet demands for increased capacities and better economy, companies are interested at this time in enlarging and bringing up to date their old power plants. Moreover, the high cost of fuel has discouraged many isolated plant owners from further use or extension of existing facilities, hence the users of electric power are multiplying and its use in residences has become an appreciable factor in increasing central-station day-power load. Therefore it behooves the central-station executive to put his plant in order, that he may realize a maximum on the investment that he already has.

A STEAM-ELECTRIC generating station is naturally divided into two parts, the boiler plant and the generating plant, commonly referred to as the boiler room and engine or turbine room. There are, as a rule, more opportunities for increasing the capacity and economy in the boiler room than in the turbine room. The cause of this is not hard to understand when it is considered that the modern boiler is fundamentally but little different from the one sold ten, fifteen or even twenty years ago. The modern boiler meets new requirements of pressure, size of furnace, superheat, etc. However, with proper regard for the pressure limit the old boiler can usually be brought up to date so that it will give a satisfactory account of itself when compared with the modern boiler. There are one or two tests that should be applied to all old boiler plants to determine whether or not they are worth extensive remodeling or whether they should only be kept in good repair until such time as conditions allow of the entire replacement with new equipment. These tests are about as follows: Will the present boilers admit of furnace improvement that will secure 200 per cent continuous rating? With the boilers operating at 200 per cent rating, will the exit-gas temperatures be more than 550 deg., and if so, will the space limitations allow installation of suitable economizers? May the boilers be insured for 175 lb. working pressure over a reasonable number of years to come?

If these three questions can be satisfactorily answered, then undoubtedly the plant is worth reclaiming and then the extent of improvements may be balanced against their cost to determine the amount of improvements to be made.

In the same way, after the tests have been applied to see whether the plant is worth reclaiming, it is well to catalog the limitations of the plant and to rate these limitations so that the money spent will be first invested where it will bring in the largest return. Some of the most important of these questions are usually found to be as follows: Coal and ash handling, furnace capacity, draft conditions, capacity and general condition of auxiliaries.

CHECKING STATION RESULTS

It is also important in laying out the improvements for the old plant to see how much can be done toward installing such equipment as will increase the possibility of checking the results from the station. The two principal things to be found out in the boiler plant are the amount of coal burned and the quantity of steam generated. With these two facts actually determined, a pretty close check can be kept upon the operation. Much detailed data must, of course, be kept in checking economies and proper operation, these data being secured in a modern plant by means of such instruments as water meters, recording thermometers, recording pressure gages, draft apparatus, furnace meters, and so on. The most of such equipment being relatively inexpensive compared to the investment in the plant, it requires only careful selection and a sense of proportion not to have too many instruments to so overburden the operating man with details that he may neglect the main operation. The old plant usually lacks facilities for handling coal and ashes. Where there are any such facilities, they are usually limited in capacity and require excessive maintenance and labor for operation. The very fact that coal has increased so much in cost makes it necessary to burn the lower grades as far as possible; therefore the central station must expect to handle relatively more coal and ash than formerly, and to keep within reasonable cost, they must be handled with little labor. A plant of any considerable capacity must receive its coal by railroad car, steamship or barge and should be provided with facilities for unloading quickly with little manual labor, and it should also have facilities for receiving all grades of coal; that is, it should be provided with crusher equipment so that run-of-mine, lump or screenings may be received with no inconvenience. Storage should be provided so that at least a thirty-day supply may be carried as a so-called emergency or seasonal storage, while a smaller storage of about two days' supply may be in continuous use. It is also desirable to arrange to dispose of the ashes directly into railroad cars with little or no manual labor.

STOKER CAPACITY OF BOILER PLANT

Increasing the capacity of the boiler plant really means only increasing the facilities for burning coal. Practically any water-tube boiler, if properly set and kept clean, will permit of driving to higher capacities, depending upon the furnace arrangement which may be worked out to advantage. Therefore, the furnace conditions must be first studied to see how much coal can be burned in each and every furnace. If stokers are already provided and capacities of 200 per cent or more are not easily obtained, then the stokers have insufficient capacity or insufficient draft. Stoker capacity may be limited by the actual size of the stoker itself or by the volume of furnace provided over the stoker. In other words, stokers are often put under old boilers that are not set high enough. There are two ways of increasing the height of the furnace: First, to raise the boiler, and second, to drop the stoker below the boiler-room floor level. It is often difficult to raise old boilers, owing to building conditions, but it frequently happens that it is comparatively easy to drop the furnace level so that part of the basement may be used for the stoker installation. The height of boilers of the B. & W. type is usually spoken of as the distance between the front end of the lower row of tubes and the floor line. All boilers having less than ten feet between the floor line and the lower row of tubes at this point are considered boilers of low setting, and this dimension may be profitably made up to fifteen feet or in some cases even more. However, twelve feet will give good results for the underfeed type of stoker where capacities of 250 per cent of boiler rating are desired. The common limitation in furnace capacity, and this more often applies to furnaces equipped with stokers, is insufficient draft. The underfeed stoker is often applied to old boilers with the idea of increasing economy and capacity with providing for additional draft at the boiler uptake. The underfeed stoker or forced-draft type burning larger quantities of fuel, therefore increasing the volume of gas to be handled, calls for a high draft at the boiler uptake. Natural draft provided by stacks may, of course, always be used to advantage, but the most satisfactory way to increase the draft at the boiler uptake is by induced-draft fans. These may be arranged to discharge into the base of existing stacks, they may be motor-driven and may be obtained in the high-speed radial-flow types which allow installation in very limited quarters.

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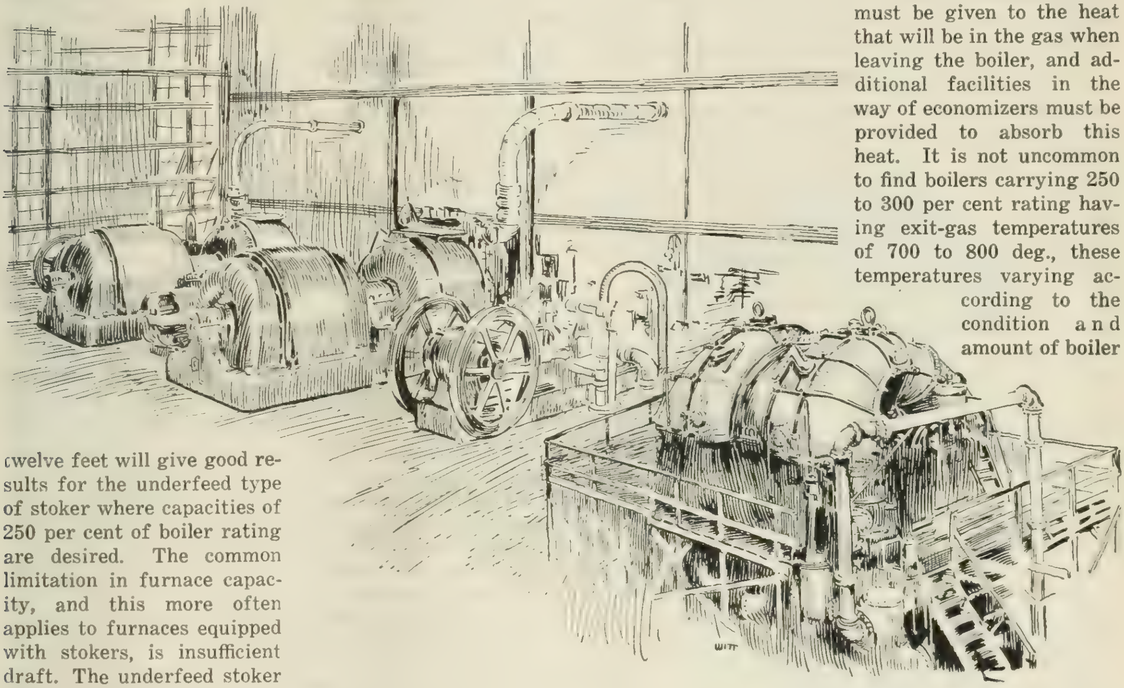
*Chief Engineer, E. W. Clark & Co. Management Corporation, Columbus, Ohio.



Another factor, and one that is often overlooked in the draft question, is the dimensions of the boiler uptake, the size of the flues and connections with the stack. It is extremely important that the opening out of the boiler be made the maximum size permitted by the construction of the unit and that the flue be as large and as straight and free from sharp turns as possible. It is equally important to see that the flue is tight. Brick flues can be made satisfactory, but old brick flues are often full of leaks that are not very apparent unless a thorough inspection is made. Therefore, it is important in studying the condition of any given boiler to see: First, if the furnace volume is ample; second, if sufficient draft is provided both at the boiler uptake and under the fuel bed. These factors have most to do with the capacity of the furnace, although of course they will have considerable effect on the economy. However, the economies of the boiler plant must be looked to: First, in regard to the tightness of the boiler setting; second, the cleaning of the boiler to see that it is free from soot on the outside of the tubes or scale on the inside; and third, to consider the exit temperatures of the gas leaving the boiler. It is practical to force boilers to high capacities, but in doing so, consideration must be given to the heat that will be in the gas when leaving the boiler, and additional facilities in the way of economizers must be provided to absorb this heat. It is not uncommon to find boilers carrying 250 to 300 per cent rating having exit-gas temperatures of 700 to 800 deg., these temperatures varying according to the condition and amount of boiler surface provided. It is usually profitable to install sufficient economizer surface to reduce the flue gas to temperatures of 400 deg. and less. As a general rule the space available, in old plants, for economizer surface will determine the amount of surface rather than the temperature of the gas. By working over the old layout so that the boilers, which are quite commonly installed in batteries, may be treated as units, economizers can usually be installed of ample size to provide for quite high overload capacities. These unit arrangements may be worked out so that a battery of boilers, single economizer and induced-draft fan and forced-draft fan may become a unit discharging its flue gas into a common flue which may lead to existing stack. In some cases short stacks may be provided for each induced-draft fan to good advantage.

The steam-pressure limitation which will always be involved in old boiler plants is usually not a very serious one, and by installing superheaters the temperature of the steam can be raised to such a point that the economy of the station will compare favorably with modern plants. Superheat will usually require looking into the main steam-pipe layout. If the main steam layout has in its make-up numerous cast-iron flanges, fittings, valves, etc., it may be necessary to provide new main steam lines. If this is required, it is important to look over the layout and see that the new lines provided are not too large. Practically all old steam piping was put in of such large size that the steam velocity was very low and would be unsuited to handling steam even if its construction was adequate. By installing the new piping with a few right-angle turns all made up of pipe bends, it is practical to use steam velocities up to 8,000 ft. per sec. This decreasing the size of the steam-pipe lines makes it possible to make considerable saving, not only in the pipe itself, but in the cost of the valves. The smaller valve is also a more satisfactory piece of equipment, as it is usually tighter and the cost of repairing is proportionately reduced.

INCREASED BOILER-FEED SUPPLY

Increasing the capacity of boilers will call for enlarged feed-water supply, and if the present facilities consist of reciprocating feed pumps, which take up much valuable space, it is well to consider the modern centrifugal pump, either motor- or turbine-driven, and in making a new layout to ascertain if the number of feed-pump units cannot be decreased to advantage. Two or three good feed-pump units should be sufficient for a fair-sized plant. The smaller number of units will allow a considerable saving to be made in piping and savings in repairs and other operation.

As practically all old plants are provided with some form of feed-water heating equipment, it is well to ascertain if all the steam from auxiliaries is used up in the feed-water heater to advantage and if the existing heater provides a reasonable increase in the temperature of the feed water and still does not use up all auxiliary steam. Investigation should be made to see if the amount of auxiliary steam cannot be decreased by the application of motors to auxiliaries rather than to increase the size of the feed-water-heater equipment.

If it is found practical to install economizers, feed-water temperatures of 150 deg. or more are entirely satisfactory and sufficient, and the power for driving auxiliaries can usually be efficiently made by the main turbine units; and there certainly is great satisfaction in the operation of the motor-driven auxiliary, considering the elimination of small piping and the cost of its repairs and maintenance.

The motor-driven forced-draft and induced-draft fans are extremely satisfactory as well as motor-driven centrifugal feed-water pumps. Stoker drive may also be motor-driven and variable-speed alternating-current motors can be obtained that are satisfactory for such work. There are, in fact, very few arguments for the steam-driven auxiliary, while there are a great many arguments against its use. It is no longer necessary to use steam-driven auxiliaries in order to obtain variable or regulated speeds or to obtain reliability; there is nothing more reliable in the power station than the electric motor, and there is probably nothing that is more easily kept in good condition.

All efficient designers of modern steam plants aim to lay out the plant as simply as possible with a minimum amount of steam piping, both large and small. The old station always represents an accumulation of piping and it is well to investigate carefully to see if considerable piping can not be eliminated to advantage. All piping is subject to heat loss, either by direct leakage or by heat radiation due to insufficient covering. Pipe covering is expensive and hard to maintain, especially on small pipes around the boiler room. Superheated-steam lines need no drains or trap systems. A few well-located drain valves to free cold pipe from water are sufficient.

PREVENTING LEAKS IN BRICKWORK

Boiler settings must be continued to be made up largely of brickwork and there is always great opportunity for small leaks in the brickwork itself and in the connections between the brickwork, boiler, flue, and door-frame connectons. In recent years there have been manufactured many boiler brickwork coatings that will prevent leaks through poor joints and cracks. The chief essential of such coatings is that it shall remain in a more or less plastic state and not dry hard, so that as the brickwork cracks the coating will retain its continuity over the cracks and prevent air being drawn in. Asbestos may be used to advantage in stopping leaks around door frames, flue connections and all boiler connections. Such work must be carried on continually or at regular intervals as new leaks will reoccur from time to time.

Within the boiler itself there are some improvements that may be applied to old work at a relatively small cost. Practically all boilers are provided with baffles of one shape or another. Heretofore these baffles have been made of brick or tile of various dimensions, very often of special shapes and small in size. The natural consequence of using numerous small sections of brick or tile is that the baffles have a great many joints, all of which must admit of some leakage even when new. As time goes on and new tubes are put into the boiler and the tubes themselves become somewhat warped so that the baffles are deformed, the leakage increases. Several companies have perfected baffle designs of considerable merit. The fundamental feature of all these different designs is monolithic construction. Some companies use a quantity of plastic material, building up the entire baffle by means of form work and pouring in the plastic material. Others use a combination of tile and plastic, obtaining the same results. As a general thing there is considerable merit in these designs and they go a long way toward securing tight baffles.

BURNING LOW-GRADE FUEL

Burning the lower grades of coal at increased rate probably causes more soot and ash to be deposited among the tubes and baffles of boilers than formerly. The old method of blowing out this soot by means of a hand lance from the side of the boiler is rather inadequate and unsatisfactory, therefore the soot blower has become an indispensable piece of boiler equipment. Practically no new boiler layouts are now made which do not provide mechanical soot blowers, which in most cases will thoroughly clean soot or ash, which may be deposited in the boiler in a very short space of time. The advantage in the use of this equipment is that not only is the boiler cleaned more thoroughly than by the hand method, but since it is done more easily it is done more regularly by the operating force and with a consequent saving in labor cost and with increased advantage in the operation of the boiler.

There has been a tendency, I believe, in a great many cases in installing soot blowers, to provide rather more than the situation warrants. It has been my experience that a soot blower will clean more surface than the manufacturers claim, or in other words, fewer elements are actually required than advocated by the manufacturer. The essentials of installing soot blowers are to see that they are properly located and that full boiler pressure, preferably of superheated steam, is provided at each soot-blower element so that a high velocity may be set up when the blowers are placed in action and that the steam may be thoroughly dry; otherwise the wet steam coming in contact with the hot soot-blower elements may cause them to be warped out of shape. It is, of course, important, in installing the soot-blower elements in the front passes of the boiler, to be sure that they are protected from the direct furnace heat as much as possible.

In remodeling an old plant, a great deal depends on the designer's sense of proportion. It should be obvious that the old plant cannot reach the same standard as a new one. When thought is not given to this phase of the situation, too much may be spent on one detail, leaving too little to spend upon another. Improvements may be made in steps, but some improvements amount to very little unless others are also made. For example, a very fine stoker layout would be useless if proper draft equipment was not also provided. In the same way stokers without any coal- and ash-handling facilities would in most cases be rather expensive to operate.

I believe that certain modern boilers may be and should be operated at ratings of 300 per cent and over. However, there are very few old boiler plants from which it would be profitable to try to get 300 per cent boiler ratings.

Much may be accomplished around most old boiler plants by improving working conditions. For example, a good boiler room does not have to be hot and gloomy, or positively dark; windows should be added wherever possible to admit daylight and fresh air; ventilators should be installed to remove heated air and gases. These improvements will assist in improving labor conditions and also insure more attention being given to detailed repairs, such as the care of recording instruments, small auxiliaries and work of like nature. Men will do more and better work where conditions are good than where they are bad and disagreeable.

Falls of Ohio Can Be Harnessed

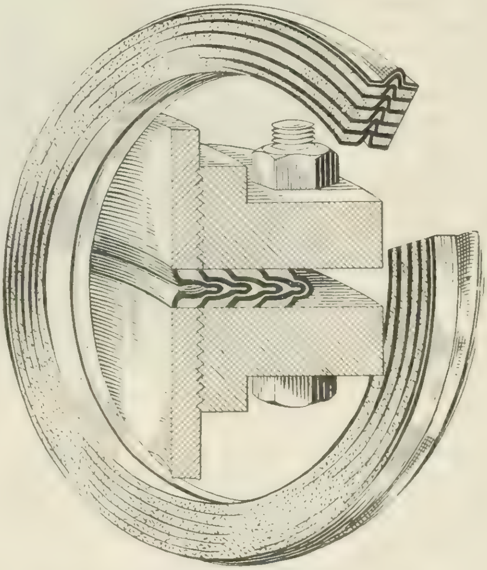
Production of electric power from the falls of the Ohio River at Louisville, Ky., is a practical project, according to a committee composed of W. H. McAlpine, principal assistant, United States Engineers, L. S. Streng, engineer Louisville Gas and Electric Co., and F. H. Miller, Louisville Railway Co., in a report read by the former at the Engineers and Architects' Club on Nov. 20.

Although the enterprise is not without its difficulties, nevertheless it warrants further investigation and study. The report estimated that a plant based on a 50,000-hp. basis and working on a 50 per cent "load" could be used from 65 to 75 per cent of the time. It was also estimated that the plant would be idle about sixty days a year because of low water. An auxiliary steam plant would be necessary in conjunction with a hydro-electric station. If the dam were elevated to flood stage it would still be impossible to have a hydro-electric plant in continuous operation during the entire year; it was estimated that in this case the plant would be idle at least forty-five days a year.

The cost of building a wall, power-house site and generating equipment was placed at $11,000,000 at present construction prices, and the cost of erecting the steam plant was estimated at $8,000,000. Members of the club termed as "criminal waste" inaction in not harnessing the falls, and a resolution prepared by a special committee was adopted unanimously, asking Congressman Charles F. Ogden to obtain, if possible, such legislation as will result in authorizing the United States to make such an investigation as may be necessary to determine the feasibility of water-power development. It is generally expected that favorable action will be taken early in the new year.

Flexitallic Boiler and Flange Gaskets

Flexitallic gaskets consist of a cushion of waterproof asbestos spirally wound to conform with metal strips, put in place under pressure; the metal strips are wound in a spiral dovetail shape, starting on the inside and working out ply by ply to the size of the gasket required, about 19 plies to every inch width of flange. This makes it practically impossible to blow out, and at the same time creates great resiliency.



GASKET BEFORE AND AFTER APPLYING TO FLANGE JOINT

The illustration shows the design of a gasket before and after it had been compressed between pipe flanges. As the metal is on edge and at right angles to the line of pressure, the gasket does not adhere to fittings and takes care of expansion, contraction and vibration.

This gasket is made by the Flexitallic Gasket Co., Camden, N. J. It is suitable for use on boiler manholes and tube caps for water-tube boilers; also pipe flanges, superheaters or on any joint where it is difficult to make the gasket hold tight.

The Solid-Injection Oil Engine

BY EDGAR J. KATES

THE article on "The Pressure-Injection and the Air-Injection Oil Engines," by Hermann Shultz, in the Dec. 14 issue of *Power* attempts to show why pressure-injection oil engines (or solid-injection engines as termed in this country) can never be successful because they are based upon a wrong principle; whereas, in point of fact there are on the market solid-injection engines that are actually doing the very things that he claimed to be hopeless of accomplishment.

By solid-injection engines is meant oil engines in which the charge of fuel is sprayed into the combustion chamber solely by pressure from a pump and without the aid of air injection.

In the previous article it is stated: "In truth one is compelled to speculate more or less if the designers of these latter types of motors really understood the process of combustion occurring in the cylinder of the gas motor, or rather, the oil engine. Surely, if the processes of vaporization or gasification, ignition and combustion were fully appreciated, hope that the pressure injection, or as the Americans term it, solid injection, would show an economy anywhere near the Diesel motor would vanish." In view of the fact that one of the successful solid-injection engines built in America is constructed by a factory that has built Diesel engines for a number of years, the development of these later designs can hardly be attributed to lack of appreciation of the Diesel principles.

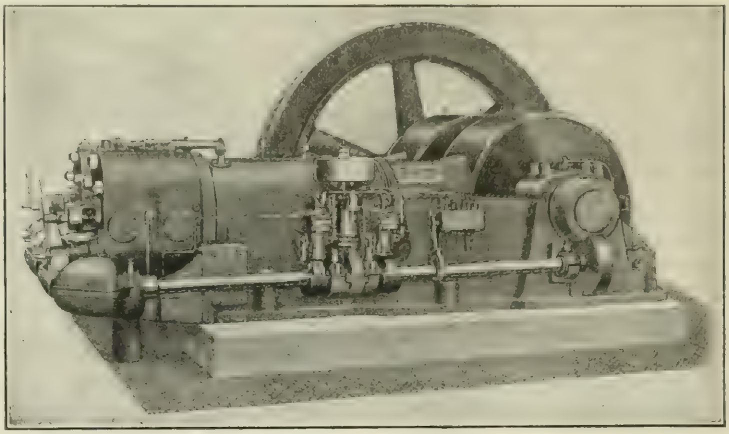


FIG. 1. 200-HP. TWIN CYLINDER DE LA VERGNE SOLID-INJECTION OIL ENGINE

The principal objection advanced in the article to the solid-injection oil engine was that it was impossible to obtain complete combustion of the fuel and consequently the engine must necessarily be inefficient. That this is not the case is demonstrated by actual tests of solid-injection engines in sizes of 100 and 150 hp. per cylinder which have shown a fuel consumption of only 0.41 lb. of oil per brake-horsepower-hour, which is equal to or better than the fuel consumption of Diesel engines of corresponding size. The regular manufacturers' guarantee on these engines is 0.45 lb. of oil per brake-horsepower-hour, which is as good as the guarantee offered by Diesel manufacturers. A detailed test report on one of these engines is given in Table I.

In the Diesel engine the atomization of the charge of oil inside the combustion chamber is accomplished by means of a blast of compressed air at a pressure of about 1,000 lb. per sq.in., the oil being all delivered to the spray valve by the fuel pump before the spray valve is opened by the cam. In the solid-injection engine the atomization results from the oil being delivered at high velocity and with a rotary motion through an orifice, which causes it to break up into an extremely fine mist in the combustion chamber. The spray valve is not mechanically operated, but opens only when the oil pressure is against it. The fineness of the atomization in the solid-injection engine is fully as good as in the air-injection Diesel engine, the completeness of the combustion being evidenced by low fuel consumption and complete lack of smoke in the exhaust gases.

A typical solid-injection engine as now manufactured in this country is illustrated in Figs. 1 and 2. This is a single-acting, four-stroke cycle engine, the sequence of events being as follows:

Suction Stroke—The intake valve is opened mechanically, and the piston is moved forward on the suction stroke, drawing in a full charge of pure air.

Compression Stroke—The intake valve is closed. The piston returns, compressing the air from the cylinder into the combustion chamber to a pressure of approximately 330 lb. per sq.in. On account of the excellent spraying action of the fuel, which fills the entire combustion space with a uniformly distributed oil mist, this compression pressure is ample to cause ignition.

Working Stroke—The oil is injected slightly in advance of inner dead center. Combustion at constant volume occurs, and the pressure rises from the compression pressure to approximately 500 to 550 lb. per sq.in. The piston starts out on the working stroke.

Exhaust Stroke—Near the end of the working stroke the exhaust valve is mechanically operated. The pressure drops and the piston returns, expelling the burnt charge.

It should be noted that this engine is entirely free of hot caps, uncooled castings, hot surfaces or igniting plugs, ignition being brought about solely by the air temperature resulting from the compression of the cylinder charge. The temperature required to effect ignition in the solid-injection engine is less than is usual in the Diesel engine, for two reasons: First, because the entire combustion space of the solid-injection engine is filled with a uniformly distributed oil spray, whereas in the Diesel engine the mixture is not homogeneous; and secondly, because in the solid-injection engine the incoming spray of oil is not chilled through expansion of the injection air as is the Diesel.

In this connection the writer takes exception to the statement in the preceding article reading: "The air blast performs a greater service in the combustion chamber than in the spray valve. The amount of fuel injected into the cylinder has no effect on the process of combustion, since the air blast effectually breaks up and mixes the low-load charge as well as it does the full-load charge."

As a matter of fact, in most Diesel engines the chilling effect of the injection air upon the fuel is so great that at light loads it is necessary to reduce the pressure of the injection air in order to prevent occasional failures of the fuel to ignite, or in other words, misfiring. This of course cannot take place in the solid-injection engine as the oil is injected entirely by mechanical pressure and there is no highly compressed air blast to chill it.

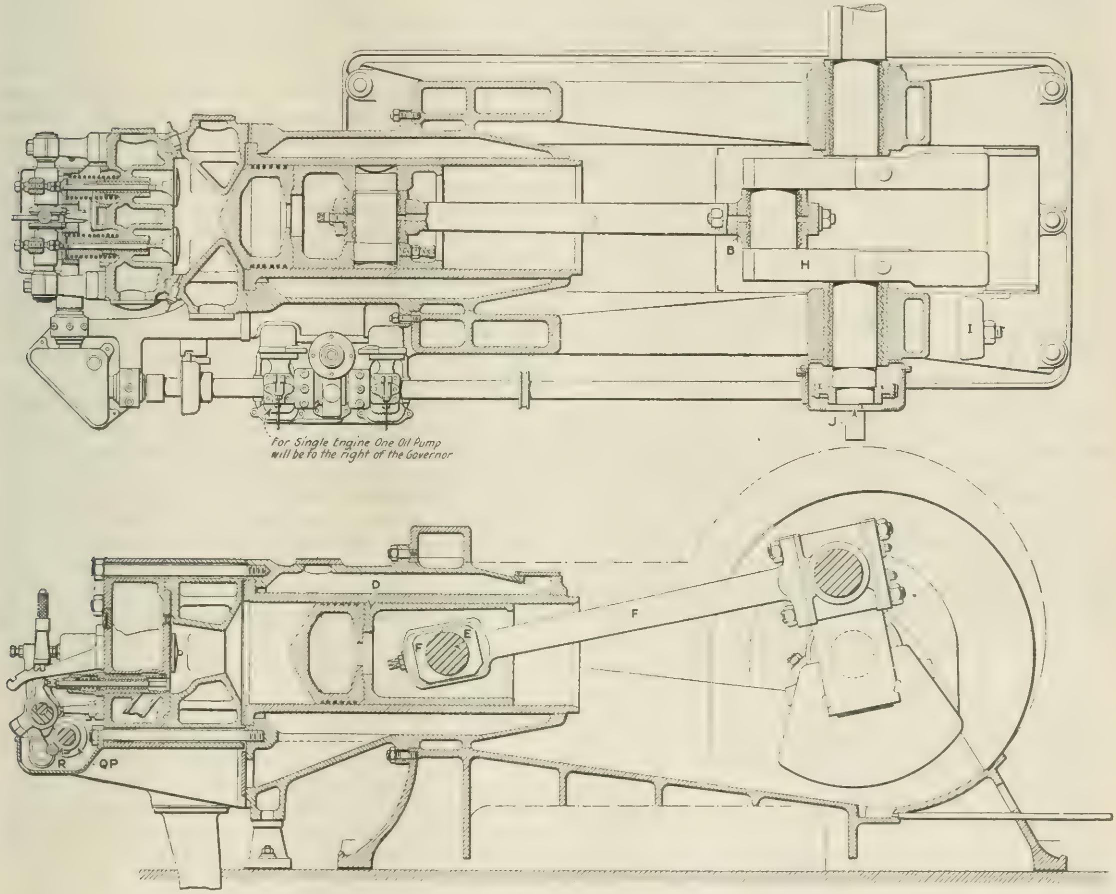

B
H
I
J
For Single Engine One Oil Pump will be to the right of the Governor
D
F
E
F
R
QP
A

FIG. 2. SECTIONAL VIEW OF SOLID-INJECTION OIL ENGINE

Contrary to the opinions expressed in the previous article, the fuel-pump pressure in the solid-injection engine is by no means excessive. The pressure in the fuel line of the successful solid-injection engine already described has been measured and was found to be between 1,500 to 2,000 lb. per sq.in. at the moment of maximum pressure. When it is considered that this is a liquid pressure and that hydraulic installations commonly use pressures between 5,000 and 10,000 lb. per sq.in., the pump pressure in the solid-injection engine is seen to be well within the limits of good engineering practice. It is far easier to maintain a liquid pressure of 2,000 lb. per sq.in. than an air pressure of 1,000 lb. per sq.in. as used in the Diesel engine. The fuel pump of the solid-injection engine is as simple and as sturdy as that of any good Diesel engine.

In the earlier article it is stated that "a more important feature of the action of this type of injection (referring to solid injection) is the high maximum pressures occurring at the moment of fuel admission. Frequently, the indicator cards show pressures several atmospheres higher than is usual in Diesel engines." It is also stated that "the excellent efficiencies shown by some of these engines are undoubtedly secured with a maximum explosive pressure well above 800 lb." That this is not the case with a well-developed solid-injection engine is shown by the typical indicator card, Fig. 3, which was taken from the same type of engine for which Table I gives a test report. It will be noted that the maximum combustion pressure is 520 lb. per sq.in., which is well within Diesel-engine limits, and in fact less than is used on many Diesel engines.

It is claimed by the author of the preceding article that solid-injection engines smoke badly at full load and that during the war this was the chief criticism against this design. The author goes on to explain that this is due to the character of the spray action, there being no expansive force to cause diffusion. The result of this is said to be that only the outer portions of the spray are broken up while the interior is fairly solid, resulting in this portion of the oil going through a "cracking process" and depositing heavy hydrocarbons which appear as smoke.

With due respect to the theory, the fact is that a properly designed solid-injection engine does not smoke at all at full load or even at a moderate overload. The form of the spray and the shape of the combustion space are so designed and inter-related that the combustion chamber is filled with a uniformly distributed and finely divided oil mist which burns completely without leaving any solid residue whatever. In an overload test run on a twin cylinder 17 x 27½ solid-injection engine rated 200 hp. at 200 r.p.m., the engine carried a load of 250 hp. (or 25 per cent overload) with no trace of smoke or color in the exhaust gases, and only when the load was increased to 260 hp. (or 30 per cent overload) did the exhaust start to become smoky. A detailed record of this test is given in Table II.

Further proof of the clean combustion that comes with properly designed solid-injection engines is presented by the inspection of the combustion spaces of engines that have run for many months under heavy loads. If "cracking" of the oil did occur, with resulting incomplete combustion, not only would the exhaust have been smoky, but carbon deposits would have formed on the walls of the combustion space. Invariably, however, it has been found that these walls have collected no carbon deposits whatever.

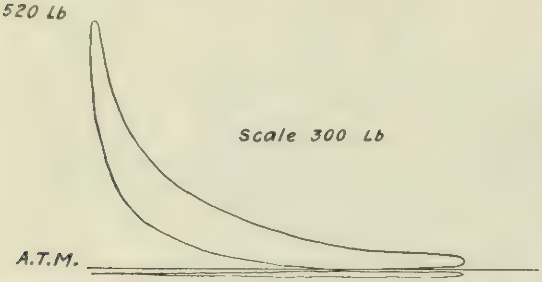


FIG. 3. TYPICAL INDICATOR CARD OF SOLID-INJECTION OIL ENGINE

TABLE I. FUEL-CONSUMPTION TEST ON 200-HP. SOLID INJECTION OIL ENGINE

Engine Data

200-hp. De La Vergne Type SI Engine
Two cylinders, 17-in. dia. x 27½-in. stroke, 200 r.p.m.
Compression pressure cyl. No. 1, 322 lb. per sq.in.
cyl. No. 2, 318 lb. per sq.in.
Max. cyl. pressure at full load Cyl. No. 1, 540 lb. per sq.in.
Cyl. No. 2, 545 lb. per sq.in.

Test Data

Date of test—Oct. 5, 1920 Fuel—24 deg. BÉ. fuel oil

Per Cent Load	Brake, Hp.	R.p.m.	Fuel Consumption
10 per cent overload	220	200	0.421 lb. per b.hp. hr.
Full load	200	200	0.420 lb. per b.hp. hr.
75 per cent load	151	202	0.410 lb. per b.hp./hr.
50 per cent load	101	204	0.458 lb. per b.hp./hr.

Many of the other criticisms of the solid-injection engine advanced in the previous article, such as "after burning," "spray dripping," etc., are more fanciful than real. The phenomena of the combustion of fuel within an engine cylinder are extremely involved and are not nearly well enough understood to permit positive deductions to be drawn by purely theoretical methods. Consequently, abstract theorizing cannot be accepted unless verified by actual test.

"After burning," if it existed, would result in a high fuel consumption and this, as we have seen from the test reports previously quoted, does not occur. The tests show that a solid-injection engine is not any more susceptible to "after burning" than any good Diesel engine.

"Spray dripping," is referred to in the previous article in connection with the statement that "the action of a pump is by no means as rapid as a needle valve. The cessation of the oil spray into the cylinder is necessarily slow, and the lines may continue to leak." If this occurred, the oil pressure at the end of the injection would be lower than normal and the final portion of oil would be introduced into the cylinder in the form of fairly large drops instead of a finely divided spray. Such drops would not burn completely and would form carbon deposits which would have a tendency to build up in the combustion chamber directly under the spray nozzle. Such carbon deposits did actually occur fifteen years ago when the low-compression hot-bulb type of oil engine—for example, the Hornsby-Akroyd engine—was being developed, and were the result of imperfectly designed fuel pumps and spray valves. In modern solid-injection engines this action never occurs and the combustion space close to the spray valve is as clean as elsewhere.

TABLE II. COLOR OF EXHAUST

Test on 200-hp. De La Vergne Type SI engine
Twin cylinder, 17 in. x 27½ in., 200 r.p.m.

	Hp.	
50 per cent load	100	Exhaust clear
75 per cent load	150	Exhaust clear
Full load	200	Exhaust clear
10 per cent overload	220	Exhaust clear
20 per cent overload	240	Exhaust clear
25 per cent overload	250	Exhaust clear
30 per cent overload	260	Exhaust started to show color

The preceding part of this article has been devoted to a contradiction of several criticisms made in error against the solid-injection engine. However, if this engine merely had the negative virtue of not being so bad as it is claimed, there would be nothing to justify its rapidly growing importance in the field of efficient prime movers. On the contrary, the solid-injection engine has many real and vital advantages, the value of which are being recognized more and more as engineers are becoming acquainted with them. This type of engine has the same good points as the Diesel engine—namely, high fuel economy with a wide range of oils, immediate starting, no stand-by losses, etc.—and has besides, the following advantages:

1. The air compressor is eliminated with all air valves, pistons, connecting rod, crank and high-pressure air pipes. The air compressor and its attendant mechanism, which is an inherent part of all Diesel engines, is by far the most troublesome feature of the engine. The elimination of these parts results in a great gain in simplicity and ease of maintenance. Not only is the reliability of the engine increased and the cost of maintenance reduced, but about 10 per cent of the total power is saved and made available for useful work.

2. In addition to the elimination of the air compressor, the mechanically operated spray valve is done away with and replaced by a simple spray nozzle with no external moving parts. This eliminates the cam and linkage required with the Diesel spray valve and also does away with the high-pressure stuffing box, as the solid-injection spray valve has no stuffing box at all.

3. The mechanical efficiency of the engine is improved by eliminating the power loss in the air compressor and this results in lower average cylinder pressures for the same brake load.

4. Lower air pressure can be used for starting. On account of the compression pressure being 100 to 150 lb. less than that on the Diesel engine.

How To Correct for Error in Instrument Voltage Transformers

Regulation of Voltage Transformers—Usual Practice in Transformer Connections—Phase Angle and Change in Ratio of Transformation-Problem Worked Out, Showing How Wattmeter Readings Are Affected by Transformer Error

By J. B. Gibbs
Transformer Engineer, Westinghouse Electric and Manufacturing Company

VOLTAGE transformers are used in the measurement of high voltages for two reasons: First, because it would be dangerous to handle circuits of these voltages; and second, no meter designed for such voltages could compare in accuracy and cost with the standard low-voltage instruments. These transformers are usually of small capacity, since the only load which they are expected to carry is a few instruments. They are designed for extra good regulation, so that the secondary voltage shall bear as nearly as possible a fixed relation to the primary voltage under all conditions of load. It is impossible to get exactly correct ratio and phase angle at all loads because of the iron and copper losses that are always present in transformers. In good voltage transformers, however, the errors are small—a fraction of one per cent in ratio, and considerably under a degree in phase angle. In addition to this the transformer is "compensated" so as to give correct ratio at the load that it is expected to carry.

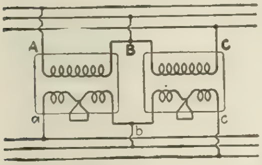


FIG. 1. OPEN-DELTA TRANSFORMER CONNECTION

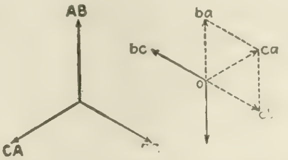


FIG. 2. VECTOR DIAGRAM OF VOLTAGES IN FIG. 1

These transformers are made for circuits of all voltages and are used with voltmeters, wattmeters, watt-hour meters, relays, etc. Several instruments may be connected to the same transformer provided their combined load does not exceed the load for which the transformer was designed. In single-phase systems one voltage transformer is needed for each circuit that is to be measured independently, and a switching device is usually provided so that one voltmeter may be connected to any one of the transformers. Two-phase systems are the same as two single-phase systems. In three-phase circuits, three voltage transformers may be used connected in delta or in star, but the usual practice is to use two transformers connected in open delta. The latter gives the voltage of all three phases, saves the cost of one transformer, and the error which it introduces is extremely small. The connection is the same as for power transformers and is shown in Fig. 1. Why the voltage across the open phase corresponds to the voltage between lines *A* and *C* is shown in the vector diagram, Fig. 2. *AB* represents the primary line voltage from *A* to *B*; *BC* that from *B* to *C*; and *CA* that from *C* to *A*. In the secondary windings of the two transformers voltages will be induced opposite to the corresponding primary voltages, and these are representated by *ab* and *bc* respectively. Now the voltage from *c* to *a*, Fig. 1, will be the vector sum of the voltage from *c* to *b* plus the voltage from *b* to *a*, and these voltages will be represented in the diagram by vectors opposite in direction to *bc* and *ab* respectively. These are shown by dotted lines in the diagram, and their resultant is *ca*, which is the same length as *ab* and *bc*, and which lies 120 deg. from each of them. This is the same as saying that *ca* is opposite to *CA* in phase and proportional to it in length, which is the condition desired. Iron and copper losses in the transformer not only cause a small change in the ratio of transformation as the instrument load is increased, but they also cause a small shift in the position of the secondary voltage with respect to the primary voltage. For instruments that measure voltage only, such as voltmeters and certain relays, the phase angle is of no importance; but for wattmeters, and especially for watt-hour meters, it may make an appreciable difference when very accurate measurements are needed. Suppose that *E* and *I*, Fig. 3, represent the voltage and current in a certain circuit. The true power in the circuit, then, will be

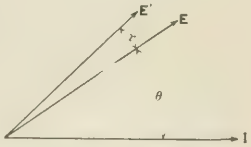


FIG. 3. CURRENT AND VOLTAGE RELATIONS IN VOLTAGE TRANSFORMER

$$P = E \times I \times \cos \theta$$

But it is necessary to use a voltage transformer which delivers a reversed secondary voltage of *E′*, which is slightly smaller than *E* and slightly out of phase with it. The wattmeter reading, therefore, will be

$$R = E \times I \times \cos (\theta + \alpha)$$

The true power in the circuit is found from the wattmeter reading by means of the expression

$$P = R \times k \times \frac{\cos \theta}{\cos (\theta + \alpha)}$$

where

P = True power;
R = Wattmeter reading,
k = ratio of E to E'. This is the same as "per cent ratio" in the calibration curves of the voltage transformer;
θ = Phase angle between E and I, in the main circuit; that is,
$\cos \theta$ = Power factor of the main circuit;
α = Angle by which E' leads E. This is found for the particular load from the calibration curve.

Example: What is the true power when the wattmeter shows 875 kw., the voltmeter 2,300 volts, and the ammeter 500 amperes? A voltage tranformer is in use having the characteristics shown in Fig. 4, and the load on the voltage transformer is 40 volt-amperes at 80 per cent power factor.

Solution: From the curves for 80 per cent power factor, at 40 volt-amperes load, $k = 100.2$ per cent and $\alpha = 11$ min. leading, as indicated by the dotted lines on the chart, Fig. 4. The power factor of the circuit is

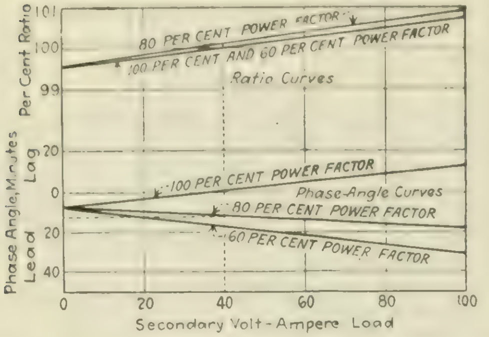


FIG. 4. VOLTAGE-TRANSFORMER RATIO AND PHASE-ANGLE CURVES

$$\frac{watts}{volts \times amperes} = \frac{875{,}000}{2300 \times 500} = 0.761 = \cos\theta \,(approx.)$$

$$\text{Therefore } \theta = 40\ deg.\ 32\ min.\ and\ 9\ sec.$$

$$\theta + \alpha = 40\ deg.\ 32\ min.\ and\ 9\ sec. + 11\ min. = 40\ deg.\ 43\ min.\ and\ 9\ sec.$$

$$\cos(\alpha + \theta) = 0.7579$$

$$\text{Therefore } P = 875 \times 1.002 \times \frac{0.761}{0.758} = 880.3 \text{ kilowatts.}$$

It will thus be seen that for the figures assumed, the error due to the voltage transformer is 5.3 in a total of 880, or about 0.6 of one per cent, which is less than the error of the wattmeter. In general, errors due to well-designed voltage transformers may safely be neglected except in accurate laboratory measurements.

The manufacturer will usually supply to purchasers on request "typical curves" of ratio and phase angle for the class of instrument transformer purchased. These represent the performance of any individual transformer of the class very closely, say, within one-half of one per cent, and are sufficient for everything except the most accurate laboratory measurements. Where the highest possible accuracy is required, ratio and phase-angle curves should be used for the individual transformer in use. These require special testing, and a charge is usually made for them.

Economic Value of Coal—IV. Impurities in Coal

BY B. S. MURPHY

As the function of coal in a power station is to produce heat, any substance in or on coal that will not give heat in the reaction of combustion is an impurity. The most economical coal is, then, one containing the minimum of impurities.

IMPURITIES in coal at the best are inert and are therefore a dead loss, as they occupy space that belongs to the carbon and for this reason reduce the heat content. In reality the impurities are rarely inert, so at their worst they will form slag or clinker and so insulate from heat, or block off the free passage of air which is required for the supporting of combustion, as to retard the reaction of the remaining, or carbon, portion of the fuel. Ordinarily, they are between these two, and every coal will vary; even the same coal will vary in operating results, depending on the furnace and other boiler conditions.

A chemical analysis of coal for the impurities, or the so-called ash, only gives an indication as to what may be expected under conditions of actual operation; the true test is the burning of the coal on the grates under a boiler, and the measure of the result is the proportionate amount of furnace refuse as compared to the coal as fired. Such a figure takes into account the unconsumed carbon in the ash, for if the impurities will prevent the burning of all the carbon, this carbon itself will add just that much to the furnace refuse, and such a test will also give the kind of ash as clinker, swelling, etc. In this latter connection determinations of the fusing point by laboratory tests is extremely useful, but will not exactly prophesy the coal's behavior in the boiler furnace. However, it is rarely possible to burn under operating conditions each new coal that is offered; so, from other performances with coal of similar characteristics as shown by laboratory analysis, we must base our discussion as to what may be expected in practice.

TWO CLASSES OF IMPURITIES

Broadly speaking, we can divide the impurities into two classes—that on and that in the coal. In the former division, under most conditions, we can say that these impurities are dirt and water. The dirt may come from the method of mining, lack of treatment after mining or method of storing, and the water from rain or snow in storage or transit, and if the haul is very short, water from the washing. An excessive amount of water on the surface of coal may be beneficial and at times may be necessary, but as this water has to have heat applied to it to drive it off, it is an impurity. As an extreme case of water being a harmful impurity, an instance may be cited where a leader from the roof-drainage system of a power station came adrift through the coal bunkers during a heavy rainstorm. The result was the deadening and finally the extinguishing of the fire in the particular boiler whose chute was nearest to this broken leader. The surface dirt may come from mining methods where care is not taken in the picking and washing or from storage of yard coal at the power station, and, in fact, this latter is often due to storage in some muddy location or against higher ground where the run-off, carrying large amounts of suspended matter, flows through the storage coals and deposits this mud. And at times, if such a deposit as this is not removed before using the coal, it may be a very positive detriment.

Unfortunately, the external impurities on the coal cannot be regulated by the consumer, as he has no control over the mine, and if proper care in mining is not exercised or in the treatment between the mining and the tipple, an excellent coal may be worthless, owing to the great amount of foreign matter, causing low calorific value as fired and operating difficulties in the furnace itself. From the consumer's viewpoint it is immaterial whether the impurities exist in the coal itself, on the surface of the coal or in the mass of the fuel, as he has but little opportunity to separate them. He purchases the fuel, and it must be utilized as received.

For all ordinary purposes a proximate analysis is all that is required for a day-to-day record of the fuel; this, of course, will tell the sulphur, volatile matter, fixed carbon, incombustible reported as ash, moisture and calorific value. For a new coal a complete analysis is extremely useful if not imperative, but this requires more labor and time, and for ordinary routine is not necessary. Among the most valuable data is the fusing point of the ash, but here again too much dependence may not be placed on this alone, for an ash may have a fusing temperature by test apparently high enough to prevent trouble, but when in contact with the furnace refractory may fuse and stick at a much lower temperature.

In this connection it might be mentioned that a certain anthracite gave excellent results under hand-fired boilers at from 75 per cent to 100 per cent rating, but when used on stokers it was too uncertain in its behavior to be trusted. One day it would apparently give fair results, but the next day it would fuse so badly as to shut off the draft. In other words, it was being used at its critical temperature, and one day, or at least one peak hour, where the boilers did not have quite the demand and the fires were not forced so much, the temperature was relatively low, so there was no fusing, while a slightly greater demand, necessitating greater rating and higher temperature, caused the fusing.

A coal high in sulphur is, of course, to be avoided because of its clinkering tendency; the limit will vary with other plant-operating conditions and the coal itself. But for economic results it is good practice to avoid any high-sulphur coal.

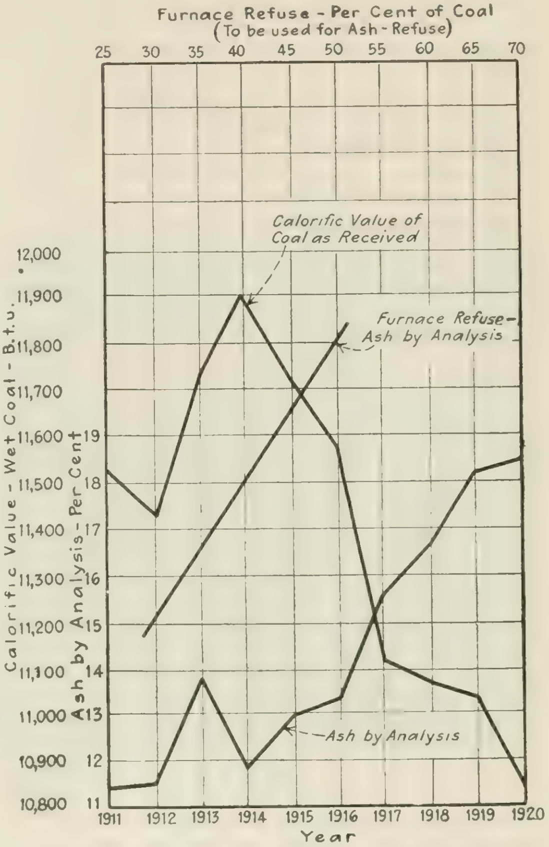
In order to harmonize the burning or operating characteristics of the fuel with the laboratory analysis, a large anthracite station made it a practice to have the boiler-room foreman classify each day the visual appearance of the coal during combustion before he was informed of the laboratory results. This was done by a series of symbols to represent the burning quality, swelling and fusing, and this information, in connection with the laboratory data, was found to be extremely useful in the purchase of different coals and at the same time shows what can be expected from the boilers, for it is manifestly unfair to expect the same boiler output and capacity irrespective of the adaptitude of the particular fuel to the operating conditions.

RAPID INCREASE OF ASH IN COAL

In order to show how rapidly the incombustible in the coal has increased for the last few years, the laboratory analyses have been plotted for anthracite received at a certain power station from 1911 to 1920. This shows a very rapid increase from 1914 to date. On this same curve has been plotted the average calorific value for this coal as received, and this shows the corresponding falling off in the calorific value with the increase in the combustible, as would be expected.

EFFECT OF IMPURITIES IN COAL

In hand-fired boilers the increase in the impurities is more noticeable than with stokers, and as a general rule stokers will burn economically a coal that will be absolutely unsuited for hand fires. In hand fires the impurities affect the firemen themselves to a very great extent, as much more coal has to be handled and a very much greater volume of ash has to be removed; and though four or five years ago it was possible to get the average fireman to take a pride and interest in his work and try to overcome such difficulties, this condition has passed to a large extent, and on account of the additional labor involved, it is becoming more and more difficult to procure men of the right caliber to do this laborious work. Also, it tells on the boiler capacity with hand fires to a much greater extent than with stokers. A fire will go just so long between cleanings—the less the impurity content the greater the interval—and then it must be cleaned, and of necessity, during the cleaning process the boiler will practically stop making steam, and unless this cleaning can be done at off hours of the load, it will necessitate additional boilers on the line to carry the same load.



FURNACE REFUSE AND ASH IN ANTHRACITE

As an instance of this, in a large railway station that was hand-fired with anthracite, the peak periods extended for 90 minutes in the morning and evening. At that time, with coal containing ash of from 12.5 per cent to 13.5 per cent, the fires were all cleaned before the start of the heavy demand period, and they would carry through for about two hours before becoming so heavy that cleaning was necessary. The impurities in the coal increased to 15.5 per cent on the average and on certain days as high as 20 per cent. As before, the fires were cleaned previous to the start of the load, and after most careful nursing, within from 45 to 65 minutes the fires would become so thick that there have been times where actually we had to pull out some of the ash and coal through the firing doors to make room for enough green coal to carry through the peak period even with two additional boilers on the line. In this case it was absolutely necessary to abandon the hand-firing and go to stokers, irrespective of any saving that could be anticipated and that was actually had by the installation of the mechanical grates.

With stokers the impurities are not quite so noticeable in the fireroom, as the great increase in hand labor is not required, but of course, as the ash goes up, more boilers will have to be placed on the line to get the heat required. More coal must be burned, and even attempting to increase the rating will not be enough, for with the high ash coal you cannot burn enough coal on your grates or in your retorts to generate the heat required.

CALORIFIC VALUE AND RELATIVE PLANT ECONOMY

In the chart shown in the second of these articles (page 937, Dec. 14 issue) were plotted two curves to show the relation between the calorific value and the ash for No. 3 buckwheat coal. One was from results found at a certain power station and the other from data of the United States Bureau of Mines. It will be noticed that these curves agree quite well and show that for 29 per cent ash the calorific value is between 9,000 and 10,000 B.t.u. On this same graph was plotted the relation between the calorific value and the relative plant economy, and the calorific value curve and the ash curve are near enough to being parallel so that the relative plant economy may be read directly from the ash curve; this shows that the limit is reached when we approach 30 per cent of ash by analysis. Of course, for existing plants the limit is much below this, for even disregarding the additional cost for fuel, the plant having about 22 per cent of ash is operating at only 50 per cent of its economy and about the same in capacity.

The larger part of this loss in economy is due to the absence of heat in the fuel, but the ash itself has a very great effect in addition to the clinker formation. If there is a large volume of ash, the carbon particles become smothered, or if the ash is a sticky one, these particles become coated with this insulator and a large percentage of unconsumed carbon or incombustible in the ash results.

In the accompanying chart is plotted the relation between the furnace refuse, including soot, for No. 3 anthracite with stokers and high ratings and the ash as found by laboratory analysis. It must be borne in mind that this is far from exact and must not be used for other stations except in a very general way. The reason for this is that the rating is the controlling feature next to the volume of ash in the combustible found in the refuse irrespective of the kind of coal when chain-grate stokers are used and, to a minor degree, with other types of stokers. And it is a loss that we must bear to get the desired work out of the boilers. Next, the behavior of the specific coal will have a very great influence in that a pasty ash will coat over and insulate the carbon, or a swelling ash will bury the carbon, and so on. Also, the curve is based, not on actual weights, but on volumes converted to weights by an average unit volume constant. This in itself will make quite a difference. For instance, some time ago in a certain station No. 1 buckwheat had to be used in place of the regular No. 3 buckwheat with hand fires. The ash from this No. 1 puffed up like so much popcorn, and though by analysis we found only 15 to 17 per cent against 18 to 19 per cent for the No. 3, volumetrically it made one-half more ash. Therefore this curve may be used in a general way only to show the relation between the ash by analysis and the actual refuse that has to be handled. For instance, for the 15.5 per cent by analysis, over 30 per cent of the weight of coal must be expected as refuse, while with 19 per cent nearly 43 per cent, or about half of the weight of the coal, is useless.

UNCONSUMED COMBUSTIBLE

This variation between the ash analysis and the furnace refuse is the unconsumed carbon in the refuse and soot. The combustible in the refuse is a very large item when using the poor grades of anthracite where the boilers are forced and will show great variations, depending on the coal itself as well as the boiler rating. This percentage may vary for a good anthracite under fairly normal conditions from 26 per cent to 50 per cent where there is a clinkering, swelling ash and high ratings. The use of chain-grate stokers also accounts for some increase in this, an increase that we have estimated may be about 1 per cent or slightly over, but is more than counterbalanced by the other advantages.

Now, returning to the hypothetical anthracite station, in 1911 to 1914 the ash by analysis averaged about 12 per cent, and we will assume that the refuse then would be about 20 per cent. The coal for this period would have averaged about 109,000 tons per annum, so it would have been necessary to provide for the removal of some 21,800 tons of refuse per year. In 1920 the ash was 18.4 per cent, making about 42 per cent refuse, or 45,780 tons (110 per cent) more. This will, of course, at least double the cost of removal and very likely make necessary additional capital charges for apparatus of increased capacity.

Semi-Diesel Engine Suggestions

If a semi-Diesel is operated with a low-temperature cooling water discharge, it usually smokes badly and will not carry its load. The engineer should experiment until he secures the temperature for best results.

With a wet or water injection engine if too much injection water is used the engine misses fire, the exhaust has a very heavy gray color and the hot bulb cools off.

If the water is insufficient, the engine will preignite at each revolution. If too much water, the engine sometimes misses a shot and preignites on the next stroke.

If a hand-operated air starter is used, a check valve should be placed between the engine cylinder and starting valve. Without a check valve the flame in the cylinder may blow back through the air line.

If the engine continues to preignite, the adjusting nut on the fuel injection pump can be screwed in, making the injection point occur later.

Refrigeration Study Course—XX
Erection and Operation

By H. J. MACINTIRE
Professor of Refrigeration, University of Illinois, Urbana, Ill.

IT IS not possible to give more than fundamental ideas in a short study course such as this is, and especially is this true of erection and operation. In the case of erection only general statements can be made of facts that are true of all makes and that are not affected by the detail design.

The main essentials in refrigeration are to make the system ammonia-tight, the valves so that they open properly with the least excess pressure necessary and close properly and promptly. Of course the valves must be ground to a tight seat. The compressor must be erected so that the reciprocating parts are central, for it is impossible to maintain tight rod packing otherwise. Adjustment should be made to give more clearance on the head end for the double-acting machine, because of the effect of friction on the length of the piston rod. It will be remembered that the operator can easily stall a compressor by tightening on the stuffing-box packing. The inclosed type of compressor, having no stuffing box but having the entire connecting rod exposed to the temperature of the suction gas, which is colder than the temperature of the air which prevailed during erection, should have no clearance. During operation the rod will cool and shorten.

The refrigerating system is an inclosed one and the plant will retain all impurities that are left in it when erected. In consequence care should be taken to make the inside as free from pipe threads, mill scale and dirt of all sorts as possible. Before erection each length of pipe should be cleaned, at least by hammering on one end. After testing with compressed air for leaks it is usual to open each coil or section of pipe directly to the atmosphere to blow the loose stuff out of the system.

The piping should be carefully erected. Ammonia is very difficult to keep tight, and special provision is always made to prevent leaks. This includes special (ammonia) fittings of dense, close-grained cast iron, steel castings and drop forgings. The piping should be wrought iron or steel, and the steel may be butt or lap welded in the smaller sizes, but only lap welded in sizes over 2 in. diameter. When steel pipe is used, it is wise to specify extra-heavy rather than full-weight, especially if the plant is troubled with corrosion due to galvanic action or stray electric currents.

Joints should be made up with litharge and glycerin (mixing up a little at a time as needed) or by the use of the sweated joint. The work done at the shop, such as condensers and other piping put up in stands, is preferably sweated—by tinning and then making a shrink fit with enough solder to fill the screw threads and the cup at the back of the fitting. The piping should be securely fastened and arranged without low spots where water, oil or mud will accumulate. Where low spots are necessary the piping should be arranged to drain to this spot and a trap should be placed there. It will assist in keeping the system free from impurities and will be handy during overhauling.

The trap for small plants may discharge into the atmosphere, but for larger plants it should be connected with other traps feeding into the regenerator. The regenerator should always be used in plants of any appreciable size. It is the only way that we have of keeping the ammonia alive and in good operating condition without the necessity of removing the charge and returning it to the manufacturers of ammonia for purification. A suction-line trap should be placed in

FIG. 1. REFRIGERATING PLANT BUILT AT CAMP TRAVIS DURING THE WAR

the pipe line near the compressor to prevent the passage of scale and other impurity into the compressor. This trap acts similarly to the steam-engine separator and will assist in preventing slugs of liquid ammonia entering the compressor during operation.

Discharge Receiver Should Not Be Placed Near Compressor

It is a mistake to place the discharge (oil) receiver too near the compressor. The receiver is most useful in removing oil from the discharge gas and will do so if the oil is in a liquid form and the velocity not too great. But frequently the temperature of discharge is excessive and some of the oil, particularly some grades of oil, is vaporized. The discharge line, being uncovered, will quickly lose its superheat and therefore the separator will be more likely to function properly if placed nearest the condenser. The temperature of discharge is important, and every compressor should be supplied with thermometers for the suction and the discharge pipe lines.

It is generally conceded that the most economical manner of operation is to bring the ammonia back to the compressor in a dry, saturated condition. Too much superheat of the return gas cuts down the capacity of the machine, and too wet a condition (wet compression) of the gas allows excessive re-expansion in the clearance volume as well as inefficient use of the liquid ammonia. By means of thermometers the operator can tell whether the suction gas is superheated by the reading of both temperatures, and whether it is wet by the low temperature of discharge. These readings are similar to those in the steam-power plant, the CO_2 apparatus, the steam-flow meter, the boiler-draft gage, etc., and are a ready means of showing changes in operating conditions, as just mentioned. The old method of trying to operate by placing one's hand on the pipe should be avoided, as it is hardly likely to lead to good results.

Operating Conditions

Reviewing the operating conditions which cause decreased capacity in plants, increased power input or inability to secure the required temperature, the main troubles are valve action, ammonia contamination, with inert gases in the condenser or water in the liquid receiver and the expansion coils, and scale, mud, oil and other pipe troubles in the condenser and the expansion coils.

The compressor is a pump, and as a pump it is necessary that the cylinder fill completely at each stroke with gas at the pressure of the expansion coils and discharge out of the cylinder at the pressure of the condenser. There must not be any "slip" of the valves or loss of gas past the piston rings, for otherwise the object of the compressor will not have been fulfilled, the purpose being to lift the maximum weight of gas from the suction or low-pressure side to the discharge or high-pressure side. Mill scale or other impurities are likely to work under the valves, and irregular wear or wiredrawing will cause leakage. This is also true of the piston rings and the cylinder. These cannot be neglected with the impunity with which the steam engine is run, but must be kept tight by constant care and attention. The steam engine has moist steam, which often will remain fairly tight under conditions that would be impossible in the refrigerating plant.

Inert gases in the condenser are not only bad because of the extra pressure against which the compressor has to pump, but also because of the decreased efficiency of the condenser containing them. As already explained, air, nitrogen and hydrogen in the condenser act as an insulator on the pipes, and it is possible for parts of the pipes in the stand to be put out of commission. Inert gases are mainly due to the presence of air and of decomposed lubricating oil. There is little decomposition of the ammonia at the usual operating conditions. Care should be taken not to operate at a vacuum at any time, unless very low temperatures are necessary, and even then a vacuum is not usual. The trouble with operating under a vacuum is that air will always get into the cylinder through the stuffing box, even though the packing is sufficiently tight to prevent the ammonia escaping into the atmosphere when the suction pressure is greater than the atmosphere. Lubricating oil should be selected for the two extremes of temperature, so that it will not freeze at the suction and disintegrate at the temperature of the discharge under the most severe operating conditions. Incidentally, the maximum temperature of the discharge gas is obtained when the suction pressure is the lowest combined with the highest condenser pressure. The condenser pressure should be compared frequently with that corresponding with the ammonia tables, using a temperature a few degrees higher than that of the exit condensing water. Any marked difference between these two pressures indicates that non-condensable gas is present in the condenser, which may be removed only by purging. But the reader is warned against too frequent purging, as it has been proved that the greater part of the ammonia lost in some plants is due to this cause. It is impossible to purge without allowing a large amount of ammonia to go out. Large plants have devices to reduce this loss to a minimum, by purging into water and distilling the ammonia out of the water, or by the refrigerated purge tank. The latter is simply a device to cool the gases being purged with refrigerated coils with the idea of condensing the ammonia out of the permanent gases.

Adding Oil to the System

Some engineers believe that after the first few months little or no oil should be added to the system, because, being a closed system, oil will travel around the cycle with the ammonia. This probably will work out right with careful attention to details by experienced engineers. The oil trap should be kept drained of oil at all times, and the condensers and the expansion system should have regular overhauling. As oil in the expansion line is likely to congeal, it is essential that proper means be used to get the oil to flow.

After pumping a vacuum on the cooling coils to free them of ammonia, heating the pipes if necessary, the coils should be drained and finally blown out with steam under pressure, giving a rather free exhaust so that the velocity of the steam will carry out the liquid and other soft deposit. After this steaming has been completed satisfactorily hot air should be pumped into the pipes to dry out any moisture remaining. Finally, in pumping a vacuum on the coils preliminary to recharging the system, the compressor should be slowly run. This is because with oil and air in the compressor there is needed only the proper mixture and the flash-point temperature to secure an explosion. This flash-point temperature is easily reached with vacuum pumps when one considers the very high range of pressures possible under the conditions.

Leaks in the system may occur at any point, and daily care is necessary to keep the plant tight. The piston rod is responsible for the greater part of the loss in the engine room, especially if the rod is not central in the gland. Ammonia test paper should always be on hand and used, and Nessler's solution should be available for periodic tests of the jacket water, the condenser water and the brine. The condenser can be leaking with a split pipe for weeks without giving visible signs of trouble. The operator should approach the matter with an open mind, and remember that conditions are different in a certain respect from those in the steam plant. In the case of steam the loss of 100 lb. through the stuffing boxes, flanges, etc., probably would be of slight moment. With ammonia it would cause a loss of about $30 and would be objectionable on account of the odor. And so, just as in the boiler plant, where continued care is necessary to prevent blowoff-valve leaks, leaky settings and air holes in the fuel bed, it is necessary to be always on the lookout to keep the refrigerating plant in good condition.

BOILING TEMPERATURE OF AMMONIA VARIABLE DEPENDING ON PRESSURE

Unless the surrounding medium (air, brine, water, etc.,) is hot enough the ammonia will not boil. The ammonia boiling temperature is a variable, depending on the pressure to which it is exposed, just as in the case of the steam in the boiler or the steam in the steam pipe or the radiator. If a brine tank has brine at 14 deg. F. it will not be possible to boil ammonia at a pressure of 30 lb. gage because the boiling temperature of the ammonia at that pressure is slightly over 16 deg. F. This is not important where but one expansion valve is used, but most plants have a variety of conditions, including cold storage, ice making and possibly a sharp freezer. In these plants, if the suction pressure is not low enough to boil the ammonia in the coldest room, then the liquid feed to the coldest coils will not boil and so will accumulate and finally become flooded, and "lost" or "dead" ammonia is the result, combined with unsatisfactory operation. A condition such as has been mentioned is often found in the case of plants requiring a heavy load of short duration, like the chillroom of the packing plant or the dairy with its pasteurizing load, or even the plant which has to pull down the brine-tank temperature in the morning. Incidentally, it is wise to remember that at times it is possible to have a double suction, or to have one machine on the low-temperature and the other machines on the medium-temperature refrigeration. It is unwise to have to govern the conditions of the whole plant by the conditions prevailing in one room.

On the other hand, the operator should remember to keep the suction pressure as high as possible and still carry the load at the proper temperature. This is because the tonnage of the compressor drops off rapidly with a decrease of the suction pressure, and the horsepower per ton of refrigeration increases very greatly at the same time.

[*This article concludes the Study Course.*—EDITOR.]

Low air pressure will cause the Diesel to smoke badly. If the combustion is efficient, there will be no smoke out of the exhaust pipe with proper air pressure. If excessive air-injection pressure is carried, the efficiency is decreased and the engine tends to pound.

Power for Nothing

For some reason or other the reconstruction period in which we are struggling seems to stimulate the inventive ingenuity of perpetual-motion schemers to a remarkable extent, and it would be interesting to know whether the financial response is as general and hearty as it used to be years ago when similar opportunities for investment were offered.

A correspondent calls attention to the H. B. L. Wind Motor Co., of Davenport, Iowa, which in a neatly printed folder outlines one of the simplest get-rich-quick possibilities which have come to notice. In fact, after reading this description it would seem hardly surprising if we should eventually see old chimneys quoted in our trade and financial papers in the same way that old metals or other commodities are today.

While the pamphlet referred to does not go into detail in describing the invention, some of the statements contained in it are wonderfully enlightening. For instance, "It looks so simple that a first glance a man is inclined to say 'it can't be done.'" It would undoubtedly be cruel to comment on this statement that sometimes a first glance is as good as a last.

Another statement is, "Nothing is left of the old power plant but the smokestack," and this is the key to the entire principle involved, which, indeed, is simplicity itself, for though the writer never realized before that the principle could be utilized in exactly this way, it is undoubtedly true that the pressure of the atmosphere at the level of the ground in ordinary locations used for power is somewhere around 15 lb. per. sq.in., while several hundred feet higher the pressure, of course, is a good deal less. What is simpler, then, than to build a high stack, as the H. B. L. people do, and by putting an air turbine in the bottom of the stack attain unlimited power from the turbine equipment owing to the draft that must go up the chimney?

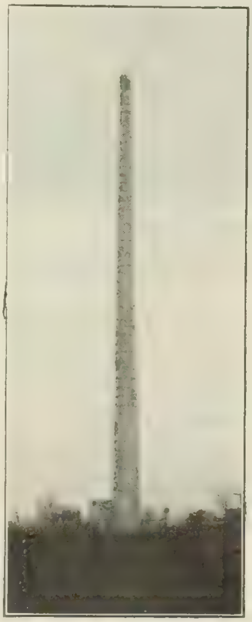


FIG. 1. THE SMOKESTACK

FIG. 2. A CLOSER VIEW

The correspondent sent the three photographs reproduced here, showing very clearly the details of the construction referred to as applying to the experimental plant (somehow or other the perpetual-motion proposition never seems to evolve a plant No. 2), in which Fig. 1 shows the 250-ft. stack at a sufficient distance to get its entire length into the focus of the camera, Fig. 2 a nearer view of the base of the stack and the front of the shedlike structure housing the air turbine, and Fig. 3 the general arrangement of air turbine, shed and base of stack.

The correspondent also states that a recent test showed the power of the air turbine (eleven feet in diameter) to be 47 hp. at 80 r.p.m., and ends his letter with the following naïve statement: "I was fortunate enough to meet a man who happened to see the test, and he informed me that there was a brisk coke fire burning in the base of the stack during the run."

Quoting again from the H. B. L. pamphlet, "The Wind Motor is just what the name implies—a Wind Motor," and "it is our desire to keep this industry entirely in the Tri-Cities." Both of these statements are doubtless correct.

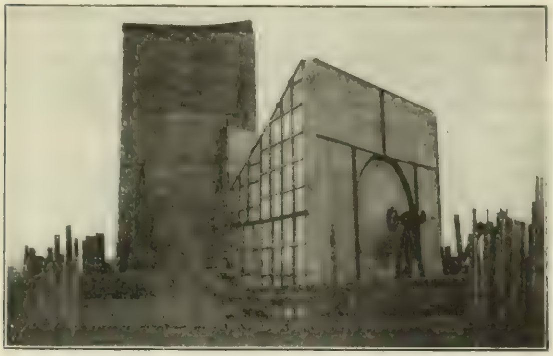


FIG. 3. AIR TURBINE AND HOUSING

The Glee Club will now favor with that classical ditty entitled "And the wind blew up the chimney just the same."

"Producto" Combustion Guide

Meters and gages tell what is wrong in boiler-room practice, but the "Producto" Combustion Guide, which is manufactured by the Progress Products Co., 1313 Race St., Philadelphia, Pa., indicates what to do in boiler operation and damper control. Even with the best of firemen there is just as likely to be a large amount of excess air as there is to be the correct amount, which must be heated to the chimney temperature. This instrument indicates when the furnace fires are too thin or too thick and when there are holes in the fire. It combines the advantage of a steam-flow meter and a multiple differential draft gage. The body is cast iron, and the indicating tubes which are usually found in instruments embodying the idea of inclined liquid passages have been replaced by machined slots in the cast iron, which are covered by plate glass. The slots in which the liquids travel are white porcelained so that the levels are plainly visible.

The idea incorporated in this instrument involves the lining up of the steam-flow and the air-flow liquid levels for a given steam load with the boiler operating efficiently. For other efficient steaming conditions this alignment is maintained at various positions of the indicating liquid levels. Pressure differences, due to both steam and air flow, vary as the square root of the velocity. The other factors involved, although different, are constant for a given condition, and the differences are compensated for in the instrument by variable adjusting tubes, which, by controlling the areas in the liquid reservoir and consequently the relative movement of the different liquid levels, make the alignment a simple proposition. The liquid level in the upper tube moves in proportion to the steam flow; those in the lower tubes in proportion to either the quantity of air flow or to the change in resistance to flow through either the boiler tube or the fire bed. The method of reading the instrument is shown in Fig. 2.

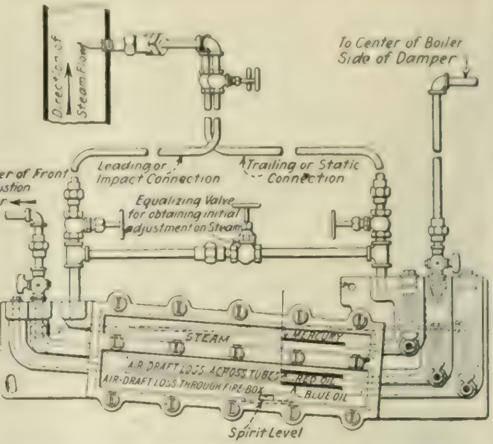
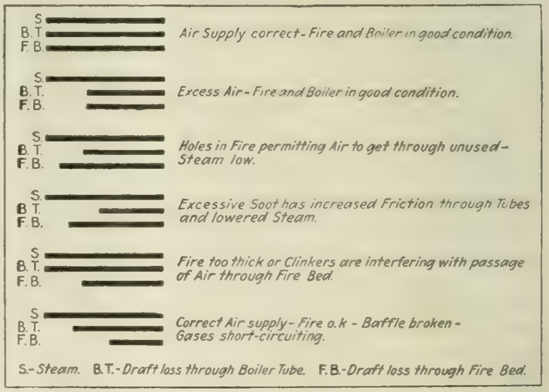

Direction of Steam Flow
To Center of Boiler Side of Damper
To Center of Front of Combustion Chamber
Leading or Impact Connection
Trailing or Static Connection
Equalizing Valve for obtaining initial adjustment on Steam
STEAM
MERCURY
AIR DRAFT LOSS ACROSS TUBES
AIR-DRAFT LOSS THROUGH FIRE BOX
RED OIL
BLUE OIL
Spirit Level

FIG. 1. COMBUSTION GUIDE AND PIPING ARRANGEMENT

The instrument is located on the boiler front level with the operator's eyes. For the steam indicator the nozzle-plug type of pilot tube is screwed into the steam main at any point more than two feet past a bend. All piping is ¼-in. except where it enters the boiler. To check the accuracy of the instrument, it is only necessary to open the equalizing valve and give the air cocks a half turn, thereby venting the pressures on all the liquid surfaces and bringing all the liquid levels to their initial positions.



Air Supply correct - Fire and Boiler in good condition.

Excess Air - Fire and Boiler in good condition.

Holes in Fire permitting Air to get through unused - Steam low.

Excessive Soot has increased Friction through Tubes and lowered Steam.

Fire too thick or Clinkers are interfering with passage of Air through Fire Bed.

Correct Air supply - Fire o.k - Baffle broken - Gases short-circuiting.

S.-Steam. B.T.-Draft loss through Boiler Tube. F.B.-Draft loss through Fire Bed.

FIG. 2. SHOWING METHOD OF READING THE INSTRUMENT

The Application of Babbitt Metals

Practical Suggestions on Grooving, Alignment, Anchorage, Shrinkage and the Results of Casting the Metal When It Is Overheated

By L. D. STAPLIN
Manager Merit Metal Department, Great Western Smelting and Refining Company

MANY users of babbitt metal feel that it is only necessary to procure a good grade of metal and their bearing troubles will be over. This result does not always follow, as good metal, carelessly applied, means eventual trouble in most cases. For that reason the progressive consumer should make sure that his bearings are made slowly and with careful attention to detail. Because of their added service value, bearings made in this way will return the extra cost of this thoroughness many-fold.

In service, trouble is often occasioned by faulty alignment and grooving. In view of all that has been written on the subject, it seems strange that such should be the case, but it merely proves that bearing makers, as a rule, do not sufficiently realize the importance of these factors and sacrifice durability through lack of attention to them.

HOW TO DO GOOD GROOVING

The rules for good grooving are simple. Groove as little as possible and yet enough to distribute the lubricant evenly on the bearing's surface and particularly on that portion of the surface carrying the load, since an excess of grooving in the latter increases the pressure per unit of contact area.

All grooves should have rounded edges. Experience has taught the writer to look first for sharp corners on the grooves when trying to diagnose bearing trouble. A sharp edge left on a groove, as in Fig. 2, acts as a scraper and destroys the oil film. Round the edges as shown in Fig. 3, and the value of the lubricant is increased and the friction reduced.

When it is necessary to groove the load-carrying part of a two-part bearing, the following method has been found effective: with a boring tool or milling cutter remove the [illegible] from both edges of both halves of the bearing except for about half an inch at each end, as shown in Fig. 1, thus making an oil chamber about ½ in. wide and ⅛ in. deep on each side, then, at each end of the lower part only, cut a narrow groove parallel to the ends, connecting the two lengthwise recesses.

ALIGNMENT OF BEARINGS

With sufficient patience any average mechanic can align a bearing correctly. It is only a question of willingness to take the necessary time to do a job in which it pays to be thorough. It is not enough to secure proper alignment when the bearing is made and then feel that the job is done. Before the bearing has run too long it should be examined, for in almost all cases readjustment will be found necessary because of unequal wear. If good alignment can be held, the best babbitt metal should be used on important heavy-pressure, high-speed bearings. If not, it is important to use an alloy adapted to the special conditions, having a plastic and yielding body, which will better conform to the contact surface.

Not many years ago the sale of the logging engines made by the largest iron works upon the Northwest Coast was hampered because the crankpin bearings became loose. Almost every known make of good babbitt metal was tried in an effort to find an alloy that would hold the bearings. The fault was so common that loggers objected to buying the engines. By request the writer followed two of the engines into the woods. When Sunday came, the crankpin brasses needed lining. Examination showed the simple fact that the anchors were too shallow to hold, because in service a logging engine crankpin brass is subject to extreme vibration. By making the anchorage deeper and using a little different style of anchor (see Figs. 4 and 5) the trouble was entirely remedied. The incident shows how simple seemingly serious bearing troubles frequently are. When trying to remedy loose liners, it will pay to examine the anchorage first.

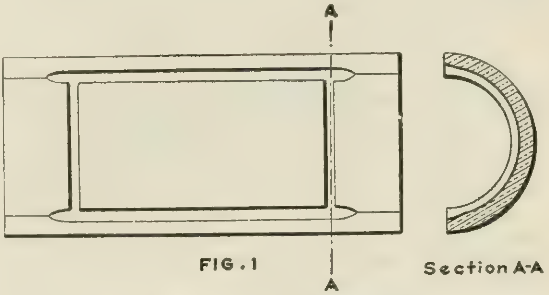


FIG. 1

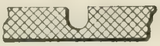


FIG. 2

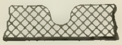


FIG. 3

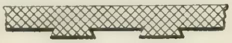


FIG. 4

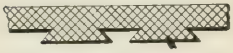


FIG. 5

FIG. 1. GROOVING IN LOWER HALF OF TWO-PART BEARING. FIG. 2. GROOVE WITH SHARP EDGES, BAD. FIG. 3. GROOVE WITH ROUNDED EDGES, GOOD. FIG. 4. SHALLOW AND WEAK ANCHORAGE. FIG. 5. GOOD SOLID ANCHORAGE

If the service is at all severe, there should be close contact between the container and the liner. Even though the anchorage is right, experience may prove that soldering or tinning is desirable, and this can be done in the following manner, using a solder of 50 per cent tin and 50 per cent lead.

For tinning brass shells the first step is the removal of grease, dirt and other foreign matter from the shells by heating them, being careful not to overheat the material of the shell or the subsequent tinning will

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*An article by the same author on "The Selection of Babbitt Metal" appeared in the Nov. 9, 1920, issue.

be difficult. A good way to remove oxide scale and to produce a good clean surface is to "pickle" the shells in a bath of water four parts and muriatic acid one part. In obstinate cases the most satisfactory way of preparing the shell for tinning is to machine or grind the surface to insure a clean metallic contact.

After cleaning, the surface is treated with zinc-chloride soldering solution and warmed either by plunging the shell into a quantity of melted babbitt metal or placing it over a fire. In the former case, a portion will adhere to the prepared face and can be spread over the surface later with a small brush, producing a mirror-like coating. In addition to this the hot face of the shell should be rubbed with a stick of solder and then brushed. This will give a good coating of solder on the prepared surface. If the shell is too hot, it will not take the solder well.

Tinning of steel shells may be accomplished in practically the same way, but care must be used in making the surface to be tinned perfectly clean and free from oil of any kind. Tinning of cast-iron shells is difficult ordinarily, but if sufficient care is taken to file the surface bright just before applying the solder, a good coating may be caused to adhere.

How to Prevent Shrinkage

Metals expand on heating and contract on cooling. There is shrinkage in every bearing metal. The hotter the metal when poured the more it expands and the more likely it is to make a lining that may not adhere solid and tight to the backing. This is because of the shrinkage in the metal when it solidifies, which may be sufficient to cause it to pull away from the backing, leaving a space into which the metal can be pressed beneath the load, thus possibly cracking the lining metal and causing it to break.

The commonly given instruction, "Heat mandrel and container whenever possible before casting," is the cause of more poor bearings than any other one common casting direction. It does not make so much difference if a low-grade bearing metal is cast while it is overheated, as its high content of lead prevents much change in structure during the cooling; but if a babbitt metal of the highest grade, such as carries a tin base and considerable content of copper, is cast while overheated, the service value of the metal will be greatly reduced. A good rule to follow where durability is desired, is to cast the metal at the lowest heat at which it will be fluid enough to flow into the bearing at one pour, and against surfaces that have been warmed only enough to remove the chill. If the container or mandrel sizzles when touched with a moistened finger, it is too hot. The more dense and solid the metal's structure, the greater will be its durability, and the foregoing principle, if applied (see Fig. 6), will produce bearings of the best value in density.

To Increase Density

It is desirable to increase the density when casting removable bearings, which may be done by immersing them in cold water as soon as the metal has solidified after casting. In doing this always be careful to immerse the casting from the bottom upward and do it slowly. The spot at which the metal is poured is always the hottest part of the casting and in cooling should enter the water last. This sudden cooling will close up the grain so that under the pressure and load of service it will not "pack" or "give."

Overheating will open the grain or coarsen the structure of babbitt metal. Since "grain" only means the distance between the particles that comprise the metal's structure, it follows that beneath sufficient pressure these particles will be packed together by the weight of the load upon the metal. This makes "clearance" equivalent to the same amount of wear.

This "packing" can be avoided if the metal is dense and solid, as it will be in ratio to its temperature when poured. Necessarily, the babbitt must be made hotter for a large than for a small casting, so heat according to the work in hand and do not be afraid to spoil a couple of castings in learning the lowest heat point. Experimentation in this connection will be repaid many-fold in the time saved in rebabbitting.

To illustrate a typical case of trouble caused by overheating a high-grade babbitt metal, the following experience will serve: The writer was called to the mill of a sugar manufacturer having trouble with centrifugal bearings. Examination showed that some would run a full season and others in the same type of machine and made from the same metal would last only a few days. After running a few days, the metal started to slough out of the bearing. By examining one of these bearings with a glass, the metal was found to contain minute cracks which would enlarge and finally cause the metal to give way under the vibration of service. The cracks were caused by contraction of the metal while cooling, after overheating and casting against a mandrel that was too warm.

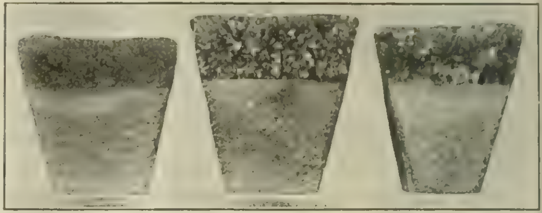


FIG. 6. STRUCTURE OF BABBITT METAL WHEN CAST AT PROPER TEMPERATURE, WHEN SLIGHTLY OVERHEATED AND WHEN GREATLY OVERHEATED

If a lead-based, moderate-priced babbitt such as is so widely used for general work is poured when overheated or against an overheated mandrel, the results, as previously explained, are not so serious. Babbitts of this class are not likely to be "ladle spoiled," and to this good point they owe considerable of their popularity. However, overheating will make them brittle and more likely to break, crack or crumble beneath heavy loads and high speeds.

A steel company was testing a certain alloy in its rolls. Two bearings were cast with the metal nearly red when poured. At the end of five days the liner was $\frac{3}{32}$ in. thinner than when the test started. It had packed that much beneath the load. The two bearings were then cast at the proper temperature, and after running for twelve days they were tested and found within a trifle less than $\frac{1}{32}$ in. of their original thickness. It was customary to reline these bearings when the liners had worn to a certain thickness; hence, by casting the metal with care, the company was able to put more tonnage through the rolls that were correctly babbitted, with a saving of time, money and annoyance.

Some Distribution Cable Experiences

Industrial-Plant Load May Increase to Where Underground Cables Are Dangerously Overloaded Without It Being Realized—In One Case Temperatures Were so High That the Duct Walls Were Softened—Method of Cleaning Out Duct Described

By T. H. ARNOLD

PLACING the distribution cables underground in a duct system is frequently an excellent solution to the industrial-plant transmission problem, but like everything else it should receive adequate attention from the operating crews. In many cases where factory buildings are compactly arranged and overhead transmission wires are objectionable, it becomes necessary to place the feeder cables underground. Low maintenance costs may be expected from an installation of this class if properly installed. Unsuspected dangerous conditions may, however, exist unless the cable system is periodically inspected. In this respect, as in the matter of ventilation and cable changes, the tunnel system offers some advantages over the duct system, for a large installation. When proper inspections are regularly made, hot cables or other unusual conditions are noticed before they become dangerous.

A factory transmission system is usually composed of a number of large low-voltage cables carrying heavy currents. Plant growth is ordinarily evidenced by the gradual addition of a motor here and there throughout the various departments. These increases may not be noticed as long as the cables give no trouble. In a large duct system of comparatively short length a cable will heat beyond the safe operating temperature before the voltage drop becomes a serious factor. A cable will frequently heat to a dangerous temperature in a duct system while carrying a current that would be perfectly safe in an isolated duct; also, it may be damaged if exposed to excessive temperatures from cables in adjacent ducts. This form of deterioration is more or less gradual and first affects the cables near the center of the run as the heat dissipation is less at that point. The nature of the ground, depth below surface, and the number and location of the ducts all have a distinct bearing on the heating of the entire system.

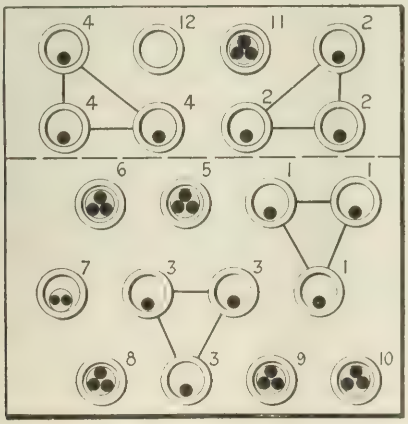


FIG. 1. DUCT AND CABLE ARRANGEMENT

A recent investigation of a cable system was made for the purpose of determining what additions to the cables would be necessary to carry a contemplated increase in load. The system was designed for 1,500 kw. at 440 volts and was carrying an average in the neighborhood of 2,000 kw. The power factor in some departments was also somewhat less than that used in the original calculations. As no trouble had been traced to the cable system, it was assumed that with some minor changes the cables were adequate for the existing condition.

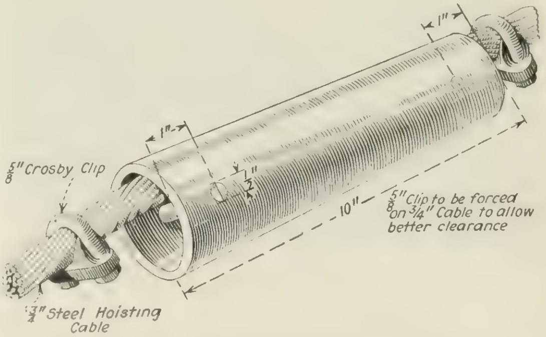

1"
1"
1"
5/8" Crosby Clip
10"
5/8" Clip to be forced on 3/4" Cable to allow better clearance
3/4" Steel Hoisting Cable

FIG. 2 DUCT CLEANER MADE FROM 2-IN. PIPE

The power plant could not possibly carry all the motors on all the circuits at any one time, nevertheless there were times when all the motors on one circuit were running at full load for a sufficient time to heat the cables. In the table are shown the rated motor load on each feeder and the size of the conductor. The manufacturing plant was operated to get the greatest output with the power available, and thus the average load carried was very close to the rated capacity of the generators. As this was a twenty-four-hour load, the cables had no opportunity to cool.

A thorough examination revealed some rather startling conditions. The manholes had been sealed to prevent the admission of water, and when opened, the interior temperature was found to be very high. The cables were paper-insulated, lead-covered, single- and three-conductor, insulated for 2,500 volts. In two manholes the lead and paper were burned completely off some of the cables, leaving them bare, and from their appearance they had been in that condition for some time. No definite date could be assigned, but from some circumstances that could not be explained at the time, it appeared likely that the burnouts had occurred about three years previously. As the interruptions were only temporary, no search was made for the cause and the cables were operated in that condition.

The duct material was of the familiar bituminous fiber or paper composition laid in concrete with the general arrangement as shown in Fig. 1. At some points the duct material had softened and completely closed the ducts. A laboratory test showed that the duct material softened at about 140 deg. C., which is sufficiently above the safe operating temperature of the cables to be satisfactory.

One cable that was removed was found to be in very bad shape in spots. The insulation was charred to a chocolate brown and the filler compound completely dried out.

In some cases where the bond wires had been removed, pitting of the lead sheath was noted. The individual cables were in no case carrying in excess of the underwriters' rating for this class of insulation and had been thought to be in a safe operating condition. The only insulation breakdowns experienced were the ones mentioned in the foregoing, but had the voltage been higher, they would have been more numerous.

In remedying these conditions, some of the old cables were removed and larger ones installed. This work was considerably delayed by the softening of the conduit and the temperature of the ducts and cables. Where the duct was in good shape, the rods invariably came out too hot to handle without gloves. It developed that where the conduit ran close to the surface of the ground little trouble was encountered, but where it was buried six feet or more the temperature was very high and the duct softened. Where possible the duct was dug up and repaired, otherwise it was cleaned out and the cable pulled through the remaining hole in the concrete.

FEEDER CABLES AND LOADING

No.	Dept	No. of Cables	Conductors per Cable	Cable Size	Connected Load Rated, Hp.
1	A	3	1	1,600,000	1,010
2	A	3	1	1,000,000	
3	B	3	1	1,000,000	1,100
4	B	3	1	1,000,000	
5	C	1	3	400,000	163
6	Lighting	1	3	No. 2/0	50
7	Direct Current	1	2	250,000	25
8	D	1	3	450,000	265
9	E	1	3	No. 1/0	105
10	F	1	3	300,000	245
	G	1	3	No. 1/0	132
12	Vacant	...	...	...	.

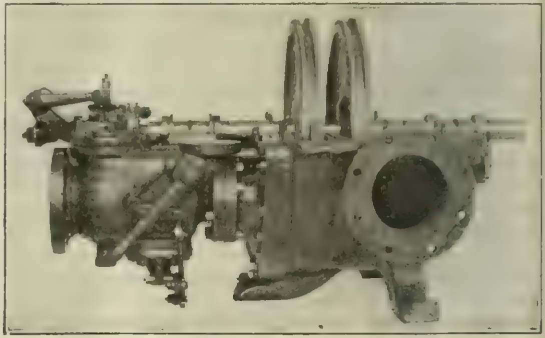
The numbers in the first column correspond with the duct diagram.

The cleaning was a slow and laborious process, and sometimes after a section was apparently clear the material seemed to cave and fill the opening again. Lengths of ¾-in. pipe suitable for handling in the manholes were started in the duct and screwed together till they reached the obstruction; they were then driven in about six inches, removed, cleaned and returned to the hole. In this manner a hole was finally driven through. The rods were then passed through and followed with a piece of old ¾-in. steel hoisting cable on which were fastened a number of Crosby clips at intervals of two feet. This was pulled back and forth till no more material was brought out by the Crosbys. They were then removed and replaced by the pipe scraper, Fig. 2. This scraper was made of a 10-in. piece of 2-in wrought-iron pipe and was placed on the cable and secured by a clip on each side. The scraper was pulled in till a stress of ten or fifteen tons was exerted on the rope. It was then pulled out, the material cleaned from the interior and returned. Sometimes it took as much pressure to pull the scraper out as it did to pull it in, owing to the material caving in behind. When the cables were pulled in they went fairly easily. The head of the cable frequently brought out large masses of the duct material. No signs of damage were noted due to the lead dragging on the bare concrete.

New Steam Turbine for Mechanical Service

A new steam turbine of either one, two or three stages for driving centrifugal pumps, blowers, etc., has recently been designed and may be arranged to operate at steam pressures of from 50 to 300 lb. with or without superheat, and either non-condensing or condensing. It is, in general, adapted to supplying an output anywhere from 10 to 400 hp. at 1,000 to 5,000 revolutions per minute. It is manufactured by the General Electric Co., Schenectady, N. Y.

The illustration shows a two-stage turbine with speed governor mounted on one end of the shaft. The connections between the governor and governor valve are shown at the left, and adjacent are the emergency valve chest and resetting lever. The upper half of the wheel casing and bearings are removable, thus permitting removal of the wheels and shaft without disturbing the steam and exhaust piping. The casing is supported on three feet; this does away with the possibility of twisting strains.



TURBINE WITH CASING REMOVED

The speed of the turbine may be varied while in operation by a simple adjustment of the governor valve. The governor weights are inclosed in a casing, and a protecting hood is placed over the governor as a whole.

When conditions of operation render it desirable, an emergency governor is supplied. This operates independently of the main governor and serves as an added protection. It does not come into play unless the speed rises to about 15 per cent above normal, when it shuts off the steam supply.

From the steam chest the steam is passed through the first-stage nozzles, which direct the flow of steam into the buckets on the wheel. For certain purposes some of the nozzles are opened or closed as required, by hand valves placed in the steam chest. Steam to all nozzles is under control of the main and emergency governors.

Preignitions in the modern two-cycle semi-Diesel engines cannot occur if the atomizer nozzle does not leak. The injection point is fairly late, and no oil is in the cylinder to ignite until practically dead center. If the atomizer leaks, oil will enter the cylinder early in the compression stroke and preignite. If the engine fails to burn all the fuel, at times part remains in the bulb to ignite on the next compression stroke.

Gray System of Automatic Combustion Control

Under date of June 3, 1919, was published a description of a combustion-control system that is now manufactured with improvements, by the Automatic Fuel Saving Co., of Philadelphia and Chicago. By this device the over-fire draft or vacuum is maintained continuously at the most efficient point by varying the air pressure under the grate. The damper is moved to pass a greater or less quantity of air, and the stoker, if there be one, is speeded to meet the demand for fuel.

All these factors are co-ordinated so that simultaneous adjustment is made of coal, air and damper position.

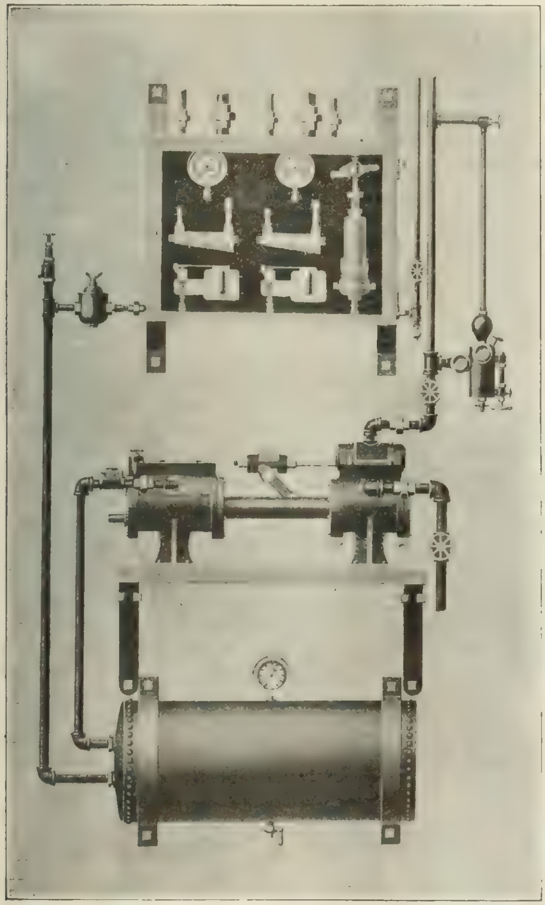


FIG. 1. CONTROL CABINET, AIR COMPRESSOR AND REGULATING EQUIPMENT FOR THE GRAY SYSTEM

The outstanding feature is the maintenance of the over-fire vacuum by the variation of the air pressure under the grate. In the regulation of a number of furnaces this method automatically compensates for variation in the fuel-fed thickness and porosity, so that each boiler is individually controlled, according to furnace conditions existing, and for all, uniform rates of combustion are insured.

It is this feature which distinguishes the present method from the system as originally developed. Control of the three elements of regulation—boiler damper, air supply and stoker speed—is obtained by means of diaphragms operated by compressed air, the necessary variation in the diaphragm air pressure being controlled by two valveless leak ports. One port is actuated by the steam pressure in the header and controls the damper position and the stoker speed. This is a part of the steam-pressure controller system. The second leak port is actuated by the over-fire vacuum and controls the air supply, being an element of the furnace air controller. Fig. 1 shows a typical control cabinet and apparatus for two boilers, and Fig. 2 illustrates the furnace controller.

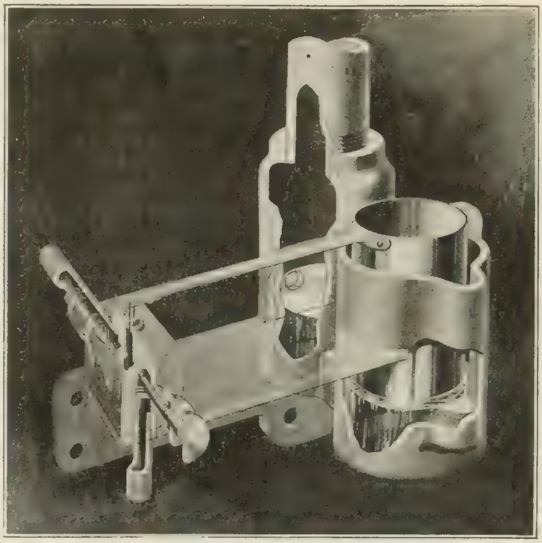


FIG. 3. THE FURNACE AIR CONTROLLER

The steam-pressure controller is operated by the variations of steam pressure in the header. This pressure is exerted upon a bronze diaphragm and is opposed by a spring whose tension is adjusted for the steam pressure to be carried. If the steam pressure falls, the spring forces down the diaphragm and the steel stem connected to it, thus opening the leak port above and allowing a definite portion of the compressed air passing to the damper and stoker speed diaphragms to escape to the atmosphere. As the pressure on these two diaphragms is lessened, the boiler damper is opened a certain degree and the stoker is speeded up, the variations in either depending on steam-pressure drop.

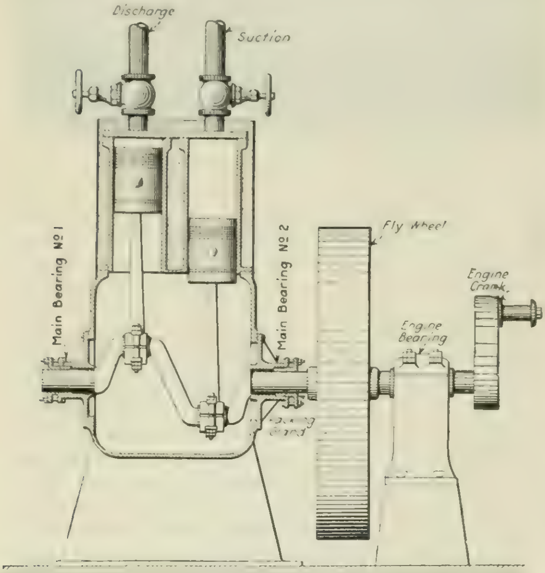
To illustrate the operation of the control on a battery of boilers, suppose an additional steam-consuming unit is cut into the line. The consequent demand for more steam results in a drop of steam pressure in the header. This pressure drop is transmitted to the steam-pressure controller, which opens the dampers of all boilers in proportion to the drop in pressure. In the case of stoker-fired furnaces the rate of feeding fuel is also increased in proportion. The opening of the damper creates a greater suction in the furnace, and this draft change is communicated through the over-fire vacuum line to the furnace air controller. This regulator, whose function it is to maintain a predetermined over-fire vacuum, speeds up the individual turbo-blower or opens the individual wind-box grate if one blower supplies the air for all furnaces. Thus the under-grate pressure is increased and each furnace is given individual treatment in accordance with its special requirements. The furnace with the highly resistant fuel bed will have a higher under-grade pressure, while the furnace with the less resistant or thinner fuel bed will have a lower under-grate pressure. The over-fire vacuum remains constant, and efficient combustion takes place under varying conditions of furnace and boiler load.

Repairing an Ammonia Compressor

By Roland L. Tullis

Occasionally, we find a piece of machinery of very poor or antique design, which proves a source of annoyance and inconvenience to the engineer. The machine described in this article has been in daily use for a number of years. It was built by a small foundry and undoubtedly was designed by men of no great experience in the refrigeration line.

It is a twin-cylinder, single-acting vertical ammonia compressor direct-connected to a tandem-compound Corliss engine. Both the suction and discharge line were connected directly on top of the head, and in case of a leak or blowing out of the head gasket it became necessary to remove a section of both the suction and discharge line as well as the suction and discharge valve on the line.



AMMONIA COMPRESSOR WITH IMPROPER MAIN BEARING

In order to remove the head on this machine, the engineer had to remove the bolts and disconnect four flanged joints and take out the suction and discharge valves. It was also necessary to disconnect both bypass valves used in pumping from the high side to low or vice versa. It was an all-day job for two men to remove the head, fit a gasket and replace it, while if the machine had been designed properly, it would not have required more than an hour at the most. The machine was fitted with a solid-flat head. The clearance was very small, and the pulling over of a small slug of liquid in the suction line would either cause the head to leak or blow out the gasket. A blown gasket was a frequent occurrence and necessitated a shutdown and a hard day's labor for two men.

The crank bearings were oiled by the splash system—that is, they dipped into the oil in the crankcase on every revolution—while the main bearing and the wristpin bearings were supplied with oil by a small rotary belt-driven pump connected to the crankshaft. This small pump took oil from the crankcase and forced it through the main and wristpin bearings, whence it was returned to the crankcase.

One day this machine began to moan and groan and pound violently. The shift engineer was a new man and a bit undecided as to what to do in an emergency. The weather was very hot, and the compressor was badly needed to hold down the temperature. He examined the oil gage on the crankcase and made sure that there was plenty of oil. The small oil pump was running properly, and by all outward appearances the machine seemed to be getting sufficient oil, so he decided to allow it to run for a few minutes and await developments.

Things began to develop in a hurry. The pounding steadily increased, and the crankcase and bearings reached a high temperature. The machine was shut down at once, the crankcase opened up and the oil withdrawn. Both crank bearings were very hot; by testing with a pinch bar, they were found very loose. They were removed and the babbitt metal was found burnt out. Both bearings were rebabbitted, scraped and fitted and replaced; but when the engine was turned over slowly the pounding was still there. Next, the wristpins and bearings were taken out; this necessitated the removal of the compressor head and the pulling of the pistons. Upon examination it was found that both wristpin bearings had run hot. They were made of cast iron in the form of a sleeve and had cracked, pounded and pulverized; pulverized cast iron was found in the bottom of the crankcase. The wristpins and bearings were repaired and replaced, but the compressor still failed to run satisfactorily. The main bearings ran hot, and there was a noticeable pounding somewhere. Next, both of the main bearings were removed and it was found that the babbitt metal had softened and allowed the crankshaft to drop about one-eighth inch.

Owing to the peculiar construction of this machine main bearing No. 2 was a corker to repair. By referring to the sketch, it will be seen that it is impossible to lift out No. 2 bearing (a solid bearing similar to a sleeve, babbitted on the inside) without removing the heavy flywheel, engine bearing and engine disk or crank from the shaft. It was finally decided to turn out a split bearing for main bearing No. 2, as this was the only type that could be put in place without much trouble.

Finally, when all the bearings were repaired and the machine properly aligned, it ran as smoothly as a clock. The whole trouble was caused by the complete stoppage of two small oil-feed pipes that delivered oil from the pump to the bearings. The wristpin bearings undoubtedly gave way first, and pulverized cast iron from these bearings probably worked into the other bearings with the oil and completed the havoc. If the machine had been shut down at the first signs of trouble, much work and expense could have been avoided.

The two small oil lines that had stopped up were in an inaccessible position inside of the crankcase. It was impossible to tell whether they were open or not without opening the crankcase. All this tends to show that every machine should be so built that all parts are accessible.

EDITORIALS

Distribution-Cable Maintenance

A FACT too frequently not appreciated is that where heat is generated it must be dissipated as fast as produced or the temperature will soon become excessive. T. H. Arnold's article in this issue, "Some Distribution-Cable Experiences," very forcefully emphasizes the foregoing.

Where electrical cables are installed in the open they are not likely to be overloaded to the point where the temperature of the copper will destroy the insulation—first, because the heat is rapidly dissipated to the surrounding atmosphere, and second, before dangerous loading is reached the volts drop reaches such proportion as to interfere seriously with the service and make some remedy necessary. However, when cables are installed in conduits or in underground ducts, a far different condition exists. Unless air is forced through underground ducts, and it seldom is, the heat must be dissipated at the point where generated in the cable. How fast this heat will be conducted away is a very complicated question, since after reaching the surface of the cable the heat must pass through the air surrounding, or partly surrounding, the cable to the wall of the duct, then through the concrete to the earth. The nature of the ground, the depth below the surface and the number and location of the ducts all have a marked bearing on the heating of the system.

A cable installed in a single duct may carry a load that would prove disastrous if placed in the center of a duct system having a number of loaded cables. In a section of a duct system near the earth's surface cables may operate at a safe temperature, while in a section six feet or more under ground they may have a temperature that is excessive. Even though the system may operate at a safe temperature when first installed, the installation of a steam main near it may result in excessive temperatures. These facts emphasize the necessity of keeping careful check on such systems, for if this is not done expensive repairs may be required, as clearly indicated by Mr. Arnold's experience.

The heat generated in a cable does not increase directly as the current, but as the square; therefore, with a 40 per cent increase in current the amount of heat to be radiated is approximately double that with the original load. Consequently, a small increase in the current above that at which the cables can safely operate may cause a dangerous condition. Overloading of cables is something that generally comes on gradually. When first installed, they may have ample capacity, but machines are added from time to time, and before it is realized the cable is operating at a dangerous temperature. For this reason it is essential that careful record be kept of the loads; if this is done, serious overloading may be avoided, and it is frequently possible to shift some of the load from cables approaching the dangerous point to those that are only partly loaded thus operating the system at a higher efficiency.

Labor Saving in the Plant

THE country has just passed through a period of labor shortage which has brought labor-saving machinery to the front in a very definite manner. The difficulties of keeping labor on the job have been great, and this has been particularly true in coal handling for the power plant. The independence and vagaries of labor in this department have been such that it has been next to impossible to keep men on the coal pile even though a dollar an hour for common labor in unloading coal has been common.

In a certain plant seven men are wheeling coal from the storage pile to the boiler room, and two men on a watch for three eight-hour shifts are distributing this coal to the stokers, making a total of thirteen men for handling the coal to develop nine-hundred boiler horsepower at a labor cost of $52.20 per day. This practice still obtains in spite of the lessons learned from the war and the high prices, which should force economy. There is an enormous field in the coal-handling departments of our industries for labor-saving machinery.

The average power plant cannot be charged with excessive labor costs for coal handling and still be expected to deliver power for a minimum cost per unit of output, more especially since the means of reducing this charge are at hand. When it is added to the cost of the coal itself, the total figure is almost prohibitive. Owners will jump at the chance to get coal at a reduction in price of one dollar per ton, and yet they will pay out day after day the same amount to get this coal into the furnace through inadequate facilities.

Probably the thing most desired is a simple system for getting the coal from the cars to storage and later from storage to the stoker hopper. These operations can absorb a tremendous amount of labor and expense if not efficiently done.

The Producer-Gas Engine

IT IS to be deplored that more efforts are not being made toward an increased use of producer-gas engines. At one time, between 1904 and 1910, a large number of producer-gas plants were installed, there being approximately one thousand such plants in 1912. The decline in the popularity of the producer unit can be attributed to several factors, the most important of which was the irrational producer designs so often sold. Being constructed to give a constant volume of gas, many of these producers were unsatisfactory with a variable gas demand. The skill of the untrained operator was unable to cope with this problem, which in recent years has been eliminated. The commercial appearance of the oil engine, both Diesel and semi-Diesel, using a low-priced fuel oil, also served to decrease the further advance of the producer-gas engine.

There are a large number of plants now using natural-gas engines, which must change over to some other form of power. Gas producers could be installed at a comparatively low cost. Of the seven or eight hundred engines using gas from the depleted gas fields, the majority are of sizes well within the range of commercial producers.

A second large field for the gas producer and engine is in the Northwest, where there are large bodies of lignite coal. This coal is not very satisfactory for boiler fuel because of its low heating value and high moisture content. On the other hand, it has given excellent results in producers. A number of gas-engine stations have been using this lignite for several years.

Other low-grade fuels, such as sawdust, peat, coke breeze, etc., are quite suitable for producer use. In localities where the price of fuel oil is high, a revival of the producer is to be expected.

Considering the efforts that the two classes of manufacturers employ, it is surprising that there are over fifty producer-gas installations in central stations, while the total number of Diesel central stations reaches a bare one hundred and seventy-five.

Co-operation Among Engineers' Associations

IN AND about New York there are some twenty organizations of operating steam engineers. They meet weekly, biweekly or monthly in small groups. Some carry out, by spurts, more or less ambitious plans of education and self-improvement.

In these groups are many men to whom the association appeals mainly from the fraternal and society side. They enjoy meeting with their fellows and going through the program according to the ritual. They enjoy initiations, luncheons, the smokers, balls and picnics. They are honored by election to the offices and perhaps are sent as delegates to the state and national conventions. They may take a more or less active part in the educational work and technical discussions, but their main interest is in their own little group.

And yet from the point of view of impressing the importance of the power-plant engineer upon the public and the profession, of showing that in responsibilities and attainments and in personality he is vastly different from the popular conception, even from the conception which prevails in certain professional engineering circles, in presenting a representative and united front in matters of legislation and from the point of view of individual advancement in engineering, greater progress could be made with one large organization, meeting amid professional surroundings and in an atmosphere of engineering inspiration.

In the heart of Manhattan is a great building devoted to engineering. It houses the four great professional engineering societies and many others. It has halls and meeting rooms to accommodate any assemblage from a committee meeting to an audience of eight hundred, with the most magnificent engineering library in America, stereopticons, projectors and all the paraphernalia for engineering assemblages. Lecturers are available in any number who would be glad to talk to a sizeable audience in such surroundings, but who cannot be asked to go to some lodgeroom in an outlying district to talk to a group of fifteen or twenty. The United Engineering Societies Building is easily accessible to the members of all the twenty-odd associations referred to.

Without in any way interfering with the autonomy of the existing associations, would it not be possible and worth while to combine those members who would be interested in such a movement into an organization for the holding of meetings for the hearing of papers and lectures upon power-plant engineering and for their discussion? This might be undertaken by the local representatives of one of the national associations, as the N. A. S. E., confining membership in the new organization to members of that association, in which case it would bear the same relation to the individual associations as the Shrine in Masonry bears to the Blue Lodge. Or it might, better, be inclusive of all engineers progressive and ambitious enough to wish to join it. Or again, it might be effected by a large number of such engineers joining the Power Section of the American Society of Mechanical Engineers. Membership in the professional sections is open to those who are not members of the main society, and at a reduced fee. While the professional sections are national in scope, it would be possible, with a sufficiently large local membership, to hold frequent Power meetings at headquarters, and the members of the Power Section would also enjoy the privileges of the sessions of the whole section at the annual meeting. The suggestion in either form is pertinent to other large centers than New York.

Regulation of the Load

WE ARE accustomed to think of the term "regulation" as referring to the speed of an engine. When driving a generator, the speed is of the utmost importance. It has a bearing on the output of the shop and on the over-all economy of the installation. While important in the engine room, proper regulation may effect greater economies in the boiler room, for it is here that the large savings are possible.

Regulation of the feed is a strong factor in the process of making steam. There are too many plants neglecting this factor. In one plant it is the regular custom to blow down ten drums of water per day, letting the feed pump run along at a set speed and "regulating" the feed-water level with the blowoff valve. The wastefulness of this practice may readily be imagined.

But regulation in the boiler room implies more than controlling the feed water. It is often possible to regulate the load on a boiler plant. Any department may take a great deal of steam at one time, while others make a demand at other periods. If properly regulated, the load usually may be made constant and economical, whereas if no attention is paid to it the demand may come from all departments at once. A peak load is created, ashpits get on fire, and an uneconomical condition is produced. After the peak is over, the boilers may loaf along for the rest of the day.

Even on Sunday loads there is an opportunity for regulation. A certain plant recently reduced its Sunday requirement from forty to five tons of coal by regulating the load and doing on a weekday some of the little things that formerly had been done on Sunday.

Too often the engineer's duty is limited to making steam. His business is to keep steam on the line day in and day out. If steam is off at any time, there is immediate trouble. The result is that excess capacity in boilers is kept on the line to meet demands that may or may not materialize. If these demands were regulated, the engineer would know when he could take his boilers out and when to be ready to meet an increase in load. Systematic grouping and regulation of the power and line steam demands in industrial establishments has great possibilities.

CORRESPONDENCE

Packing Expansion Joints

Expansion joints probably give the average institution engineer more trouble than any other one thing; at least this was true in my case until I hit upon a method of packing them that has proved so satisfactory that I am passing it along.

I first fill the stuffing box (with the exception of the last ring) with a good quality of flexible metallic packing, coating each ring with a liberal supply of powdered graphite and cylinder oil. Then I put in one ring of diagonal or cross-expansion packing cut so that the ends meet, thus leaving no room for expansion as is generally called for in directions for applying most packings. The gland is then tightened up until fairly snug. Once a week, choosing a time when steam is off the lines, all the joints are gone over and the brass sleeves are doped with a mixture of cylinder oil and powdered graphite.

As soon as a leak develops the gland is tightened a little. If this does not stop the leak, the ring of cross-expansion packing is removed, the sleeve is polished with a very fine grade of emery cloth, a new ring is fitted, and the job is done in about one-fifth the time it would require to repack the entire box, not to mention the saving in packing. Of a number of joints that were packed in this manner more than two years ago, none have required more than four renewals of the top ring.

A shredded metallic packing was first tried, but it was found next to impossible to apply evenly because of the close quarters in which these joints are installed. The unevenness, of course, caused tight and loose places in the packing when the gland was tightened and resulted in leaks. So a coil metallic packing of the proper size was resorted to with the aforementioned results.

Another point that I have found very important in keeping expansion joints in good condition is that of boiler priming, which always carries more or less scale-forming matter into the steam lines. This scale will invariably find its way into the expansion joints and collect on the sleeves, where it naturally cuts the packing; consequently it is necessary to keep the steam as pure as possible and to remove any scale found on the sleeves.

A. C. McHugh.

Norwalk, Cal.

Keeping Stuffing-Box Packing Data

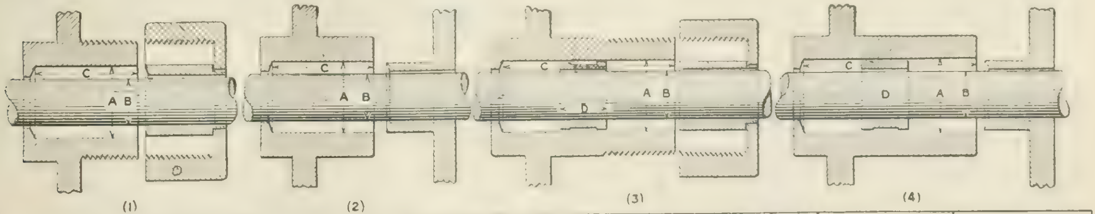
The accompanying record sheet provides an accessible and systematic method for the collection of desirable data on stuffing boxes and their numerous packing conditions, which enables the chief engineer to group all the conditions in order that he may determine the packing most suited for each. This matter, once collected, gives each shift engineer the proper information, so that when he is called upon to pack a particular rod or shaft he may select the proper packing as approved by the operating department.

This information assists in the standardization of packings for certain services and results in fewer style numbers, a smaller stock, better economy in the use of packing and larger purchases in standard styles and sizes, resulting in larger discounts. The sheet should be 24 in. wide by 32 in. long, which allows inserting information on one hundred stuffing boxes, or it may be made longer to suit the requirements of any particular plant.

The stuffing boxes of each unit should be grouped under the description of each unit by stating the name of the unit, size, etc., to distinguish it. Then in the column under the subject, location of stuffing box, enter the location or name, and along the line to the right insert the information as called for in the columns that can be used.

Jesse L. Best.

Hillsboro, Ill.



Description of Unit	Location of Stuffing Box	Number of Boxes	Dimensions A	Dimensions B	Dimensions C	Flat or Taper Bottom	Length of Gland-D	Kind of Rod	Kind of Service	Temperature	Length of Stroke	Speed in R.P.M.	Speed in ft. per Min.	Type of [illegible]	Packing Recomended	Remarks, etc

METHOD OF KEEPING RECORD OF STUFFING-BOX PACKING DATA

Eliminating Diesel Piston Fractures

In the operation of a horizontal Diesel oil engine it was found that the piston head or firing head burned out about every six months. The fracture usually occurred when the engine load was heavy, making it rather inconvenient to stop the engine. At times the fracture would open up enough to allow the flame to shoot back into the engine frame. The head was removable, being held in place by setscrews. For a time cast-iron heads made at a local machine shop were used, but these held up no longer than the factory ones.

It was noticed that the fracture always started about three inches from the center of the head at practically the same spot. Apparently, there were two causes of the fracture. The design of the head included circular ribs at the front side. In cooling, after casting, these ribs developed stresses in the head. For several reasons ribless heads were deemed inadvisable and effort was directed toward effecting some arrangement whereby the fuel spray would not be centered on this one spot. It was believed that if the spray through the one hole in the spray tip struck this spot, the high temperature, much higher than that of the surrounding metal, would cause expansion and contraction. This finally would result in a small fracture, which, as the gas blew through, would enlarge as the flame burned the edges of the crack.

Consequently, the single-orifice spray-valve tip was removed and a tip with six holes substituted. These holes were drilled slightly diagonally with the center line; the oil then issued in six streams, or sprays, and covered a greater portion of the combustion space. This stopped further fracturing of the piston head. A decided improvement was noticed in the color of the exhaust. Originally, it was always slightly dark and the piston head usually was covered with carbon. With the new tip it seems that the oil is broken up better and is mixed with a greater amount of the air, giving better combustion. Figs. 1 and 2 show the fuel-spray valve with the old and new tips. **George Grow.**

Philadelphia, Pa.

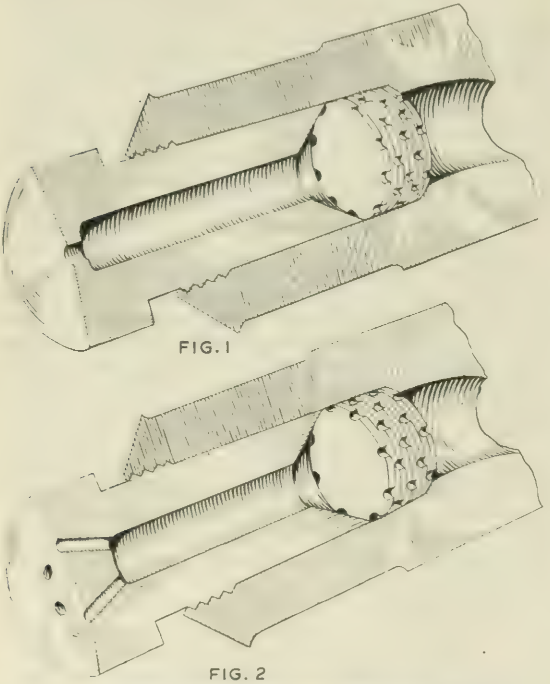


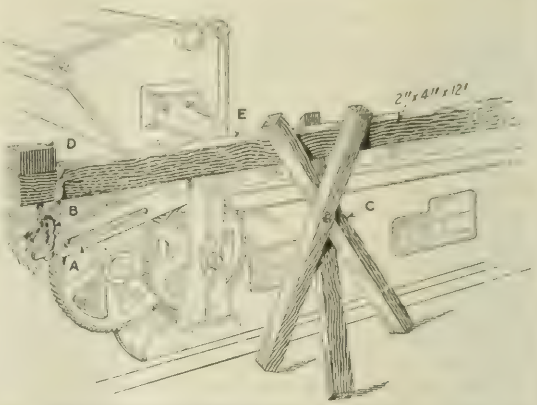
FIG. 1

FIG. 2

ALTERATION OF DIESEL SPRAY TIP

Carrying the Load Without Stoker Shafting

The first thing after the noon hour we haul out the coal cars that have been unloaded and also the cinder car. The tracks are parallel, but the cinder tracks are about four feet lower than the coal track. We do the switching with a small electric locomotive. One day, for some reason or other, some new men were on the job and everything went all right on the taking-out part, but the damage was done in replacing the empty coal cars with full ones.



HOW THE STOKERS WERE OPERATED UNDER AN EMERGENCY

They were going to put in one of those high coal cars, when the switchman threw the wrong switch and the car went down the grade into the cinder pit, pulling the little locomotive after it. The car mowed down every foot of stoker shaft, which was in the basement.

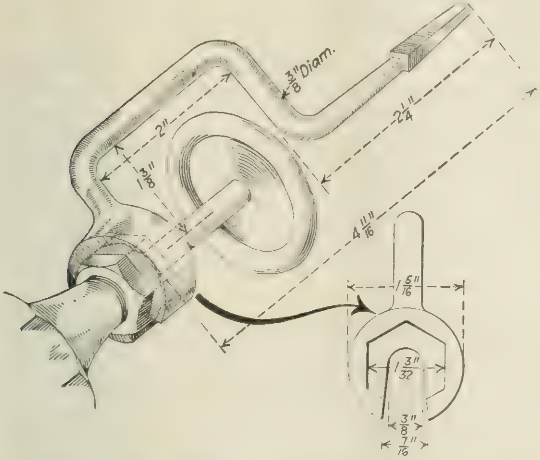
There I was with a big load and no stokers. It happened that we had all chain-grate stokers. I hustled some men up to the boiler room and pumped the stokers by hand. Meanwhile the distress whistle was sounded, which brought the linemen, sectionmen and extra motormen to the scene of trouble. Then we began figuring how the stokers could be kept going, as it took two men on each stoker on fifteen minute shifts.

Upon the suggestion of one of the men we made the apparatus shown in the illustration, from 2 x 4-in. timber. *A* is the lever on the stoker, *B* is a rope, *C* is a three-legged sawbuck, *D* is a balancing weight of firebricks, *E* is a 2 x 4-in. by 12-ft. stick for a lever. One man could sit on a box and run a stoker for two hours at a time if necessary. We ran this way for 48 hours and dropped only 200 kw. of the load, and this was at the time of the accident. We stored two of these strong-arm stokers away for fear something might happen to one of our eccentrics or some other part of the stokers. Thanks to the stoker designers for that lever *A*. **E. Littlefield.**

East St. Louis, Ill.

Valve-Stem Packing Wrench

Where there are many small-sized valves to be packed, such as the radiator valves on a heating system, it will pay to provide the men doing the work with a wrench of the type shown for each size of valve used on the system, such as $\frac{1}{2}$-, $\frac{3}{4}$- and 1-in. sizes. With such simple wrenches with a shank to fit a breast drill or a bit-brace having the usual ratchet, any man can easily, conveniently and generally with comfort repack nearly twice as many valves per hour as he can with the common wrench. The wrenches can be made of a cheap grade of tool steel forged to size, smoothed up a little on an emery wheel, heated and tempered slightly. Such wrenches will often save their cost in the packer's time alone the first day they are used.



PACKING-NUT WRENCH FOR USE WITH BIT-BRACE

The dimensions given are for a certain size of wrench and will vary with the size and make of valve. Even though several makes of valves may be used in one plant, it is possible to make one wrench serve, as it may be a little loose on the packing units without without injury. A set of two or three wrenches generally is sufficient.

Richmond, Va. FREDERICK W. SALMON.

Does a License Law Help?

After reading the article on engineer's licenses by L. M. Reed, page 833 of the Nov. 23 issue of *Power*, I wish to ask Mr. Reed a few questions. I am operating in a state where but a few cities have any semblance of a license law. I hold a city license. If I were to go to Massachusetts where would I be likely to land? Where I am now I must have an engineer's position in order to secure a license, and a license in order to secure a position as an engineer.

In this city a man may operate although his license may have expired nearly a year, and firemen on days with an engineer are not licensed, but night firemen operating alone are.

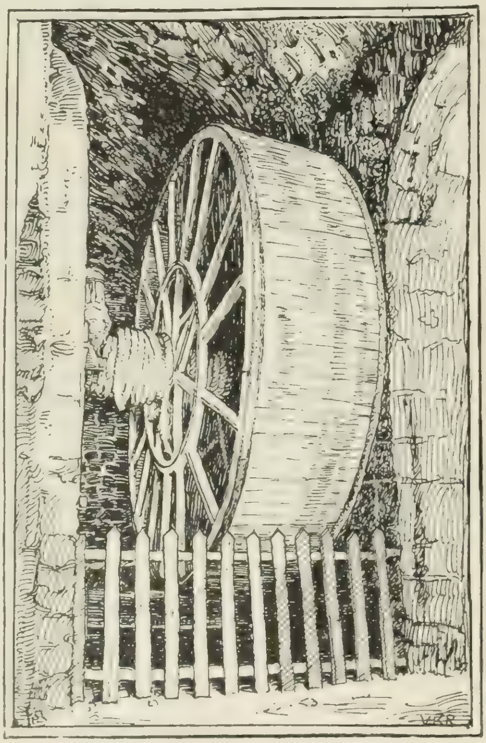
Mr. Reed's statement that there can be no Federal licensing of stationary engineers is erroneous, I believe. How about the marine license? If there is any time that the United States Government cannot pass a law on account of states rights, then all I have to say is it is a queer country.

Speaking of men holding various licenses, I worked for a chief engineer who held a Massachusetts first-class license. He had a four-valve engine the crank rod of which was so designed that the wedge bolts are behind the crankpin on one end and ahead of the crosshead pin on the other. Owing to the continual tightening up a noisy thump made its appearance on starting and stopping, but during running no noise was heard. Indicator diagrams showed that the head end was running with the piston up against the head. Perhaps this instance is an exception to the rule. This same engineer would come into his plant and see three engines where there was but one, and he was a chief engineer. R. G. SUMMERS.

Rochester, N. Y.

An Elevator With an Interesting History

The pen-and-ink drawing shown in the figure is from a postal card brought from France by William La Follette, of Kaycee, Wyo., who served overseas. It is an old treadwheel elevator run by six men, used about the Eleventh to the Thirteenth Century, for lifting provisions up approximately eighty feet to an old monastery that was separated from the main land, on the road between Brittany and Normandy at Mont Saint-Michel.



TREADWHEEL FOR ELEVATOR

What a story it tells of the evolution of the use of power, comparing it with our modern electrically operated elevators equipped with safety devices and gate interlocks invented for the safety of life and property!

Washington, D. C. THOMAS M. ROBERTS.

Instruments for the Boiler Plant

Many articles have been written on the subject of boiler-plant instruments, and it is needless to say that each has contained its percentage of good. Among the thousands of power plants in this country it is safe to say that the majority of them do not have the necessary instruments for checking fuel waste and incident boiler losses.

In the large, well-regulated and efficiently operated station will be found instruments that control the efficient operation of boilers under all load conditions. The largest number of plants where few or no instruments will be found are those ranging from 500 to 5,000 hp. rated capacity. Among the offending classes are such plants as railroad shops and terminal power plants, municipal light and water stations, ice plants and privately controlled manufacturing plants.

Instruments are necessary aids to efficiency. Their proper selection is of next consideration, and then follows the purchase of instruments that will stand up to the hard use of the boiler plant.

As a specific case take a hand-fired plant containing six 400-hp. water-tube boilers. The boilers are clean internally as well as externally, the settings are in good condition, baffle walls tight, furnaces and grates in good order. The load is more or less fluctuating, and the boilers are frequently operated at 125 per cent rating. The fuel burned is of semi-bituminous structure and grade run-of-mine.

In this plant there is a daily consumption of 76 tons. No instruments are used for checking fuel waste, and after checking the situation with test instruments, it was determined that with proper instruments a 10 per cent saving in fuel could be effected. Coal at $5.15 per ton cost $391.40 per day, $11,742 per month, $140,904 per year. The saving possible is $14,090.40 per year.

The instruments recommended consisted of the following: Three combined draft and CO_2 recorders complete with collecting tanks, $1,342; six 2-in-1 draft gages, $330; three two-record continuous recording flue-gas pyrometers, $1,050; miscellaneous and installation, $200; total investment, $2,922.

The plant had previously been equipped with recording steam and air gages, recording feed-water thermometer, recording steam-temperature thermometer, indicating-recording steam-flow meter and indicating venturi water meter.

The personnel of the plant is composed of men who could be trained to operate the boilers efficiently provided the necessary instruments were furnished, and in a short time would no doubt show savings even in excess of the determinations made.

With the necessary data at hand, the plant owners were advised that with proper equipment the plant could be made to save them $14,090.40 per year in fuel alone by reducing the present preventable waste. To the figures shown, however, no consideration was given, due perhaps to the fact that the idea cannot be grasped by them that by simply adding instruments and training firemen to use them a saving of 10 per cent in fuel can be made. However, in this same plant, very close consideration is given to maintaining the generating engines, pumps, compressors, heaters and all steam lines in good condition. This is commendable, and it is due no doubt to the fact that wastes in the use of steam are more or less readily detected, but the invisible loss of several hundred heat units going out the chimney is just the same.

Many plants employ competent engineers, pay them good wages and expect results. The wide-awake engineer is constantly on the lookout to keep his plant in tune, and yet many a competent man fails to make good, owing to the lack of support given him by his employer, who pays the bill. The waste is passed on to the consumer, who is the general public paying the price to waste our material resources and never stopping to inquire why steps are not taken to reduce this to a minimum.

Hand-fired small plants are still in the majority, and to the owners of such plants we should look for more economy of operation, and to get this an adequate check should be kept from day to day. Instead of CO_2 around 6 per cent, get 12 to 14 per cent; instead of flue gases around 600 to 800 deg. F., get from 400 to 500 deg. It is being done and can be done. Co-operation between owner and engineer will work wonders.

Hagerstown, Md. **Paul R. Duffy.**

Gasket Caused Lubricating Trouble

The following, relative to lubricating troubles with our engines caused by stoppage of pipes, etc., due to an inferior grade of oil, may be helpful to others.

The same lubricant worked very well on another engine of the splash-oiling type while the oil was being used for the first time. After being filtered and used the second time, it became too thick to flow through the pipe leading from the crankcase cover to the main bearing. If two gallons of this used oil remained in a pail for twenty-four hours, there would be about two quarts of oil at the top; the rest would be a thick spongy mass.

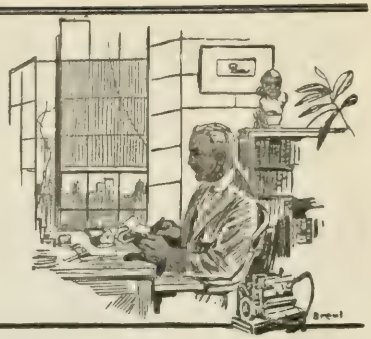
During this time a larger engine of the splash-oiling type was being repaired, and a better grade of oil was obtained so that it would be on hand when this engine was placed in service. When this unit was started up with the new oil, it developed about the same condition, apparently, as with the other oil, only it would thicken up in about twelve hours and before it was filtered. This was surprising, for I knew that the oil was next to the best grade made by the company from which it was purchased. At my request the company sent a representative to our plant, but he could give no reason for the trouble.

When the mechanic who was doing the repair work on this engine was getting ready to start up, he found it necessary to put a new gasket on the cover to the crosshead opening, and as there was nothing else at hand, he used a sheet packing made from some kind of paper and cut it the full size of the cover plate.

The day following the salesman's call this plate was removed for the purpose of inspecting the crosshead and the first thing noticed was that this packing was disintegrating from the action of the oil upon it and small particles which could be rubbed off with the finger resembled the sediment in the oil. This gave me a clue, so the center of the gasket was cut out, leaving just enough to make an oil-tight joint. Then the crankcase and other accessible parts with which the oil came in contact were thoroughly cleaned, fresh oil was put in the crankcase, the engine put in service and our troubles had disappeared. Now we can run the same engine several days without changing the oil.

New York City. **A. K. Vradenburgh.**

INQUIRIES OF GENERAL INTEREST



Running Oil Engine with Cracked Piston—If the piston of an oil engine becomes cracked halfway around the skirt below the pin, would it be safe to run the engine in that condition? E. T.

It would not be safe, as the defective piston probably would break and drop when the engine was running. The piston should be replaced by a new one.

Choice of Refrigerating System—Is a brine-spray or a direct-expansion system more desirable for a beef chill-room? R. H.

The brine-spray system is more popular at present. Its cooling capacity is greater and the danger of ammonia leakage is avoided. It has the disadvantage of causing pipe corrosion due to aëration.

Discharging Steam-Heating Returns to Common Receiver—We are having difficulty in the drainage of high- and low-pressure returns to a common receiver for use of the returns as boiler-feed water. Each system of returns is provided with a separate trap, but the low-pressure returns will not discharge. How can the trouble be remedied? Would not placing a check valve in each return prevent the higher pressure returns from backing up into those of lower pressure? F. B.

Check valves may prevent the returns of higher pressure from backing up into those of lower pressure, but it will be impossible to secure drainage of any return to the receiver unless the receiver pressure is maintained below the delivery pressure of that return. The return main of each system should be connected separately to the receiver, and to insure the delivery of all returns and prevent a higher pressure return from backing up on those of lower pressure, the receiver should be provided with a small vapor pipe discharging to the atmosphere, so as to insure no rise of pressure above the pressure of the atmosphere. The relative waste of heat will be very small and it may be reduced to a minimum by providing the vapor pipe with a small safety valve set to relieve the pressure of the receiver a few pounds below the lowest discharge pressure of any of the returns.

Location of Direct Radiators—Are direct radiators more effective for heating a room when placed along outside walls and at windows than when placed anywhere else in a room? J. E. N.

If the atmosphere of a room could be free of air currents excepting those induced from operation of the radiator, then a radiator of given size would be less effective for obtaining a high average room temperature when placed alongside of an outer wall or at a window than if placed almost anywhere else in the room, because when placed alongside of the outer wall the latter is heated to a higher temperature and there is more rapid transmission of heat to the outside of the building. But in most cases it is desirable to maintain a comfortable temperature of rooms near their outside walls and windows, and the chilling effect of walls and windows must be counteracted without overheating other portions of the rooms; it also is desirable to intercept cold air currents coming through the crevices of walls and windows. If the measure of effectiveness is uniformity of satisfactory room temperature rather than the obtainable average of temperature of different parts of the room, then with ordinary building construction and a sufficiency of heating surface, location of radiators along outer walls and windows will cause them to condense rather more steam, but usually will be found more effective for satisfactory distribution of heat.

Vibration of Steam Gage for Lower Boiler Pressure—Why does the pointer hand of the steam gage on my 90-hp. return-tubular boiler quiver when the pressure is below 80 lb. while running a 12 x 12-in. engine 270 r.p.m.? The gage is steady when the pressure is above 85 lb. W. H. P.

The pointer quivers because of sudden reduction of the boiler pressure at each stroke of the engine while taking steam. For the same load the engine takes from the boiler a larger volume of steam per stroke when the pressure is lower, and consequently there is greater lowering of the pressure and greater vibration of the gage pointer. The quivering can be dampered by slightly throttling the stop cock of the gage, and the flow of steam from the boiler can be made steadier, with less fluctuation of the boiler pressure by providing a receiver in the line between the boiler and engine.

Content of Horizontal Cylindrical Tank—How many gallons of a liquid would be contained by a cylindrical tank 7 ft. in diameter and 26 ft. long, laid horizontally, when filled with the liquid to a depth of 32 in.; and also to a depth of 65 in.? V. C. R.

For a tank 26 ft. long with flat ends, each square inch of cross-sectional area would represent a capacity of (26 × 12) ÷ 231 = 1.351 gal.

When the liquid is of less depth than one-half the diameter of the tank, the form of cross-section of the contained liquid would be a segment of a circle, the area of which is given by the formula,

$$\text{Segmental area in sq.inches} = \frac{4H^2}{3}\sqrt{\frac{2R}{H} - 0.608}$$

where H is the height of segment in inches and
R is radius of tank in inches.

Calling $H = 32$ and $R = (7 \times 12) \div 2 = 42$, by substitution the formula becomes

$$\text{Segmental area in sq.inches} = \frac{4(32)^2}{3}\sqrt{\frac{2 \times 42}{32} - 0.608}$$

= 1,938.8 sq. in.
and for 32 in. depth the liquid content would be 1,938.8 × 1.351 = 2,619.3 gal.

When the tank is completely filled, the cross-sectional area of the contained liquid would be 84 × 84 × 0.7854 = 5,541.8 sq.in. When filled to a depth of 65 in., the cross-section of the unfilled space above the surface of the liquid would be a circular segment 84 − 65 = 19 in. high, having an area of

$$\frac{4 \times (19)^2}{3}\sqrt{\frac{2 \times 42}{19} - 0.608}$$

= 939.5 sq.in.; hence the cross-sectional area of the liquid filled to a depth of 65 in. would be 5,541.8 − 939.5 = 4,602.3 sq.in., and when filled to that depth the tank would contain 4,602.3 × 1.351 = 6,217.7 gal.

Effect of Fittings on Flow of Liquid Through Pipe Lines*

By DEAN E. FOSTER

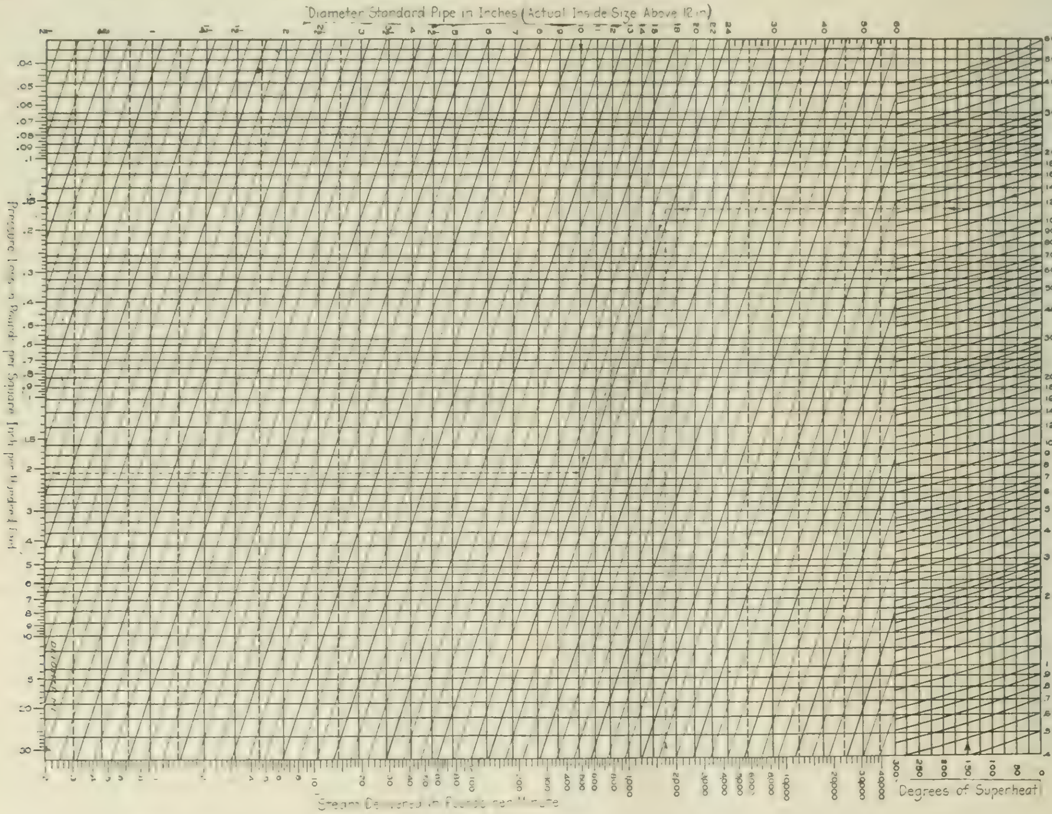
IN THE layout of piping in power plants and heating systems the engineer is frequently confronted with the problem of the proper allowance to make for the effect of the fittings on the flow of gases and liquid. In the writer's work he has used the charts and tables given in "The Mechanics of Heating and Ventilation," by Konrad Meier. They are, however, objectionable on account of the time required in using them. It is not a difficult matter to formulate the relation existing between the resistance of fittings and the resistance of piping. For the flow of water Mr. Meier gives

$$H_f = \frac{0.0257}{2g} \times V^{1.86} \times \frac{L}{d^{1.25}}$$

the resistance offered to flow by fittings

$$H_r = 1.38r \times \frac{V^{1.86}}{2g}$$

where H is loss of pressure in feet; L is length in feet; H_r is loss of pressure per fitting; r is a factor depending on the shape of the fitting; d is the pipe diameter in inches; V is the velocity in feet per second. Combining these two equations, the following is obtained: $Le = 53.75 \times rd^{1.25}$. where Le is the number of feet of pipe equivalent in resistance to a fitting.



GRAPHICAL SOLUTION OF BABCOCK'S FORMULA FOR FLOW OF STEAM THROUGH PIPE

Table I is based on this equation and may be used for oils of 32 Baumé or higher and for water.

For the flow of high-pressure steam through pipes Mr. Meier gives the equation,

$$P_f = \frac{W}{144} \times 0.0257 \times \frac{V^{1.95}}{2g} \times \frac{L}{d^{1.2}}$$

Where P_f is the pressure in pounds per square inch re-required to overcome fractional resistance. For the resistance of fitting he gives

$$P_r = \frac{W}{144} \times 1.12r \times \frac{V^{1.95}}{2g}$$

combining the two equations

$$L_e = 43.7\ rd^{1.2}$$

The author assumes that the loss of gas or air and steam losses through fitting do not differ to any extent and feels that the equivalents in Table II apply to all three.

Many charts and diagrams for the quick determination of steam pipe sizes have been published, but they have all been constructed under the assumption that dry saturated steam was the fluid to be carried. The accompanying chart, however, solves problems involving the carrying of either dry saturated or superheated steam. In order that its use may be clear the following case has been assumed, the pressure loss in pounds per square inch per 100 ft. being desired:

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*Extract of paper read before the American Society of Mechanical Engineers at annual meeting, Dec. 7-10, 1920.

Average steam pressure in line....	140 lb. abs.
Superheat	150 deg.
Amount of steam to be delivered...	1,700 lb. per min.
Size of pipe........................	10 in. standard

TABLE I. EQUIVALENT LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING NON-VISCOUS LIQUIDS

Formula Used: $L_e = 53.75rd^{1.25}$

Nominal Pipe Size, In.	Actual Inside Diameter, In.	Gate Valve	Long-Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size ¼	Standard Elbow or on Run of Tee Reduced in Size ½	Angle Valve	Close Return Bend	Tee Through Side Outlet	Globe Valve
Factor of Resistance......		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
½	0.662	0.335	0.442	0.56	0.89	1.20	1.34	1.79	2.68
¾	0.824	0.475	0.627	0.79	1.27	1.71	1.90	2.52	3.80
1	1.049	0.640	0.844	1.07	1.72	2.30	2.56	3.40	5.12
1¼	1.38	0.902	1.19	1.51	2.42	3.24	3.61	4.80	7.22
1½	1.61	1.09	1.43	1.83	2.92	3.92	4.36	5.79	8.72
2	2.06	1.49	1.96	2.50	3.99	5.36	5.96	7.92	11.92
2½	2.46	1.86	2.46	3.13	5.00	6.72	7.47	9.93	14.94
3	3.06	2.46	3.25	4.11	6.66	8.87	9.86	13.11	19.72
3½	3.54	2.92	3.80	4.91	7.84	10.53	11.70	15.56	23.40
4	4.026	3.44	4.53	5.77	9.22	12.37	13.70	18.28	27.50
4½	4.506	3.95	5.20	6.63	10.60	14.22	15.80	21.01	31.60
5	5.047	4.57	6.00	7.68	12.20	16.47	18.30	24.33	36.60
6	6.065	5.72	7.55	9.61	15.30	20.61	22.90	30.45	45.80
7	7.024	6.90	9.10	11.59	18.50	24.84	27.60	36.70	55.20
8	7.981	8.10	10.69	13.60	21.70	29.16	32.40	43.09	64.80
10	10.020	10.70	14.10	17.97	28.70	38.52	42.80	56.92	85.60
12	12.090	12.50	17.80	22.68	36.20	48.60	54.00	71.82	108.00

In the solution shown the chart is entered on the horizontal line representing 150 deg. of superheat. This line is followed to the left until it intersects the curve representing 140 lb. pressure. From this intersection the dashed vertical line is followed down to its intersection with the horizontal dashed line representing 1,700 lb. of steam. From this intersection the inclined dashed line is followed to its intersection with the horizontal line representing 10-in. pipe. The vertical thus determined gives the loss required as 2.08 lb. per 100 ft. Had a 12-in. pipe line been used, the loss would have been only 0.81 lb.

The chart can be used for the solution of any case where four of the variables are known and the fifth is to be determined. For the solution of problems involving dry saturated steam, enter the chart at the top at the point representing the pressure assumed and follow a vertical line from this point to its intersection with a horizontal representing the desired quantity of steam. The remainder of the solution will be the same as outlined for superheated steam. If the part representing superheated steam were omitted, this chart would be very similar to one constructed by H. V. Carpenter, Mem. Am. Soc. M. E., and published a number of years ago in *Power*.

Discussion by Professor Giesecke

Professor Giesecke, of the University of Texas, challenged the fundamental principle of the paper, the substitution of an equivalent length of straight pipe for a fitting, on the score that the loss in the fitting follows an entirely different law, with respect to velocity, from that in the straight pipe. He quoted, as authority, tests made by him at the University of Texas in 1912-13 and 1916-17, recorded in bulletin No. 1790 of the University. Mr. Foster admitted this point, but claimed that his relations were approximately true for the range of velocities commonly used in practice. He then made two interesting additions to the discussion. The first of these was that the larger the pipe diameter the more noticeable the losses in fittings compared to those in the straight pipe. This, he explained, was because the loss in the fittings is due to eddies, which are the result of pressure difference between the inside and the outside of the bends; and that this pressure difference becomes greater and the paths of the eddies of greater cross-section, as the diameter of the fitting increases. His second point was that increasing the radius of curvature of a long-sweep bend does not necessarily decrease the loss in that bend, as this loss is a function both of the rate of change of direction of flow and of the duration of this change of direction; that the first factor decreases as the radius of the bend is increased, but the second one increases with the length of the bend and therefore with its radius. There is a certain radius for which the loss in the bend is minimum.

TABLE II. LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING STEAM, AIR, OR GAS

Formula Used: $L_e = 43.7rd^{1.2}$

Nominal Pipe Size, In.	Actual Inside Diameter, In.	Gate Valve	Long Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size ¼	Standard Elbow or on Run of Tee Reduced in Size ½	Angle Valve	Close Return Bend	Tee Through Side Outlet	Globe Valve
Factor of Resistance......		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
½	0.622	0.031	0.41	0.52	0.84	1.12	1.25	1.66	2.50
¾	0.824	0.044	0.57	0.73	1.17	1.57	1.75	2.33	3.50
1	1.049	0.057	0.77	0.98	1.57	2.11	2.34	3.11	4.68
1¼	1.380	0.082	1.07	1.37	2.19	2.94	3.27	4.35	6.54
1½	1.610	0.098	1.29	1.64	2.63	3.52	3.92	5.21	7.84
2	2.067	1.32	1.74	2.23	3.55	4.77	5.30	7.05	10.60
2½	2.469	1.64	2.16	2.75	4.39	5.91	6.56	8.71	13.12
3	3.068	2.13	2.81	3.59	5.72	7.69	8.54	11.40	17.08
3½	3.548	2.53	3.34	4.26	6.80	9.10	10.13	13.50	20.26
4	4.026	2.96	3.90	4.97	7.94	10.65	11.84	15.75	23.68
4½	4.506	3.27	4.45	5.66	9.05	12.14	13.50	17.95	27.00
5	5.047	3.88	5.11	6.42	10.40	13.95	15.51	20.60	31.02
6	6.068	4.81	6.35	8.09	12.90	17.35	19.27	25.60	38.54
7	7.023	5.75	7.59	9.66	15.40	20.70	23.02	30.60	46.08
8	7.981	6.70	8.85	11.20	17.90	24.10	26.80	35.60	53.60
10	10.02	8.75	11.54	14.70	23.40	31.50	35.00	46.60	70.00
12	12.09	10.90	14.40	18.35	29.30	39.30	43.70	58.10	87.40

Public Utility Development in California

Expressing its belief that never again will California face as serious a power situation as that created in 1919-20 by the rare combination of the excessive demand for electric power with a minimum supply, the latter condition being due to three years of scanty rainfall, the Railroad Commission of California, in its report to Governor W. D. Stephens, tells of utility development work now going on in the state. Referring to the fact that utilities early in 1919 began to carry out hydro-electric construction plans interrupted by the war, the commission lists projects under way which, completed, will add 275,000 kw. to the state's output of electric power. Of this power 250,000 kw. is hydro-generated and 25,000 steam-generated.

According to the report of the commission, the San Joaquin Light and Power Corporation, Southern California Edison Co., Great Western Power Co. and the Southern Sierras Power Co., also the City of Los Angeles, in July, 1920, were actively engaged in increasing plant capacities to meet demands for electric energy.

The San Joaquin Light and Power Corporation recently completed its Kerckhoff[1] plant on the San Joaquin River, a plant designed to have a capacity of 30,000 kw. This corporation also completed a 12,500-kw. addition to its steam plant at Bakersfield[2], the plant using natural gas from the Midway gas fields as fuel. In addition to these developments it is completing at 100,000-volt transmission line from its Kerckhoff development to McKittrick and has plans under way for the installation of a 12,500-kw. steam plant near the gas fields, to be completed before summer.

The Southern California Edison Co. has also been active in the development of power. It has been engaged in the completion of its Kern No. 3 power plant, of 30,000 kw., on the upper Kern River, which should be completed early in 1921. This plant has no storage facilities and depends entirely upon stream flow; it should have an average output of at least 150,000,000 kw.-hr. annually.

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[1] See *Power*, Dec. 14, 1920. [2] See *Power*, Dec. 7, 1920.

The Edison Co. should complete late in 1920 an additional unit of 17,500 kw. to its Big Creek No. 2 plant. It has under construction, for completion in 1921, a diverting dam and tunnel from Shaver Lake reservoir to its Big Creek No. 2 plant, which should be completed in the fall of 1921, and is carrying on the construction of a third plant on Big Creek of 25,000 kw. capacity, known as Big Creek No. 8. Other plans of the company contemplate commencement of work to bring to the Huntington Lake reservoirs waters from the south fork of the San Joaquin River, through a tunnel approximately ten miles in length and requiring several years to complete.

The Great Western Power Co. is actively engaged in construction work on its Caribou development. The first unit of the plant, totaling 40,000 kw. capacity, is expected to be in operation early in 1921. The development consists of tunnels diverting the waters from Lake Almanor to Butt Creek, and additional tunnels from Butt Creek along the mountainside to a point where the water will be dropped through penstocks to the Feather River below, a difference in elevation of 1,140 ft. The first is being so constructed that two more units, bringing the total to 80,000 kw., may be added before increased capacity will be required.

The Southern Sierras Power Co. has also been active in the construction of its Levining Creek plant of 10,000 kw., which will not be completed until the fall of 1921. It also has under construction its Adams plant, in the Owens River gorge, of 2,500 kw., to be in operation in the spring of 1921. During the past this company has reinsulated its entire transmission line so as to transmit energy at 85,000 volts, and is now operating the line at that voltage.

The City of Los Angeles has recently completed its San Francisquito No. 2 plant on the aqueduct near Saugus, with a capacity of 20,000 kw. It also is contemplating the completion of its San Fernando and Franklin Canyon plants, which will further enlarge its capacity.

The Los Angeles Gas and Electric Corporation is adding a 10,000-kw. steam unit to its equipment.

The Pacific Gas and Electric Co., serving most of northern California, did not begin construction of any hydro-electric plant until 1920, when work was started on a 12,500-kw. unit to be added to its Oakland steam plant and to be in operation by the winter of 1920. It has also started construction work upon two 10,000-kw. hydro-electric plants on Hat Creek, a tributary of Pitt River, and has plans under way for the construction of a 60,000-kw. plant on the Fall River. It has also commenced work upon a 220,000-volt transmission line to transmit the power thus produced from the Pitt River, some 250 miles or more, to the San Francisco Bay district. This new line will be the highest-voltage transmission line so far to be constructed in the United States. A small plant of approximately 9,000 kw. on the Stanislaus River, to be known as Spring Gap, is expected to be installed by the summer of 1921.

Motor-Fuel Symposium

Four prominent speakers and an extended discussion aroused a great deal of interest at the 312th meeting of the Chemical Society of Washington, Thursday, Dec. 9, when the entire program was devoted to a symposium upon the present status and future prospects of motor-fuel supply.

R. W. Ambrose, Chief Petroleum Technologist of the Bureau of Mines, discussed petroleum products for motor-fuel supply. He described the three classes of investigators of this subject as pessimists, optimists and super-optimists. The pessimist believes the problems cannot be solved; the super-optimist believes there is no problem. Neither of these classes is right in Mr. Ambrose's opinion. The optimist believes that there is a problem of difficulty, but that it can be solved by proper planning.

The present gasoline requirements of the country indicate a need for from 4 to 4.5 billion gallons of motor fuel for 1921. This represents many times the demand of ten years ago, but the crude oil available from domestic production is only about twice that of ten years ago. The output of motor fuel has been increased from petroleum by better recovery of crude, by higher-percentage recovery of motor fuel during refining and by conservation in use of fuel. Efficiency on the part of the ultimate consumer is the most promising means of relief of the shortage.

Shale-oil development, still in its infancy as a commercial business, offers little encouragement for the present, because of the difficulty of economical retorting to secure an easily refinable product for motor-fuel production.

Coal-Tar Products as Motor Fuel

W. M. Rile, of the Barrett Co., discussed the subject of coal-tar products as a source of motor fuel, especially motor benzol. This is really a mixture of benzol, toluol and xylol. Typical specifications for motor benzol are: 0.878 specific gravity, neutral reaction, sulphur not exceeding ¼ per cent, ability to pass the "doctor" test and the gumming test, and distillation as follows: First drop 79 to 80 deg. C., 60 per cent below 100 deg. C., 90 per cent below 121 deg. C., dry at 135 deg. C., with no appreciable residue. Because of the greater vapor tension at a given temperature and materially higher heating value of benzol per gallon as compared with gasoline, distinct advantages in the way of thermal efficiency and miles per gallon are experienced. However, under present conditions the total available motor benzol supply of the country, even if all light oil from byproduct coking and city gas plants equipped for light-oil recovery be included, is barely 2½ per cent of the gasoline requirements of the country. By extreme measures, including byproduct recovery from all coal coked, stripping of all city gas supplies for light oil and other increases to be expected during the next few years in these lines, we cannot anticipate that much over 5 to 10 per cent of the gasoline demand of today will be met from motor benzol, as this term is now used.

Industrial Alcohol

Industrial alchohol as a motor fuel was discussed by B. R. Tunison, of the Industrial Alchohol Co. The present output of this product, which might conceivably be diverted into motor-fuel use if the requirements for solvent and chemical operations were ignored, is approximately the same order of magnitude as the total available motor benzol. The estimated industrial-achlohol plant capacity of the entire country is only about 100 million gallons per year, or about 2½ per cent of the motor fuel requirement of today.

The carburetion characteristics of alcohol, benzol and gasoline were contrasted by Dr. Tunison, and it was shown why the blended fuels including some of each of these three constituents could be expected to give superior motor performance. The great advantage of alcohol for motor use is that it fires quickly, but does not increase its rate of burning as much during combustion as do the other motor fuels. Moreover, the range of full air ratio for successful operation is wider with alcohol than with either benzol or with gasoline. Alcohol also permits much higher compression ratios, thus giving large possible increase in efficiency under the most favorable conditions, but it is not under normal circumstances best applied alone. It lends itself rather to the blended-fuel application.

Forest products as a source of alcohol for motor fuel were discussed in a paper prepared by C. Sherrard, of the United States Forest Products Laboratory, presented by Dr. H. F. Betts, of the Forest Service. The possibilities of alcohol production from wood waste were fully set forth. It was pointed out that this was one of the most promising sources of cheap raw material for industrial-alcohol production. The estimates indicated that about fifteen gallons of alcohol could be expected under ordinary conditions of plant operation per ton of wood treated. The investigations of the Forest Products Laboratory on the best conditions for cooking of wood pulp with acid as the initial stage in alchol production were also discussed in this paper.

Austria's monthly requirements of coal are estimated to be 1,156,600 tons, of which only about 15 per cent can be produced within the country itself.

Practical Refrigerating Engineers Meet in Chicago

DECEMBER 13 to 16 at the Hotel Sherman, Chicago, the National Association of Practical Refrigerating Engineers held its eleventh annual convention. The attendance was exceptionally good, coming principally from Kansas City and the states of the Southwest, where the association was formed. The program was so full that it was difficult to work in all the papers scheduled. The new Chicago subordinate organized last year is to be congratulated on the arrangements made for the convention and credit is due President Kloss, of Kansas City, for his businesslike conduct of the proceedings.

It should be stated that the association is rapidly gaining headway in the refrigerating field. With a Kansas City chapter added two years ago and a large subordinate organized in Chicago in 1920, it is the intention to branch out still more during the coming year. With Philadelphia chosen as the next convention city the rich refrigerating territory of the East is to be invaded and there are high hopes of enlarging what was originally a Southern organization into a broad national body thoroughly representative of the practical refrigerating engineers of the entire country and devoted to their education and general betterment.

At the first session Monday the usual addresses of welcome, the responses and routine business were followed by a paper on "Combustion," by Joseph W. Hays, who reviewed briefly the elementary theories of combustion and spoke of the losses that might occur. It was his thought that there was danger of making the record system too complicated and that instruments were of no avail unless their indications were carefully analyzed and digested. In obtaining combustion efficiency about 10 per cent was due to instruments and 90 per cent to operation. The discussion on the paper turned to the proper height of the boiler above the grate, the height of the bridge wall, the choice of baffling, whether horizontal or vertical, when burning oil or coal, and other practical problems.

Powdered Coal and Its Application to Industry

Milton W. Arrowood talked on powdered coal. He called attention to its application in various industries and its burning in boiler furnaces. In this connection he emphasized the importance of mixing the pulverized coal and the air for combustion in proper proportions before the fuel reached the furnace, cutting down in this way the large volume now considered necessary to receive the gases of combustion and to give the proper time interval for burning. With a proper mixing device less excess air would be needed in the furnace, reducing the loss in the flue gases, and by reducing the volume of the gases, giving a longer time interval for the boiler to absorb the heat. The fuel from the mixing device was injected horizontally into the furnace at low velocity. There was no impingement on brickwork and no formation of slag on the tubes. In view of the fact that each particle of coal requires for combustion eight to ten thousand times its own volume in air, the speaker pointed out the importance of mixing the coal and air outside the furnace to avoid the probable stratification that would take place when this mixing was attempted in the furnace. The suggestion was offered that ice plants might enter a new field by pulverizing coal for their own use and for outside consumption, as it was the speaker's opinion that powdered coal would be widely used in the near future, especially if it could be supplied as readily as other forms of fuel.

George H. Trout, director of the Smith Gas Engineering Co., gave an interesting address on "Gas Power for Ice-Making and Refrigerating Machines." The fields for gas power were reviewed and mention made of the limitations imposed on the cost of the prime mover by the load factor of the plant. Reference was made to the Smith gas producer as recently perfected, its ability to gasify bituminous coal, lignite or most any kind of fuel, the producer capacity in service and records for length of operation without shutdown. One producer had operated continuously for 280 days, and mention was made of a gas engine that had given continuous service for 84 days. With producer gas utilized by a gas engine as high as 25 tons of ice per ton of coal had been produced. From a ton of lignite 12 tons of ice had been made.

At the Tuesday morning session "Oil Engines as Applied to Refrigerating Machinery" was the topic discussed by J. D. Harper, of the Fairbanks-Morse Co. In making a choice of prime mover the selection was a problem to be decided for each individual plant. Location near an oil field was often a determining factor and there were merits in electric drive that should not be overlooked. In the past the oil-engine manufacturer had dwelt too much on theoretical efficiency and not enough on durability and records of service in refrigerating plants. There had been a great advance in the modern oil engine and its use had been extended.

For units exceeding 400 hp. the prime mover to adopt was the Diesel engine, the speaker claimed, and where the power requirements were 300 hp. or less, or where the load factor was such that the total power might be separated into units of this size or less, the surface-ignition engine gave the best results. It was usually a two-cycle valveless machine of staunch construction and had the advantage of using dirty oil, such as American fuel oil, with minimum attention. As to reliability, citation was made of engines that had run from 50 to 250 days without stopping. The operating cost ranged from ⅜ to ½c. per horsepower-hour, so that in order for purchased current to compete it must be bought at ¾c. per kilowatt-hour or below.

The Unaflow Steam Engine

In an elementary talk Robert Cramer explained the principles of operation of the Unaflow steam engine, illustrated its construction, and showed how its remarkably flat steam curve was due to the elimination of cylinder condensation. One of the essential requirements was that the cylinder heads should be steam-jacketed. Steam rates ranged from a shade over 10 lb. to 23.5 lb. per indicated horsepower-hour. Owing to the high uniform economy over a wide range of load, the Unaflow engine had reclaimed part of the steam-engine field. The compound engine could be built to give better economy at a particular load, but with only slight variations the efficiency dropped rapidly, so that for general service the Unaflow engine maintained a much higher average efficiency.

Thomas C. McKee, representing the Carbondale Machine Co., traced the development of the high-speed ammonia compressor which had been made possible by the use of the feather valve. The merits of the feather valve were brought out and details given on the construction, lubrication and general advantages of the compressor. In the discussion the fact was brought out that more clearance was required than in the old slow-speed machines. A loss in efficiency, however, was not sustained as it was merely a case of speeding up the compressor one revolution per minute to maintain the same economy. The extra gas gave back as much energy in expanding as was required to compress it.

Following was an interesting paper on the "Present Status of the Two-Stage Ammonia Compressor," by Harry Sloan, advisory engineer of the Vilter Manufacturing Co. Introducing the subject, Mr. Sloan reviewed the evolution of the two-stage air compressor and the application of the same principles to refrigeration. There had been certain developments up to 1880, when the question of compounding ammonia compressors was brought to a standstill, as it was generally considered that the higher economy did not more than offset the additional overhead on the initial investment. The general use of booster outfits for low-temperature work finally gave impetus to the movement, so that eventually D. I. Davis brought out the two-stage ammonia compressor. The advantages of the machine as well as those of the plate valves employed were enumerated, and the construction shown by numerous slides. Practical results from machines in service showing high economy were given. The gain in efficiency from the compound compressor was due to the lower temperature range per cylinder and to intermediate cooling. A 20 per cent saving in power per ton of refrigeration was readily possible and a steam rate of 24 lb. per ton of refrigeration had been obtained.

At the Tuesday afternoon session H. T. Whyte, superintendent of ice factories of the Consumers Co., summarized briefly the results obtained by adding a Voorhees multiple effect device of two of the company's ammonia compressors. This device admitted suction gas to the compressor cylinder at two different pressures, the low-pressure gas entering first and eventually the high-pressure gas, giving the cylinder a denser charge and increasing from 25 to 35 per cent the theoretical capacity of the compressor. In actual operation in the plant there has been a diminution of 3 per cent in the power required per ton of ice and an increase of 20 per cent in ice produced. The machines were electrically driven and required 47.6 kw.-hr. per ton of ice.

C. W. Koehler, general engineer, Booth Fisheries Co., traced the cycle of operation in an absorption system and brought out many points that would effect economy in operation. Gilbert Sellers, chief engineer of the South Chicago Ice Plant, spoke on the manufacture of raw-water ice, giving the results of his early work in this line with a small experimental plant of his own making and later with one of the early raw-water plants remodeled according to his own design. The difficulties encountered were numerous, but excellent results had been obtained until air agitation and treatment of the water by the cold process gave nearly as good results in a simpler way.

Electrical Drive for Refrigerating Machinery

"Electrical Drive for Ice-Making and Refrigerating Machines," by William J. Bray, sales engineer of the General Electric Co., was the first paper Wednesday morning. It was a comprehensive treatment covering the entire electrical installation. Particular attention was given to slip-ring induction motors and to the advantages of synchronous-motor drive. In comparing slow-speed belted compressors with direct-connected high-speed compressors equipped with plate valves, the obvious advantages were saving in floor space, elimination of belt trouble, and higher efficiency. At full load the smaller synchronous motors used had shown an efficiency of 91 per cent. In machines of 800 or 1,000 hp. capacity the efficiency increased to 94 per cent. Below 100 hp. slip-ring induction motors were desirable.

W. J. Hughes, of the International Filter Co., gave an elementary talk on the "Treatment of Water for Raw-Water Ice." Following a simple explanation of the properties of water and its chemical constituents, he showed the relation of water purification to fuel conservation. Comment was made on the different salts in water with which it is necessary to contend when making raw-water ice. Analyses of water before and after lime treatment were given. Softening water by the Zeolite process was shown to be unsatisfactory for ice making. The character of the different scale-forming ingredients in the water and the losses caused thereby were given brief attention, and in conclusion details on the construction and operation of International softeners.

F. C. Pedley, of Dubuque, Iowa, brought out various factors in the engine and boiler room affecting economy in ice-making and refrigerating plants. He was followed by Charles M. Gilbert, president of the Midwest Engineering Co., who enumerated briefly the things to do when overhauling and rehabilitating ice plants.

On Wednesday afternoon the first order of business was the election of officers, with the following results: President, C. W. Koehler, Chicago; first vice-president, F. L. Brewer, West Tulsa, Okla.; second vice-president, J. E. Lawrence, Dallas, Tex.; secretary, Edward H. Fox, Chicago; treasurer, W. R. Ilch, Kansas City; sergeant at arms, Roy Noyes, Chanute, Kan.; board of directors, E. J. Dean, Philadelphia; Norman Register, Dallas, Tex., and W. W. Stevens, Los Angeles, Cal.; chairman publicity committee, E. H. Fox, Chicago; chairman educational and examining committee, J. E. Porter, Oklahoma City, Okla.

Refrigerating Standards

The remainder of the session was devoted to refrigerating standards. J. E. Porter made a strong plea for the standardization of ammonia fittings. With some 25 to 30 different companies manufacturing ammonia fittings, each company is putting out a different fitting and many of them have changed the design several times, with the result that the situation is growing steadily worse instead of better. It was his recommendation that the association unite with the American Society of Refrigerating Engineers and the various ice-manufacturing associations to bring about standard conditions in this field. In the discussion a letter was read from the secretary of the American Society of Refrigerating Engineers reviewing the efforts already made by that society without avail. A representative of the Crane Co. called attention to the fact that his company had adopted the extra-heavy steam standard so that refrigerating engineers already had a standard from the flange, bolting and metal thickness points of view.

A motion was made that the incoming president appoint a committee of five to study the standardization of fittings, and a resolution was passed that the society express its opinion that all ammonia valves and fittings be standardized, so that valves and fittings of all makers would be interchangeable, a copy of this expression to be sent to all manufacturers of this equipment.

For the general interest of the association Gardner T. Voorhees spoke of the work of the joint committee of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers in establishing a standard ton of refrigeration, 288,000 B.t.u., and a standard commercial ton of 200 B.t.u. per minute. Later on attention was called to the code for the regulation of refrigerating machines and refrigerants tentatively adopted by the American Society of Refrigerating Engineers. Requests were made for copies of this code, instructions given that the secretary mail to each member a copy for study and that the chairman of the standards committee represent the association on the joint code committee of the various societies interested.

H. C. Johnson, inspector, department for the inspection of steam boilers, steam and cooling plants, City of Chicago, reviewed the Chicago code for the installation and regulation of refrigerating machinery. He gave particular attention to the penalties, rules applying to cylindrical shells, and to the ten points requiring specific attention when inspecting the plant.

Local Examining Boards

On Thursday morning J. D. Porter, chairman of the educational committee, urged that the association create local examining boards in each of the subordinates. A personal interview would give a better line on the ability of the applicant and facilitate the issuing of certificates. The National Examining Board was to be retained and would issue the certificates upon recommendation from the local board. The suggestion was favorably received and will be put into effect. The rest of the day was spent in excursions to plants of interest to refrigerating engineers.

In the way of entertainment a theater party was tendered to all members by the Chicago Subordinate on Monday evening. There was a smoker and entertainment Tuesday evening at which music and vaudeville acts were interspersed with motion pictures showing the manufacture of wrought-iron pipe and the production of petroleum lubricants. R. A. Griffin, of the Reading Iron Co., presented the former and C. M. Larson, of the Sinclair Refining Co., showed the lubricant films. On Wednesday evening was held the annual banquet, which was an unqualified success. Complimentary to an older association closely allied in the work of educating the engineer, Fred Raven, secretary of the National Association of Stationary Engineers, was requested to act as toastmaster.

American Engineering Council Holds First Meeting

Herbert Hoover, president of the Federated American Engineering Societies, presided at the Executive Board meeting held in New York, Dec. 17, of American Engineering Council, which is the governing board of the Federation. Every member of the Council was present with the exception of A. M. Greene, and two new members of the board were elected—W. B. Powell, of Buffalo Engineering Society, representing District No. 1, New York and New England States, and Gardner S. Williams, Grand Rapids Engineering Society, representing District No. 2, Michigan, Wisconsin and Minnesota.

The president appointed standing committees: On Procedure, Constitution and By-Laws, Publicity and Publications, Membership and Representation, Finance, and Public Affairs.

In discussing the program of the Council immediately ahead, Mr. Hoover stated that he had called engineers together in various cities he had visited lately, and that he found that the general desire of engineers everywhere was to join in the Federation movement, but that the general trend was for territorial organization, as distinguished from national organization. One of the stumbling blocks in the way of these territorial organizations' joining the national organizations was the question of dues. Another complexity was that individuals hold memberships in more than one society. For example, the Western Society of Engineers has about four thousand members, of which three thousand are already members of national societies who have affiliated with the Federation. Mr. Hoover also stated that there had been some opposition to the Federation based on the constitution, but that the question of territorial organization was the most important, and he suggested that a committee should be appointed to canvass and help the situation. This question was discussed and referred to a special committee, which will include the six district delegates.

As a step forward in co-ordinating various intersociety activities already established, the necessary action was taken to make it possible for certain of the activities of Engineering Council to be taken over by the new organization. As soon as the United Engineering Societies have passed officially upon Engineering Council's proposed action to transfer the work of its committees who have not yet finished their work, the president will appoint the necessary committees of American Engineering Council to take over this work. At the meeting of Engineering Council held in Washington there was harmony of all the member societies to this end. In this connection action was taken to amend section 9, paragraph 6 of the by-laws so that members of committees can be selected from societies other than those at present members of the Federation. Civil engineers and engineers in other bodies not at present affiliated with the Federated American Engineering Societies can, because of this action, co-operate in the committee work.

The four so-called founder societies in addition have been associated in a common employment service, and American Engineering Council has offered to take over this service as a part of its function.

American Engineering Council in this meeting voted not to affiliate with the United States Chamber of Commerce. It was the thought of the meeting that the Council could make its best contribution to the public by acting independently of other organizations.

The Council authorized the appropriation of one thousand dollars as an initial fund to carry on publicity work, and the Committee on Publicity and Publications was given authority to set up a board of engineering editors.

It was voted that full expenses of members of the Executive Board for attendance at meetings would be paid.

A special committee reported on candidates for permanent executive secretary of the organization, but no final action was taken at the meeting.

There was a general feeling expressed that the meetings of the board should be held at different centers, and the place of the next meeting, which will be held Feb. 11, was after considerable discussion left to the discretion of the president.

Annual Meeting of the American Society of Refrigerating Engineers

The annual meeting of the American Society of Refrigerating Engineers was held at the Hotel Astor, New York City, Dec. 6-8. The Monday morning session was devoted to the business of the society, the Council report being received and the officers for the new year elected. Fred Ophuls, of the engineering firm of Ophuls, Hill & McCreery, was elected president. Mr. Ophuls is one of the most prominent refrigerating engineers in the country and has been a member of the Council for a number of years.

At the afternoon and evening meetings a number of papers were presented and discussed. Among these were papers on the "New Ammonia Tables of the Bureau of Standards," and on "Total Heat Diagrams and Clearance Volume Meters," which will appear in *Power*.

The Tuesday sessions were devoted to papers on practical refrigerating problems. A paper by H. C. Newlean on concrete brine tanks occasioned lengthy discussions. It was borne out by means of numerous diagrams that the sand to gravel ratio and the water percentage were the determining factors in the construction of concrete tanks. The speaker stated that the gravel and sand should be screen-tested to determine the correct ratio. He claimed that failure to secure proper proportions reduced concrete compression strength as much as 50 per cent.

The subject of pipe welding was covered by two papers, one on the "Thermite Process," by R. L. Browne, and one on "Electrical Welding as Applying to the Resistance Method," by J. H. Gravell. It appeared from the paper that electrical welding of pipe was practical only in cases where a large number of joints were to be welded. Its most successful application was stated to be in plate welding. Thermite welding was stated to be uniformly successful in the welding of pipe. A demonstration of the case of the thermite process was made before the society, pipe ends being welded together in a few seconds. The joints were free from internal decrease of area and were apparently perfect. The cost per weld was said to range from one to two dollars, depending on the pipe size, the size range being from one to six inches.

The question of "Pressure Relief Diaphragms" was taken up and fully discussed. The increasing popularity of the small family refrigeration machine compels the incorporation of some safety device in the design. Diaphragm relief valves seemed to be considered most feasible, but the questions of diaphragm form and support are still matters of experimentation. The author of the paper, H. E. Willsie, rather inclined to favor the design where the support had rounded edges and the rupture occurred in the center of the diaphragm.

The final sessions were taken up by the discussion of papers on "Pipe Corrosion," "Use of Refrigeration in Air Conditioning," "Brine Propellers" and "Electric Rates." The paper on pipe corrosion in refrigeration systems aroused much comment. The author, F. N. Speller, stated that as the result of a great many tests extending over a number of years it was proved that steel, iron and piled tubes corroded at the same rate. He further discussed the causes of the corrosion in piping and felt that it had been amply proved that the free oxygen in the pipe lines caused the trouble. This had been solved in many instances by inserting iron perforated sheets in a tank connected to a pipe system. The free-oxygen coming into contact with these sheets before entering the pipe lines produced their corrosive effect on the sheets.

Two or three members took exception to the statement as to the uniformity of corrosion in steel and iron tubes. It was claimed that in certain plants the steel condenser tubes were destroyed in half the time required by the iron tubes. Mr. Speller felt that conditions other than corrosion or inequality in exposure to corrosive agents caused this decrepancy in life.

Plans are being made to utilize the peat in the moorlands of Esthonia and Latvia. These bogs have a total area of 4,300 square miles. It is estimated that coke from this source will cost but one-fifth as much as imported coke.

Power House Engineer Wanted by the Government

The United States Civil Service Commission has announced an open competitive examination for power house engineer. A vacancy at the United States Military Academy, West Point, New York, at $1,200 a year, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion. After six months' satisfactory service appointees may be allowed the increase granted by Congress of $20 a month. The duties of the appointee will be to take charge during his watch of the plant, consisting of boilers of 3,000 hp. and 1,500 kw. generating capacity, in Corliss d.c. machines and motor generation a.c. machines, and to make minor repairs. Applicants must have had at least four years of general power-plant experience, of which at least one year must have been in responsible charge. Each completed year of a mechanical-engineering course in a college or technical school of recognized standing will be accepted as equivalent to not more than nine months of general power-plant experience. Applicants should apply for form 1800, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.; to the Secretary of the United States Civil Service Board, West Point, N. Y., or Custom House, New York, N. Y. Applications must be filed with the Civil Service Commission, Washington, D. C., prior to the hour of closing business on Jan. 4, 1921.

Overheard at the A. S. M. E. Convention

"Well, well, this doesn't look much like the old Thirty-First Street quarters, does it? Do you remember the way we used to drop in there in the morning after a night on the zigzag and breakfast at the Murray Hill and tell Miss Parker, or Frank Hoadley or Robert that we wanted a room, thereby setting our expense account back a whole dollar? That reading room certainly was about the quietest and coziest place in New York to look up information in. And if I remember rightly we felt that with our few hundred membership we were doing some pretty good things and had a pretty important organization even if we hadn't as yet begun to rob the cradle. 'Member the dances at Sherry's and the night when the Admiral danced three times with the missus and you were going to sue the United States Navy? That punch certainly did have a good deal to answer for. Of course I suppose things are all right as they are now, but I really would like to drop into the little back room of the old Engineers Club on the avenue and have a little—yes, dear, yes, I'm coming right along. So long, Bill, see you later."

Wages for Government Employees

In the revised Reclassification Bill, which is now under preparation, it is understood that the following basic rates have been agreed upon for power-house employees in the Government service: Power-plant, central-station, service-station, or pumping-station engineman, $1,680 per annum hoisting engineman, $1 per hour; supervising engineman, $1,920 to $2,160 per annum; assistant chief engineman, $2,280 to $2,520; chief engineman, $2,700 to $3,060; fireman and assistant electric substation operator, $1,200 to $1,300; portable boiler fireman, $1,260 to $1,380; boiler cleaner, $1,320 to $1,440; oiler, water tender, assistant gas-engine operator, $1,380 to $1,500; assistant engineman, $1,680, and gas engineman, refrigerator engineman, $1,680 per annum.

How the A. S. M. E. Boiler Code Works in Ohio

Out of about 20,000 boilers in use in the State of Ohio there were but three explosions in the fiscal year ended June 30, 1920. The cause of failure in one of these cases was the punching and drifting of rivet holes in the construction of the boiler; this practice was permitted at the time this boiler was built, but has since been prohibited in Ohio. Another explosion was due also to careless construction, made possible by incorrect design; the Ohio Board of Boiler Rules is taking steps toward the elimination of this particular type of boiler by the reduction of its safe working pressure. A third explosion resulted from the use of a boiler that had not been inspected and was used in violation of the Ohio boiler inspection law. If this boiler had been properly inspected safety devices would have been insisted upon that would have prevented the explosion.

These facts are set forth in the annual report of the Division of Boiler Inspection of the Industrial Commission of Ohio. It may be mentioned in this connection that the State of Ohio has adopted the A. S. M. E. Boiler Code and has made it a part of its boiler-inspection laws.

A. A. E. Growing Rapidly

The results of the membership campaign recently conducted by the American Association of Engineers, now officially tabulated, show that 3,735 applications were received during the drive lasting from Sept. 15 to Oct. 30. In addition more than the usual number of applications has come in since the campaign, owing to the impetus of the drive. The membership on Dec. 8, 1920, was 23,004. The association now has 240 chapters and clubs and maintains offices in thirteen cities: New York, Washington, Pittsburgh, Boston, Detroit, St. Louis, St. Paul, Omaha, El Paso, San Francisco, Los Angeles, Seattle and Portland. It has state assemblies in ten states: Nebraska, Montana, Ohio, Washington, California, North Carolina, Illinois, Arizona and Tennessee, and state chapters have been established in Nevada, North Dakota, Minnesota, Idaho and Oregon.

The paper on "The Constitution and Properties of Boiler Tubes," which was abstracted in Power for Dec. 14, has been revised by its author. Inasmuch as a mistake mentioned by him was carried into the abstract, its correction is noted here. In the 19th line of the article as it appeared in *Power*, the phrase "sodium carbonate" should be changed to "calcium carbonate."

New Publications

STUDY OF THE RELATION BETWEEN THE BRINNELL HARDNESS AND THE GRAIN SIZE OF ANNEALED CARBON STEELS. Bureau of Standards Scientific Paper 397. By H. S. Rawdon and Emiles Jimeno-Gil.

This paper deals with material and methods, microscopic examination, hardness determination and growth.

CRANES DIRECTORY OF CLASS, TRADE AND TECHNICAL PUBLICATIONS AND MARKET DATA BOOK. Published annually by G. D. Crane, Jr., 417 South Dearborn St., Chicago, Ill. About 500 pages, cloth binding. Price, $5; in advance of publication, $3.75.

This is the first edition of the book and is still on the press. It lists all the business publications of the United States and Canada, giving circulations, rates, type-page sizes, closing dates, etc., and makes a market analysis of each trade, profession and industry. The book is designed to be of value to advertisers and readers of trade and technical papers.

COAL-SAVING IN THE CHEMICAL INDUSTRY. By David Brownlie. Reprinted from *The Chemical Trade Journal and Chemical Engineer* for August-September, 1920, by Brownlie & Green, Ltd., technical chemists and engineers, 2 Austin Friars, London, E. C. Paper; 15 pages, 8½ x 11 in. Price, 2s. 6d.

This pamphlet gives the results of investigation that have been carried out by its author through a period of about nine years in the steam-boiler plants of sixty chemical works in Great Britain. The writer points out that the net working efficiency of these sixty plants is only about 58 per cent, and he believes that this could be easily increased to about 72½ per cent. Results of a number of tests are given, and explanation is made of various methods of scientific control of boiler plants.

SLUSHING OILS. Technologic Paper No. 176, prepared by Percy H. Walker, chemist, and Lawrence L. Steele, associate chemist of the Bureau of Standards of the United States Department of Commerce. Paper binding, 23 pages, 7 x 10 in.

This booklet contains the results of experiments recently conducted by the Bureau of Standards, both in the nature of laboratory tests and exposure tests. The report shows that laboratory tests cannot be relied upon in every instance, but that they are valuable in certain cases. Requirements for slushing oils which are to be used for different purposes are discussed, and suggestions are given for easily made and effective mixtures. The booklet may be obtained by remitting 5 cents to the Superintendent of Documents, Government Printing Office, Washington, D. C.

PROCEEDINGS OF THE ANNUAL CONVENTION OF THE I. R. A. A.

Published by the Industrial Relations Association of America. A verbatim report of addresses and discussions heard at the annual convention, which was held in Chicago May 19-21, 1920. It should be of value to anyone who is strongly interested in the relations of capital and labor. Copies may be obtained from the Administrative Offices of the association in Orange, N. J.

SAFETY IN THE MACHINE SHOP

Prepared by the Travelers Insurance Co., Hartford, Conn 188 pages, 6 x 9 in., paper bound Sent without charge to anyone making a request for it to the Supply Department, Travelers Insurance Co., Hartford, Conn. This booklet is exceptionally well gotten up and treats in considerable detail of the prevention of accidents in the machine shop. It deals with plants both large and small and gives concrete suggestions for the safeguarding of workers in them. Four chapters of especial interest deal with infection from cutting oil, injuries from the use of hand tools, illumination and its bearing on accidents, and the employment of women. The book should be useful to anyone who is in responsible charge of machine tools.

Personals

L. K. Sillcox has been advanced from the position of assistant general superintendent to that of general superintendent of motive power of the Chicago, Milwaukee & St. Paul Railway Co.

F. K. Copeland, president of the Sullivan Machinery Co., Chicago, Ill., has been named new national councillor of the Compressed Air Society of New York, to represent it in the Chamber of Commerce of the United States.

Harry N. Winner, formerly with the Johns-Manville Co. and for 17 years prominent in the Garlock Packing Co., has taken a position with the United States Rubber Co. as manager of the packing department, with offices at 1790 Broadway, New York City.

James T. Whittlesey, a graduate of Yale University and for twelve years chief engineer of the Public Service Electric Co. of New Jersey, has been appointed director of a new Pacific Coast branch of the Engineering Business Exchange, of New York City, with offices in the Chas. Spreckels Building, San Francisco.

A. W. K. Billings, of Barcelona, Spain, is making a brief business trip in the United States. Since 1912 he has been engaged in the extensive hydro-electric and other work of the Barcelona company, successively as manager of construction, managing director, vice president and consulting engineer. During the war he served with distinction in charge of naval aviation construction in Europe.

T. H. Ceperley, who for the past twelve years has been chief operating engineer of the power and substations of the Albany Southern R.R., has resigned his position on account of ill health. He will spend the winter in the South and will enter the electrical field again next spring. Mr. Ceperley was formerly with the Newburgh Light, Heat and Power Co. as chief engineer of the Newburgh plant, and was also with the Fonda, Johnstown & Gloversville R.R., in the same capacity.

Society Affairs

Cleveland Section, A. S. M. E., will meet Jan. 4 in the Hotel Statler to hear an address on "Recent Developments and Modern Tendencies in Machine Design," by A. L. De Leeuw.

St. Louis Section, A. S. M. E., will meet at the American Hotel on Jan 7. Fred Key, of the Key Boiler Equipment Co., will speak on "The Key Safety Handhole Cap for Water-Tube Boilers."

Waterbury Branch, A. S. M. E., will meet Jan. 3 in the Chase Co.'s Office Building, Waterbury. Captain Harry George will speak on "Mining Experiences of a Prospector," and moving pictures will be shown of the manufacture of Byers wrought-iron pipe.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will hold a meeting on Jan. 8 at which P. T. Vanderwaart, electrical engineer of the New Jersey Zinc Co. of Pennsylvania, will discuss "Power Factor Correction and Its Relation to Plant Operation."

Trade Catalogs

The M. H. Detrick Co., 155 East Superior St., Chicago, has issued an 8-page folder showing installations of its arches with Type "E" and Coxe Stokers. Layouts with leading makes of boilers are shown by pictures and diagrams.

The Consolidated Belting Co., Philadelphia, Pa., has brought out a new 24-page 6 x 9-in. catalog of "Hycalibre" belting. The usual specifications are given, together with practical hints and formulas to be used in ordering and applying belts. It is also announced in this catalog that the company can renovate worn-out belts at a nominal cost.

The Brown Hoisting Machinery Co., Cleveland, Ohio, is distributing its Catalog "K" for 1921, of electric and steam-driven cranes. This is an 88-page, 8 x 11-in. booklet containing an unusually large number of good photographs depicting "Brownhoist" locomotive cranes for loading and unloading cars, excavating, handling ore, stone, sand, lumber, etc., and general use up to about twenty-seven tons.

The Illinois Stoker Co., Alton Illinois, has published a 50-page 10 x 7-in. catalog on natural-draft and forced-draft mechanical stokers and Illinois arches. It contains a discussion of "Boiler and Furnace Efficiency" in which there are carefully worked-out diagrams; this section, together with the thoroughness with which the booklet goes into the subject of combustion control, gives it a value distinct from its function as a catalog.

COAL PRICES

Current mine quotations, with interesting comparisons, are given in the following tabulation:

	Nov. 1919*	Aug. 5 1920	Dec. 16 1920	Dec. 23 1920
Pittsburgh steam	$2.30	$10 00	$3 25	$3 75
Pittsburgh screened gas	2 30	12 00	3 75	4.50
Hocking	2 50	9 00	3 00	3 75
Franklin, Ill	2 35	6 50	3 40	4 00
Indiana 4th vein	2 35	7 50	3 25	3 25
Eastern Ohio, No. 8	2 35	10 50	3 40	4 00
Fairmont	2 50	13 50	3 00	3 75
Kanawha	2.60	14.00	3 50	4.50
S. E. Kentucky	3 00	10 50	4 00	4 75
Western Kentucky	2 35	5 25	3 75	4 00
Clearfield	2 95	12 00	3 75	4 75
Cambria and Somerset	2 95	13 50	4 75	6 00
New River	2 70	14 00	5 00	5 00
Pocahontas	2 35			

*Government prices.

New Construction

PROPOSED WORK

Mass., Charlestown (Boston P. O.)—J. Rogers, Agt., 18 Tremont St., Boston, is having plans prepared for a 7 story industrial building on City Sq., here. About $300,000. F. O. Lewis, 30 Broomfield St., Boston, Archt. and Eng.

Mass., Holyoke—The School Bldg., Comn. is having plans prepared for a 3 story junior high school on Maple St. About $300,000. G. P. B. Alderman & Co., Alderman Bldg., Archt.

Mass., Holyoke—The School Comn. plans to build a 2 story grade school. About $250,000. Archt. not selected

Conn., Hartford — Our Lady of Sorrows Church, Rev. H. Galvin, pastor, 85 New Park Ave., had plans prepared for a 75 x 170 ft. church including a steam heating system. About $250,000. O'Connell & Shaw, 18 Boylston St., Boston, Mass., Archts.

N. Y., Brooklyn — The New York Telephone Co., 15 Dey St., New York City, had sketches prepared for a telephone exchange including a steam heating system, on Willoughby Ave., here. McKenzie, Voorhees & Gmelin, 1123 Bway., New York City, Archts. and Engrs.

N. Y., Rochester — Gordon & Kaelber, Sibley Block, will soon award the contract for a 9 story apartment hotel including a steam heating system on East Ave. J. A. Armstrong, 127 North Dearborn St., Chicago, Ill., Archt.

N. J., Trenton—The Sanitary Ice & Coal Co., Old Rose St., plans to build an ice cream storage plant and install equipment in same. W. B. Maddock, 42 Division St., Pres.

Pa., Raven Run—J. S. Wentz Co., Markle Bldg., Hazleton, plans to build a coal breaker here, inclding a boiler plant. About $150,000. G. S. Troutman, Markle Bldg., Hazleton, Archt. and Engr.

Md., Baltimore — S. T. Williams, 223 North Calvert St., is in the market for one 400-hp., three-phase, 60-cycle, 2,300-volt, about 600 r.p.m., electric motor

Md., Baltimore—The Potomac Power & Development Co., c/o W. H. Stineman and A. M. Quick, Engrs., 418 Equitable Bldg., had preliminary plans and surveys made for the development of a project to include a dam, 1,200 ft. long and 65 ft. high and a main dam, 1,200 long and 22 ft. high; a 20,000-hp. power plant including the installation of five 5,000-hp. vertical turbines, generators, also a three-phase, 60-cycle, 13,200,-volt transmission line; a 30,000-hp. power plant including installation of five 700-hp. vertical turbines, and generators; flood gates, 18 x 30 ft., etc.

Md., Crisfield—The McCready Memorial Hospital, c/o G. F. Fyle and A. G. Brown, Archts., 109 North Dearborn St., Chicago, Ill., plans to build a hospital here, including a 42 x 45 ft. power house. About $200,000.

W. Va., Charleston — Kanawha County plans to build a county jail at Court and Virginia Sts. About $300,000. H. R. Warne, Masonic Temple, Archt.

N. C., Hickory—The Catawba Creamery Co. plans to rebuild packing plant and refrigerating rooms of creamery plant recently destroyed by fire. About $300,000.

Ga., Augusta — The Y. M. C. A., Green and 9th Sts., plans to build a 4 story Y. M. C. A. building. About $300,000. Murphy & Dunn, 331 Madison Ave., New York City, Archt., Y. M. C. A. Building Comn., Augusta, Engr.

Ga., Sandersville—The city plans to improve power house. About $40,000.

Ga., Tybee Island—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build 2 or more radio buildings here.

Fla., Gainesville — The city voted $30,000 bonds for improvements to the municipal light and power plant.

La., New Orleans — The International Harvester Co., 606 South Michigan Ave., Chicago, Ill., plans to build a storage warehouse for the manufacture of twine and farm implements. Est. cost, between $3,000,000 and $6,000,000.

Tenn., Millington — The town plans an election to vote on $20,000 bonds for a new electric light and power plant.

O., Cleveland—The Bd. Educ., c/o F. G. Hogan, East 6th St. and Rockwell Ave., is having plans prepared for a 2 story addition to school, including a steam heating system, at East 146th St. and Kinsman Rd. About $250,000. W. R. McCormack, East 6th St., Archt.

O., Portsmouth—The Bd. Educ. plans to build a 3 story, 110 x 130 ft. high school including a steam heating system. About $400,000. A. Pretzinger, 1155 Reibold Bldg., Dayton, Archt.

O., West Park—The Bd Educ., F. W Featherstone, Clk., is having preliminary plans prepared for a 2 story school including a steam heating system in the Lenox Park district. About $250,000. Fulton, Taylor & Cahill, 8120 Euclid Ave., Cleveland, Archts.

Ind., South Bend—The Fraternal Bldg Assn., C. Bell, Pres., plans to build a 6 story, 75 x 95 ft. fraternal building including a steam heating system at 109 East Wayne St. Freyermuth & Maurer, 308 South Michigan St., Archts.

Mich., Eloise — McFarlan, Maul & Lenz, Archts., 1259 David Whitney Bldg., Detroit, will receive bids until Dec. 31 for a 3 story, 100 x 200 ft. hospital and home including a steam heating system here, for the Wayne Co. Poor Board, c/o E. J. Jeffries, 1804 West Gd. Blvd. About $300,000.

Mich., Grand Rapids — The Catholic Central High School plans to build a 4 story high school including a steam heating plant. About $[illegible]. H. L. Mead, Archt.

Mich., Wakefield—The city had plans prepared for a 2 story memorial building. About $250,000. Herbst & Kuenzli, Caswell Blk., Milwaukee, Wis., Archts.

Ill., Chicago—A. Bath, c/o A. Chervatt, Archt., 3611 Millard Ave., had plans prepared for a 3 story, 40 x 125 ft. ice plant. A steam heating system and ice making equipment will be installed in same. About $80,000.

Ill., Chicago—The West Chicago Park Comrs., West Chicago Ave., will receive bids until Dec. 31, for 1 story, [illegible] x [illegible] ft. social center building including a steam heating system. About $[illegible]. Chatten & Hammond, 64 East Van Buren St., Archts.

Ill., Chicago — McCormick Estate, c/o Holabird & Roche, Archts., 104 South Michigan St., is having plans prepared for a 3 story, 101 x 135 ft. top addition to office building at 11 South La Salle St. including a steam heating system. About $1,250,000.

Wis., Taycheedah — The State Bd. of Control, Madison, will receive bids until Jan. 11 for furnishing equipment for the Industrial Home for Women here, including two 50-kw. d.c. engine type, 230 volt generating sets with duplicate balancer sets of 10-kw. each; switchboard and distribution system; two 600-hp. open type feed water heaters; two hot water converters, each for 20,000 sq.ft. of radiation, two boiler feed pumps; two hot water circulating pumps; two turbine-driven centrifugal circulating pumps, 300 g.p.m., 150 ft. head, or two direct-acting steam pumps, same service, etc. A. Peabody, Capitol, Madison, Engr.

Minn., Crookston — The Sisters of St. Benedict, c/o Bishop T. Corbett, plan to build a women's college. About $700,000. Archt. not announced.

Minn., Duluth — The Miller Memorial Hospital Board, Mayor T. W. Hugo, Chn., plans to build a 3 story, 100 x 200 ft. hospital including steam heating plant and mechanical ventilating system on 5th Ave. About $250,000. German & Jenssen, Exchange Bldg., Archts. and Engrs.

Minn., Litchfield—The Bd. Educ., J. T. Mullen, Clk., plans to build a 2 or 3 story high school including a steam heating system. About $300,000. Archt. not announced.

Minn., Minneapolis—The Bd. Educ., G. F. Womrath, Bus. Supt., 305 City Hall, is having plans prepared for two 2 or 3 story junior high schools including a steam heating system, at 6th St. and 13th Ave. and at 28th Ave., S. and 41st St. About $700,000. E. H. Enger, above address, Archt.

Minn., St. Paul—H. D. Loeb, 30 North La Salle St., Chicago, Ill., plans to build a 3 and 4 story, 100 x 157 post office here, including a steam heating system. About $750,000. J. P. Cowing Engr. Co., 30 North La Salle St., Chicago, Ill., Engr.

Kan., Wichita—The Midian Shrine, c/o Col. T. G. Fitch, Trustee, plans to build a 2 story, 200 x 200 ft. temple at 1st St. and St. Francis Ave. About $1,000,000. Archt. not selected.

Neb., Hastings—Hastings College is receiving bids for a 3 and 4 story, 80 x 190 ft. memorial hall including a steam heating system. About $400,000. Miller, Fullenweider & Dowling, 6 North Michigan Blvd., Chicago, Ill., Archts.

S. D., Watertown — The Bd. Educ., A. Herzel, Clk., plans to build a 2 or 3 story high school including a steam heating system. About $250,000. Archt. not selected.

Mo., St. Louis — The Mississippi River Commission, c/o Secy., 1311 International Life Bldg., will receive bids until Jan. 17 for furnishing 6 return-flue boilers for steamboat. Further information may be had on application.

Tex., Fort Arthur — The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received bids for an operating building and tower at the Naval Radio Station here from Hyde & Easter, 1311 G St. N. W., Wash., D. C., $8,[illegible], 150 days; W. F. Martens, [illegible] Franklin St., Rochester, N. Y., $[illegible],188, 100 days; Rosen Constr. Co., [illegible] East Lexington St., Baltimore, Md., $9,988, 120 days. Noted Nov. [illegible].

Tex., San Antonio — The Hot Wells Mineral Bath & Hotel Co., South Presa St., plans to build a dam for the development of 140 hp. Four turbines and other equipment will be required.

Okla., Tulsa—D. Hunt, c/o Hunt Co., 311-313 South Main St., is having plans prepared for a 10 story, 50 x 140 ft. office building. About $150,000. W. D. Vansielen, 319 South Detroit St., Archt., A. F. Waseidewski, 1319 South Cheyene St., Engr.

Col., Denver—Bennett & Meyers, Tabor Bldg., has purchased site at Bway., East 17th Ave. and Lincoln St. for a hotel. About $5,000,000. Archt. not selected.

Wash., Ocean Park — The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build a radio building here.

Ore., Astoria—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build a raido building here.

Cal., Pasadena—C. W. Komer, Gen. Mgr. of the municipal light plant, announces that enlargements for the coming year will cost $300,000. The initial unit will include a boiler and appurtenances to cost about $50,000.

Cal., Pittsburg — The Contra Costa County Bank will receive bids until March 1 for a 1 story, 50 x 100 ft. bank at 4th St. and R.R. Ave. A heating system including a low pressure gas burning boiler will be installed in same. About $85,000. B. G. McDougal, 381 Bush St., San Francisco, Archt.

Cal., San Francisco—The Pacific Gas & Electric Co. applied to the Railroad Comn. for permission to issue $10,000,000 bonds to carry out its hydro-electric construction program, particularly for the Pit River projects of the Mount Shasta Power Corp., a subsidiary of the Pacific Company. It is also estimated that betterments and additions to the property of the Pacific Gas & Electric Company for the years of 1921 and 1922 will cost in excess of $20,000,000.

N. S., Halifax—The Nova Scotia Power Comn. plans to install 20,000 hp. for the benefit of this place and other municipalities and to develop additional power for the pulp and paper industry.

Ont., London—The Bd. Educ., c/o R. M. McElheran, Hydro Offices, is having plans prepared and will receive bids about Feb. 1 for three 2 story, 100 x 200 ft. high schools including steam heating systems. About $750,000. L. E. Carrothers, above address, Archt.

Ont., Tilbury — The Ontario Flax Co. plans to rebuild flax mill recently destroyed by fire causing loss of $75,000, and is in the market for machinery, engine, boiler, etc.

B. C., Prince George—C. Gordon, Pres. of Dominion Textile Co., 112 St. James St., Montreal, Que., is interested in a project which includes a pulp and paper plant to cost $6,000,000 and the development of water power on the Fraser River, here. Bids will soon be received.

CONTRACTS AWARDED

Mass., Lee—The Tayford Co., Inc., 154 Nassau St., New York City, has awarded the contract for a hydro-electric plant on the Housatonic River here, to H. W. Taylor, 154 Nassau St., New York City, at $150,000.

Conn., Meriden — The Home National Bank, 16 Colony St., has awarded the contract for a 1 story bank including a steam heating system to J. T. Fox & Co., Inc., 109 Main St., Springfield, Mass., at $350,000.

N. Y., Brooklyn — The Bureau of Yards and Docks, Navy Dept., Washington, D. C., has awarded the contract for the installation of a refrigerator for Building F at the Naval Hospital, here, to J. Mundet & Son Inc., 24 Stone St., New York City, at $12,[illegible].

N. Y., Brooklyn—The Y. M. H. A., c/o D. J. Rubinstein, 189 Montague St., will build an 8 story clubhouse, including a steam heating system, on South Rodney St. About $400,000. Work will be done by day labor.

N. Y., New York—The Consolidated Ship Building Co., 177th St., has awarded the contract for a 1 story, 35 x 35 ft. boiler house to Post & McCord, 101 Park Ave., at $15,000.

N. J., Bloomfield—C. F. Stiefel, 60 Orange St., has awarded the contract for a factory and power house to the White Constr. Co., 95 Madison Ave., New York City, at $80,000.

Pa., Philadelphia—The Amer. Ice Co., 6th and Arch Sts., has awarded the contract for a 2 story, 75 x 100 ft. ice factory to Monaghan & Losse, 3016 Chestnut St., at $120,000. Equipment for the manufacture of ice will be installed in same.

Ga., Trion—The Trion Co. will build a 3 story, 25 x 40 ft. power house addition. About $100,000. Work will be done by day labor. Noted Nov. 2.

O., Cleveland — Telling-Belle-Vernon Co., 3814 Cedar Ave., has awarded the contract for an 8 x 43 ft. boiler house addition to Uhl-Jaster Co., 1900 Euclid Bldg. One 200-hp. boiler will be installed in same. About $10,000.

O., Cleveland—Keith Theater Co., E. F. Alber, Mgr., 1564 Bway., New York City, has awarded the contract for a 20 story, 130 x 180 ft. theater and office building including a steam heating system at East 17th St. and Euclid Ave., here, to Lundoff-Bicknell Co., 5716 Euclid Ave., at $3,000,000.

O., Dayton — The City Comrs. have awarded the contract for installing heating and plumbing system in buildings on city workhouse farm to W. Haas Plumbing Co., 429 East 3rd St., at $29,875.

Ill., Dixon—The State Dept. of Pub. Wks. and Bldgs., Springfield, has awarded the contract for 2 hospitals here, including steam heating systems, to Simons & Dick, Bloomington, at $400,000.

Ia., Newton—The city has awarded the contract for a pump house including 2 motor-driven centrifugal pumps to A. Phelps Co., Knoxville, at $44,825.

Minn., Elk River—The Elk River Power & Light Co., M. E. Waterman, Secy., has awarded the contract for an additional unit at its power house to Siems, Helmers & Schaffner, 514 Guardian Life Bldg., St. Paul.

Cal., Santa Monica — The Santa Monica Ice Co., 12th and Colorado Aves., will build a 1 story, 32 x 50 ft. ice plant. About $8,000. Work will be done by day labor.

N. B., St. John—The Water Power Comn. has awarded the contract for dams on the Musquash River, 12 miles west of here, to the New Brunswick Constr. Co., at $248,000.

Ont., Chippawa — The Hydro-Electric Commission Toronto, has awarded contracts for transformers, electrical equipment, and other material needed in connection with power development here, to Westinghouse Co., Hamilton; Canadian General Electric Co., Peterboro; Allis-Chalmers Co. and John Englis Co., both of Toronto.

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